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Stimulus equivalence and exposure learning: a cross-disciplinary study of rapid vocabulary acquisition

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STIMULUS EQUIVALENCE AND EXPOSURE LEARNING:

A CROSS-DISCIPLINARY STUDY OF RAPID

VOCABULARY ACQUISITION

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CONTENTS

SUMMARY

Cognitive/developmentalists and behaviour analysts have developed parallel paradigms of relevance to the investigation of the exposure learning of vocabulary in three contexts: non-ostensive, ostensive, and fast mapping/exclusion. Researchers have claimed that young children are able to comprehend new words following a limited number of unreinforced exposures. However, methodological limitations of such studies render the researchers' conclusions equivocal: participants' accurate responses on comprehension tests may reflect false positive responses, and cognitive/ developmental researchers have failed to demonstrate that word-referent relations acquired are symbolic, and thus linguistic. The behaviour analytic stimulus equivalence paradigm provides a methodology for assessing the symbolic properties of such relational responding. The present series of studies thus investigates young children's exposure learning of equivalence relations in rigorously controlled conditions.

Study 1 investigated the exposure learning of a single new word-object relation; results highlighted the existence of false positive responding in such studies, and the necessity of exposing multiple relations. Studies 2 to 5 thus examined the exposure learning of two novel relations. Five children, aged 25 to 32 months, demonstrated the acquisition of word-referent relations following unreinforced non-ostensive, ostensive, or fast mapping/exclusion exposures; where tested, these children also demonstrated the derivation of symbolic -- equivalence -- relations. A history of conditional responding also facilitated some children's performances on subsequent test trials.

However, the majority of participants (17/22) failed comprehension and naming tests. Given the paucity of methodological control implemented by cognitive/ developmentalists these results were not unexpected and question claims made by such researchers regarding the efficiency of exposure learning.

CHAPTER 1

RAPID VOCABULARY ACQUISITION: COGNITIVE/ DEVELOPMENTAL AND BEHAVIOUR ANALYTIC EXPOSURE LEARNING PARADIGMS

The acquisition of vocabulary is one of the major accomplishments of the pre-school child. During their first 24 months, children proceed from being beginners in language acquisition to being sophisticated and efficient word learners. During the first year of life, the average normally developing child learns to comprehend and produce his or her first words; by the second year of life, he or she has a large receptive and expressive vocabulary, and is beginning to talk in short sentences (e.g., Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick, & Reilly, 1993; Nelson, 1973).

In the early stages of language development, there is a well documented dissociation between an infant's acquisition of his or her receptive and expressive vocabulary. Many studies have shown a difference between the age of onset of comprehension and production, and have found that the majority of normally developing children, aged between one and two years, understand many more words than they produce (e.g., Bates, Dale, & Thal, 1993; Bates, Bretherton, & Snyder, 1988; Benedict, 1979; Goldin-Meadow, Seligman, & Gelman, 1976; Harris, Yeeles, Chasin, & Oakley, 1995).

Bates (1993a) charted the course of language development in normally developing children aged between 16 and 30 months. She found that, for this period in general, comprehension outstrips production with the average child being able to comprehend 60 words yet produce only 10. Benedict (1979) found comparable results in a longitudinal study of children between the ages of 9 and 20 months. She found that the average child was able to comprehend 50 words before being able to produce 10. Further, when the infants were able to produce an average of 10 words, they were able to comprehend between 30 and 182 words. Benedict also found a temporal delay of approximately 5 months, on average, between the acquisition of 50 words in comprehension and the subsequent acquisition of 50 words in production. Although the pattern and rate of acquisition of receptive and expressive vocabulary differs between individual children, as is evidenced in the studies reported above, the dissociation between the onset and development of comprehension and production remains robust.

Beginning in the second year of life, there is a striking increase in children's vocabulary size, and a sudden acceleration in the rate at which children learn, and spontaneously use, new words (e.g., Bloom, 1973; Dromi, 1986; Goldfield & Reznick, 1990; Lifter & Bloom, 1989; Nelson, 1973). During this second year, normally developing children are in a predominantly receptive phase, during which the size of their receptive vocabulary accumulates at a faster rate, and with more stability across individuals, than their expressive vocabulary (Goldin-Meadow, Seligman, & Gelman, 1976; Lucariello, 1987; Oviatt, 1980). During this period, the rate at which children comprehend new words accelerates rapidly: at approximately 10 to 12 months, they begin to show evidence of comprehending individual words; between the ages of 18 months and 6 years, it has been estimated that average normally developing children learn to comprehend over 14, 000 words (Templin, 1957); this amounts to an average rate of acquisition of nine new words per day, or almost one per waking hour (Carey, 1978, 1982; Dromi, 1987).

This rate of lexical acquisition is such that it may seem implausible that each and every new word a child learns during this period is explicitly trained and directly reinforced by the verbal community. It also may seem implausible that there is a concomitant increase in reinforcement provided for children's appropriate responses during this period. How, then, can children learn so many new words in such a relatively short period of time?

Perhaps it is the case that children are able to acquire a large proportion of their vocabulary quickly and incidentally, in the absence of explicit tutoring and direct reinforcement for appropriate responding. They may be able to derive receptive vocabulary from social interactions in which they are merely *exposed* to new words and their referents (e.g., Stemmer, 1996; Whitehurst, 1996). This may arise, for example, in conversational contexts in which children hear adults use unfamiliar words and observe the corresponding referents (Carey, 1978). Even in situations in which children respond appropriately to an adult's utterance (e.g., looking at or selecting a referent labelled by an adult), perhaps direct reinforcement of their responses is not required in order for them to learn the correspondence between a new word and its referent (Whitehurst, 1996). Further, the accelerated rate of acquisition of new words during this period suggests that children are able to acquire new words following only limited exposure to them, perhaps after hearing them used only once or twice in an appropriate context (Woodward, Markman, & Fitzsimmons, 1994).

The studies that constitute this thesis are concerned with this question: are young children able to derive receptive vocabulary, or listener repertoires, from limited unreinforced exposures to novel stimulus relations (i.e., novel word-referent relations)? Independent yet parallel lines of research directly relevant to this issue have been conducted within two fields of psychology -- those of cognitive/developmental psychology and behaviour analysis. In cognitive/developmental psychology, research has focused on the investigation of children's rapid mapping of new words as a result of unreinforced exposures to these words and their corresponding referents. In behaviour analysis, research has focused on emergent behaviour, and has investigated how previously unrelated arbitrary stimuli become related without explicit instruction or direct reinforcement for appropriate responding. Despite the very different research traditions and philosophies, the paradigms utilised in both these fields have employed similar experimental methods. These have been, or may be, used to investigate the acquisition of word-referent relations following unreinforced exposures to novel stimulus pairings. Therefore, arguably, they have investigated the same phenomenon (Huntley & Ghezzi, 1993; Wilkinson, Dube, & McIlvane, 1996, 1998).

This chapter presents the paradigms and methodologies that have been employed in order to investigate such exposure learning. The chapter focuses on three paradigms that have been conducted concurrently in both cognitive/developmental and behaviour analytic research. In these, different types of unreinforced exposures to novel stimulus relations have been presented -- those of *ostensive*, *non-ostensive*, *and fast mapping* (cognitive/developmental) or *exclusion* (behaviour analytic) exposures. The convergence in experimental methods employed across the different research traditions is highlighted.

In Chapter 2, the limitations and weaknesses of these paradigms and procedures are discussed with particular reference to their failure to implement adequate control procedures. In particular, methodological criticisms that question whether the emergent performances shown by children in such studies demonstrate evidence of real word learning are outlined; the resulting methodological controls required in order to determine whether specific one-to-one mappings have been derived are presented.

In Chapter 3, a final fundamental and theoretical limitation of much of the research is discussed: even where controlled tests of word learning have been conducted, they fail to demonstrate that the novel relations acquired have any symbolic properties, and are thus specifically linguistic. The behaviour analytic *stimulus equivalence* paradigm is introduced as an experimental method for assessing symbolic responding, and its relevance to exposure learning paradigms is outlined.

Chapter 3 concludes with a presentation of the rationale for the experimental research that constitutes this thesis

* * *

The acquisition of new names is essentially the learning of relationships between two sets of stimuli; that is, the learning of relations between novel words and their corresponding referents (Rice, 1990). Both cognitive/developmental psychologists and behaviour analysts have employed experimental paradigms that have been, or may be, used to investigate how young children form these stimulus relations in the absence of an explicit history of reinforcement for doing so: they have studied receptive vocabulary acquisition in contexts in which participants are merely *exposed* to the pairings between novel words and their referents. Whitehurst (1979, 1996) argues that the acquisition of receptive vocabulary may arise from such observational learning episodes: when a child hears a new word, his or her response towards the corresponding referent, and the adult's subsequent reinforcement of this response, are not required in order for comprehension of the word to occur. A child needs only hear a novel word and see the corresponding referent in order to learn the new relation. Despite the differing research traditions and philosophies, the cognitive/developmental and behaviour analytic exposure learning paradigms have employed similar methodologies and research protocols. These paradigms are outlined below.

1.1. Cognitive/Developmental Paradigms

Cognitive/developmental psychologists have investigated children's learning of new word-referent relations in order to account for the apparent rapid acquisition of vocabulary during the second year of life. Due to the earlier onset of comprehension, the study of the acquisition of receptive vocabulary provides a sensitive measure, and enables an earlier assessment, of word learning in young children. The earliest words children tend to acquire are nominals -- labels for objects or events in the environment (e.g., Benedict, 1979; Gillham, 1979; Goldfield, 1993; Goldin-Meadow, Seligman, & Gelman, 1976; Nelson, 1973;) -- and thus the comprehension of object labels provides an early measure of lexical acquisition. Despite this, much of the research conducted on early language acquisition used tests of production as their measure of word learning (e.g., Nelson & Bonvillian, 1973; Goldfield & Reznick, 1990). The study of the acquisition of receptive vocabulary was neglected in early cognitive/developmental research as a result of the problems inherent in assessing comprehension in young children (Bates, 1993; Bricker, Vincent-Smith, & Bricker, 1973; Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987; Harris, 1997; Hirsh-Pasek & Golinkoff, 1996; Huttenlocher, 1974). However, in the last 20 years there has been an increase in research conducted on the acquisition of receptive vocabulary. Although these are still relatively few in number, cognitive/developmental psychologists since the late 1970s have begun to examine children's comprehension of new words in controlled experimental contexts. Amongst these is a body of research that investigates children's rapid mapping of new relations in contexts in which participants are given unreinforced exposures to novel words and their corresponding referents.

Much early word learning research has taken the form of naturalistic *lexical training studies* (e.g., Dollaghan, 1985; Dunham, Dunham, & Curwin, 1993; Oviatt, 1980, 1982). In such studies participants are initially introduced to a single new word and its corresponding referent -- the target relation. This is introduced as part of an ongoing dialogue, or game, that parallels early language learning situations; this initial stage forms the exposure or training phase of the study. Following this, participants are typically given further tasks or test trials in order to determine whether they have, as a result of the exposure trials, mapped the novel word and referent together. These tests ordinarily take the form of *multiple choice tasks* in which participants are requested to select a referent from an array of visual stimuli upon presentation of a corresponding word (e.g., they may be shown three familiar toys and requested to, "Find the X," where X is a familiar word corresponding to one of the toys in the array). In order to maintain a naturalistic context, participants are typically introduced to novel visual stimuli that consist of unfamiliar household objects (Woodward, Markman, & Fitzsimmons, 1994; Lucariello, 1987), unfamiliar children's toys (Dunham et al., 1993;

Baldwin, 1991, 1993a), or pictures of unfamiliar objects (Hutchinson, 1986); the novel auditory stimuli consist predominantly of the corresponding conventional names (Lucariello, 1987) or nonsense words or syllables (Baldwin 1991, 1993a; Dollaghan, 1985).

Lexical training studies employing these procedures have assessed the rapid acquisition of novel word-referent relations following three types of unreinforced exposure trials: *ostensive* exposures (Baldwin, 1993a; Dollaghan, 1985; Dunham et al., 1993; Oviatt, 1980, 1982; Woodward et al., 1994), *non-ostensive* exposures (Baldwin, 1991; Tomasello & Barton, 1994; Tomasello, Strosberg, & Akhtar, 1996), and *fast mapping* exposures (Carey & Bartlett, 1978; Hutchinson, 1986; Golinkoff, Hirsh-Pasek, Bailey, & Wenger, 1992; Mervis & Bertrand, 1994). Each of these paradigms, and the related performance outcomes, are outlined in detail below.

1.1.1. The Ostensive Paradigm

A number of lexical training studies have assessed children's mapping of novel word-referent relations following the presentation of unreinforced *ostensive* exposures (see Figure 1.1). Ostensive exposures are characterised by the introduction of a novel word and its corresponding referent simultaneously, in an episode of joint visual attention on the referent. Baldwin and Markman (1989) classify ostensive definitions as consisting of two fundamental components. The first is a non-verbal explicit indication of the referent of a new word -- the explicit direction of a child's line of regard towards the referent. This is achieved by singling out, pointing to, or touching the referent. The second component is the concurrent presentation of the corresponding word (i.e., labelling of the referent). Thus ostensive exposure trials are operationally defined as the presentation of a novel word at a time when the corresponding novel referent is perceptually present and indicated by the experimenter (Tomasello et al., 1996; see Figure 1.1).

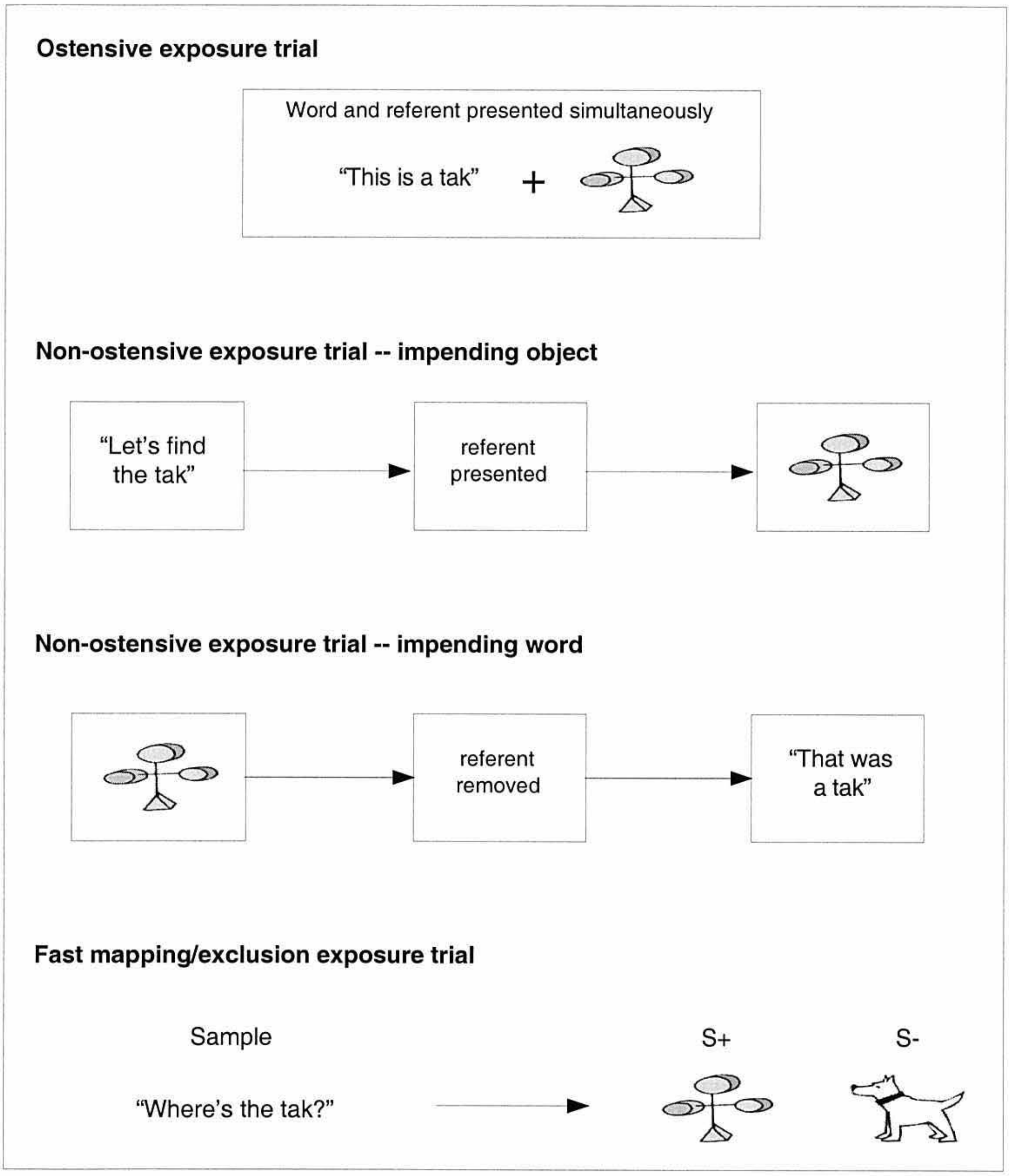

Figure 1.1. Exposure trial types employed in cognitive/developmental and behaviour analytic exposure learning paradigms.

It is generally assumed that ostensive definitions play an important role in young children's vocabulary acquisition (e.g., Baldwin & Markman, 1989; Stemmer, 1996). Baldwin and Markman (1989) argue that this is for two reasons. First, ostensive definitions provide explicit and directive information about a new word's referent, such that the pairing between the word and the referent is unambiguous. This is particularly important for infants who are unable to understand verbal definitions of new words. Second, such ostensive exposures occur frequently in early language learning situations: parents often provide ostensive definitions for children beginning when they are around nine months of age (Murphy, 1978; Murphy & Messer, 1977; Ninio, 1980). For example, during joint play or picture book reading an adult may indicate unfamiliar toys, or pictures of unfamiliar objects, and simultaneously name them: "Look, it's a X!" (where X is the corresponding word).

Although differing in procedural specifics, the studies outlined below have employed an ostensive paradigm (Au & Glusman, 1990; Baldwin, 1991, 1993a; Baldwin, Markman, Bill, Desjardins, Irwin, & Tidball, 1996; Chapman, Kay-Raining Bird, & Schwartz, 1990; Dollaghan, 1985; Dunham et al., 1993; Oviatt, 1980, 1982; Tomasello & Barton, 1994; Woodward et al., 1994) and have been conducted within the basic format of a lexical training study. This ostensive paradigm is as follows.

First, participants are presented with unreinforced ostensive exposures to a single novel word-referent (auditory-visual) relation -- the target relation (see Figure 1.1). Throughout this exposure phase, participants may also be introduced to novel *distracter* visual stimuli. These distracter stimuli may be presented and not commented on or referred to; alternatively, they may be presented and referred to in the same manner as the target visual stimulus, but in each instance they are not labelled with a novel word within the course of the study.

Second, following the exposure trials, participants are presented with a number of test trials in order to determine whether they have derived a mapping between the target novel stimuli. Typically, these are multiple choice tasks and comprise the following test trial types:

1. *Familiar test trials*. In these participants are requested to select a referent from an array of two or more familiar visual stimuli (i.e., referents to which participants have already assigned a stable name). These trials serve to ensure that participants possess the skills required in order to respond accurately on such multiple choice tasks

(e.g., the ability to attend to an auditory stimulus, and the ability to scan and select from and array of two or more visual stimuli).

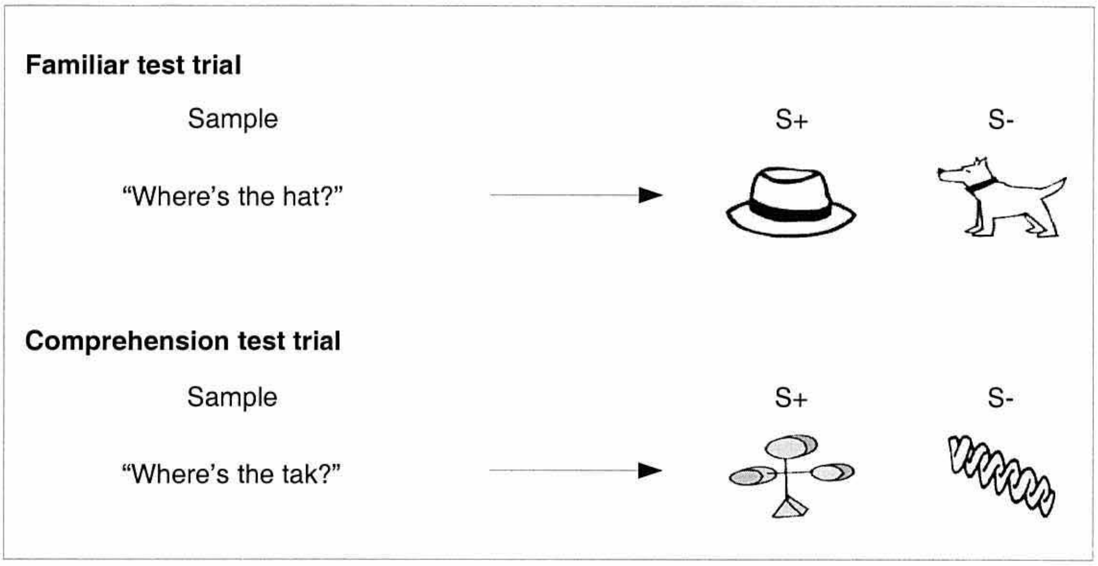

Figure 1.2. Test trial types employed in order to assess acquisition of the novel target relation in cognitive/developmental ostensive and non-ostensive exposure learning paradigms.

2. *Comprehension test trials.* In these participants are presented with the target visual stimulus and one or more novel distracter visual stimuli; the distracter stimuli may have previously been presented, but not labelled, during the exposure phase (Baldwin, 1991, 1993a; Baldwin et al., 1996; Chapman et al., 1990; Tomasello & Barton, 1994; Woodward et al., 1994). Where novel distracter stimuli have not been presented in the exposure phase, one or more novel visual stimuli that have not been encountered before in the context of the experiment are presented as distracter stimuli on these trials (Dollaghan, 1985; Dunham et al., 1993; Oviatt, 1980, 1982). In some cases, familiar visual stimuli are also presented in the visual array. On these trials, participants are requested to select the target referent upon presentation of the corresponding target word.

3. *Extension test trials.* In these participants are shown new exemplars of the novel target and distracter visual stimuli, typically of a different colour to the original

stimuli (Baldwin et al., 1996; Woodward et al., 1994). Again, participants are requested to select the target referent on these trials.[1]

In one of the earliest studies, Dollaghan (1985) gave participants, aged two to five years, one ostensive exposure to a single novel word-referent relation.[2] On a familiar test trial conducted following the exposure trial, all of the participants selected the correct referent, thereby indicating familiarity with the multiple choice task format. On the one comprehension test trial conducted subsequently, 81 percent of the participants selected the target object (from a visual array comprising this object, two novel distracter objects not encountered before in the context of the study, and a familiar object); the response accuracies of each age group of participants exceeded the 25 percent chance level.

Chapman, Kay-Raining Bird, and Schwartz (1990) conducted a similar study with participants aged two to six years. This differed from Dollaghan's procedure only in the presentation of a novel distracter object in the exposure trial. As a result of this, the array of objects on the comprehension test trial comprised the target visual stimulus, the distracter visual stimulus, a novel object not encountered before in the context of the study, and a familiar visual stimulus. In comparison to Dollaghan's (1985) study, 83 percent of the participants selected the target referent on the comprehension test trial; again, each age group of participants responded above chance level. Further, on a delayed comprehension test trial, conducted one hour later, 81 percent of the participants selected the target referent. Thus both Dollaghan (1985) and Chapman et

[1] Tests of elicited production and/or recognition of the target word may also be presented (e.g., Chapman et al., 1990; Dollaghan, 1985; Tomasello & Barton, 1994; Tomasello & Farrar, 1986; Whitehurst, Kedesdy, & White, 1982). However, the focus of the thesis is the acquisition of receptive vocabulary, and thus the research outcomes on only the test trials described above are reported.

[2] Although the study conducted by Dollaghan (1985) is often referred to as a fast mapping paradigm (e.g., Wilkinson, Dube, & McIlvane, 1998; Wilkinson & Green, 1998), it is actually an ostensive procedure. Participants were requested to manually select the target item in exposure trials; this is indeed similar to a fast mapping exposure trial. However, when the request was presented only the target object was perceptually available to the participants, and thus was not contrasted with a familiar referent. As the target referent was singled out when the corresponding target name was presented, the exposure trials employed in this study were thus ostensive.

al. (1990) claim to provide evidence of immediate comprehension of a novel word-object relation following a single ostensive exposure to these stimuli. Indeed Dollaghan (1985) concludes that "a single incidental exposure to the unfamiliar word and referent enabled a significant proportion of subjects . . . to identify the object in response to this label" (p. 453).

A number of more recent studies have assessed children's rapid mapping of a single novel word-object relation following two types of ostensive exposure trials (Baldwin, 1993a; Dunham et al., 1993). In these studies participants were presented with the target object and one or more novel distracter objects on exposure trials. The first exposure context was termed an *attention-following* (Dunham et al., 1993) or *follow-in labelling* (Baldwin 1993a) procedure. In exposure trials presented in this context, an experimenter looked at and labelled the target object when participants were already directing their focus upon it. In the second *attention-switching* (Dunham et al., 1993) or *discrepant labelling* (Baldwin, 1993a) context, an experimenter looked at and labelled the target object when participants were focused upon a distracter object; thus participants had to switch their attention to the target object. An attention-following strategy of ostensive definition, which does not require children to redirect their focus of attention, has been proposed to facilitate lexical acquisition (Akhtar, Dunham, & Dunham, 1991; Tomasello, 1988, 1992; Tomasello & Todd, 1983; Tomasello & Farrar, 1986).

This is indeed what Dunham, Dunham, and Curwin (1993) found. Eighteen month old participants were given an average of nine exposure trials in one of these ostensive contexts. Participants in the attention-following condition performed significantly better than participants in the attention-switching condition: 50 percent and 14 percent, respectively, responded correctly on a comprehension test trial. Overall (i.e., over both exposure conditions), 32 percent of the participants selected the target object on this trial. The modest numbers of participants responding correctly on the comprehension test trial may be a reflection of the complexity of the task: seven toys were present in the visual array on exposure and test trials. Further, Dunham et al. did not control the number of exposures presented and individual participants received between 1 and 20 exposures each.

Baldwin (1993a) conducted a similar study, with participants aged 14 to 19 months, in which only 2 objects were presented on both exposure and test trials -- the target object and a novel distracter object. Baldwin also controlled the number of exposure trials participants received: each participant was given four exposures to the target relation. Following the exposures, participants were given four familiar test trials and, in order to determine whether they had mapped the novel word and object, half were given four comprehension test trials. The participants' responses on the familiar test trials exceeded chance level, and thus indicated that they understood the nature of the test trials themselves. Their responses on the comprehension test trials, however, differed between the groups: the 14 to 15 month olds did not perform above chance level following either ostensive exposure trial type, and thus showed no evidence of having formed the word-object mapping; the 16 to 17 month olds performed above chance level following exposures presented only in the attention-following context (68 percent); and, in contrast to Dunham et al. (1993), the 18 to 19 month olds in this study performed above chance level on comprehension test trials following both ostensive exposure trial types. Over both exposure trial types, the 18 to 19 month olds selected the target object on 76 percent of their responses, demonstrating stronger above chance performance than the participants in Dunham et al.'s study. Thus Baldwin (1993a) claimed to have found evidence that normally developing children as young as are 16-17 months can comprehend a new word from as few as four ostensive exposure trials in an attention-following context; and by the age of 18 months they are able to benefit from unreinforced exposures presented in either ostensive context.

In a similar study, Baldwin, Markman, Bill, Desjardins, Irwin, and Tidball (1996, Study 2) gave participants, aged 18 to 20 months, ostensive exposures to a single novel relation in one of two contexts; these were termed *synchronous* and *asynchronous* condition, and paralleled those described above. However, these were presented in a simpler context in which a novel distracter object was initially presented, but was removed from view when the target object was labelled; thus the target object was the only one present when the corresponding target name was presented. In each condition the target object was exposed (i.e., labelled) six times. In comparison with the 18 month olds in the previous study, overall the participants responded above chance level on comprehension/extension test trials, selecting the target object on 63 percent of these trials. When considered separately, Baldwin et al. (1996) also found that "synchrony of labelling did not enhance the establishment of a mapping between novel label and target toy" (p. 3150); participants in both conditions responded above chance level on the comprehension/extension test trials.

In further studies, Baldwin (1991) and Baldwin, Markman, Bill, Desjardins, Irwin, and Tidball (1996, Study 1) also presented participants with ostensive exposures in a simple context: in both studies, although a distracter novel object was presented, it was removed from view when the target object was labelled, and thus the target object was the only one present when the novel label was provided. Baldwin (1991) found that, following four ostensive exposure trials, "infants as young as 16-17 months were able to map the novel labels to the correct objects" (Baldwin, 1991, p. 884); participants aged 16 to 17 months and 18 to 19 months responded above chance level on comprehension test trials, selecting the target object on 65 percent and 72 percent of these trials respectively. Baldwin et al. (1996) employed a similar procedure with participants aged 15-17 months and 18-20 months. The participants' performance on the comprehension/extension test trials, however, revealed a difference between the two age groups: whilst the older participants selected the target object on a mean of 77 percent of test trials (thus exceeding chance level), the younger participants, in contrast to Baldwin (1991), did so on only 53 percent of trials, a response accuracy that did not differ from chance.

Tomasello and Barton (1994, Study 2) found greater above chance performance with slightly older participants -- children aged two years -- who were given 16 exposures to a target relation (16 tokens of the target word said in eight pairs, each pair associated with one presentation of the target object). On two comprehension test trials, in which they were requested to select the target object when presented with this object and three novel distracters previously presented on exposure trials, 90 percent of the participants selected the target object thus demonstrating evidence of having mapped the novel stimuli.

In all the above studies, the youngest age group of participants to have passed comprehension test trials following ostensive exposures to a single target relation were aged 16 to 17 months (Baldwin, 1991, 1993a). However, in a more recent series of studies, Woodward, Markman, and Fitzsimmons (1994) claim to have shown that children aged 13 months and above demonstrate immediate comprehension of a new word following ostensive exposure trials. In each of Woodward et al.'s studies, participants were given nine exposures to a target word-object relation; they were also given equal exposure to a novel distracter object which was commented upon and referred to in the same manner as the target object, but was not labelled.

In the first study, 13 and 18 month old participants were given six test trials. These comprised three familiar test trials and three comprehension/extension test trials. Although both groups of participants performed above chance level on familiar test trials, only the 18 month olds performed significantly above chance on the comprehension/extension test trials (they responded with 76 percent accuracy on these trials). Woodward et al. argue that the 13 month olds failed to pass the comprehension test because of the complexity of the task itself.

In order to provide a more sensitive assessment of word learning, a second study was conducted in which the 13 month olds were given identical exposure trials but a simplified testing procedure was employed: the number and type of test trials presented were limited, and the test trial types were presented in discrete blocks as opposed to being interspersed among each other in the first study. On this simplified testing procedure the 13 month old participants now responded significantly above chance level on the comprehension/extension test trials (64 percent accuracy). In a third study, in which a simplified testing procedure was again employed, the 13 month olds also demonstrated evidence of having mapped the target word and object; again they exhibited modest, but significantly above chance, responding on the comprehension/extension test trials (they responded with 63 percent accuracy on these trials).

In a fourth and final study, Woodward et al. (1994) imposed a 24 hour delay between the exposure and testing phases. Although this temporal delay was considerably greater than that imposed by Chapman et al. (1990), Woodward et al. also found that their participants responded as well on the delayed test trials as the immediate test trials. The 24 hour delay did not appear to affect the learning evidenced in the earlier studies: both the 13 and 18 month olds responded significantly above chance level selecting the target object on 67 and 77 percent of these trials respectively. Woodward et al. claim that their performance demonstrated the "ability to learn and maintain a new word-object mapping" as a result of a limited number of ostensive exposures to the target stimuli (1994, p. 563).

In an earlier study, Oviatt (1980) gave younger children -- aged 9 to 17 months -- 24 ostensive exposures to a novel relation; this comprised an unfamiliar live animal and its corresponding conventional name. The participants' directions of gaze and gestures towards the target referent were measured in response to comprehension questions. These were compared to a baseline rate of looking at, and gesturing towards, the target referent during a period of free play. Based on these criteria, only 2 of the 10 participants aged 9 to 11 months passed the comprehension tests; 6 of the 10 participants aged 12 to 14 months satisfied the criteria, and all 10 participants aged 15 to 17 months passed the comprehension tests.

Similarly, greater above chance performance was found by Au and Glusman (1990), who introduced participants aged between three and six years to a single new object which was labelled seven times with the corresponding target word. Following this, participants were given a comprehension/extension test trial. On this trial they were shown the target novel object, a new exemplar of the target object, and two novel distracter objects. In this study all of the 20 participants selected the target novel objects.

In summary, all of the above procedures employed an ostensive paradigm to introduce participants to a single novel word-referent relation. Although the ostensive exposure trials varied in procedural specifics, all of them explicitly indicated the target referent and simultaneously presented the corresponding target word. In addition, all the studies presented comprehension test trials in order to asses whether participants had formed a mapping between the target word and object. On these trials, participants were presented with the target novel visual stimulus, one or more novel distracter visual stimuli, and in some cases, additional familiar visual stimuli. The authors of these studies claim their results provide evidence of rapid word learning in young children. Specifically, they claim that normally developing children as young as 12 or 13 months of age (e.g., Oviatt, 1980; Woodward et al., 1994) and above are able to demonstrate both immediate and delayed comprehension of a novel word referent relation following a limited number of unreinforced ostensive exposures to the target stimuli.

1.1.2. The Non-Ostensive Paradigm

Much early word learning research focused on the acquisition of receptive vocabulary resulting from ostensive exposures. However, in everyday situations children may be introduced to novel word-referent relations in contexts in which ostensive input is not provided, that is, in *non-ostensive* contexts. Tomasello, Strosberg, and Akhtar (1996) argue that children learn the relationships between new words and their referents in a variety of situations. They consider ostensive definitions to be analogous to "mini language lessons" which are

> not representative of the contexts in which most children learn most of their words. Outside of Western middle class culture it is not always common for adults to stop what they are doing to point out and name things for young children. (1996, p. 158)

The authors go on to argue that children are capable of learning new words from non-ostensive exposures in which such ostensive definitions are not available. For example, children often hear new words in conversational contexts and within the flow of ongoing social interactions with adults (e.g., Tomasello et al., 1996; Tomasello & Barton, 1994). In fact, Tomasello et al. suggest that non-ostensive exposures are more frequent than is acknowledged in early language learning situations. As Tomasello and Barton argue, ostensive exposures are more frequent "only in psychological experiments and the homes of Western middle-class parents who are concerned that their children have large vocabularies in early development" (1994, p. 649). Despite this observation, there has been relatively little empirical research conducted examining children's vocabulary learning in non-ostensive contexts. Recently, however, procedures have been developed in order to investigate such issues. These exposure learning procedures, and the related performance outcomes, are outlined below.

In non-ostensive exposure trials the presentation of the target visual stimulus is manipulated by the experimenter such that it is singled out and directly indicated to participants; in this respect non-ostensive exposure trials are comparable to ostensive definitions. However, in contrast to ostensive definitions, non-ostensive exposure trials are operationally defined by the *successive* presentation of the target auditory and visual stimuli: the visual stimulus is *not* in the participants' view when the auditory stimulus is dictated. Thus there is a temporal delay between the stimulus presentations (see Figure 1.1). Non-ostensive exposure trials are conducted in one of two contexts which vary in the order of presentation of the related stimuli: the target visual stimulus is in the participants' view either *before* or *after* the presentation of the corresponding auditory stimulus. These two types of non-ostensive exposure trials have been termed *impending word* and *impending referent* procedures, respectively (Tomasello & Kruger, 1992; Tomasello & Barton, 1994).

The relevance of these two types of non-ostensive exposures to everyday situations is shown in the following examples, in which the word-referent relation "shoe" is novel to the child:

1. A child observes a parent placing a shoe in a cupboard. As the cupboard door is closed, he or she then hears the parent say, "I've put your shoe away."

2. Whilst looking for items of clothing, a parent may ask the child, "Where's your shoe?" Then, upon finding the shoe hidden in the cupboard, the parent removes it and reveals it to the child.

With similarity to the ostensive procedures described in Section 1.1.1, non-ostensive procedures have been conducted within the basic format of a lexical training study, and have, likewise, introduced participants to a single novel word-referent relation; in each study the target relation was a novel word-object relation. Thus in the typical non-ostensive paradigm, participants are given non-ostensive exposures to the target novel relation in an initial exposure phase. During this phase, participants are also introduced to novel distracter objects; these are presented and referred to in the same manner as the target object, but they are not labelled (i.e., not associated with a novel word throughout the study). Despite the distinction between the impending word and impending referent exposure contexts, studies of the acquisition of novel word-object relations employing a non-ostensive procedure have utilised only the latter exposure trial type.

Following this initial exposure phase, participants' mapping of the target relation is assessed by means of multiple choice tasks. These are identical to the test trials employed in ostensive procedures (see Figure 1.2) in which participants are given two, or three, test trial types:

1. Familiar test trials. In these they are requested to select a referent from an array of two or more familiar visual stimuli.

2. Comprehension test trials. In these they are presented with the target object and one or more novel distracter objects (this amount depends on the number of distracter objects introduced in the exposure phase) and are requested to select the target object.

3. Extension test trials. In these they are presented with a new exemplar of the target object (typically of a different colour to the original object) and one or more novel distracter objects, and are requested to select the target object.

In one of the earliest studies, Baldwin (1991) claims to have found evidence that children aged 18 to 19 months rapidly acquire new words in non-ostensive contexts. Participants were given four non-ostensive exposures to a single novel relation. In each exposure trial, participants were focused on a novel distracter object when the target object was labelled (this was in accordance with the original hypothesis); their attention was then manually directed to the target object which was revealed after the corresponding target word was presented. Participants' performances on the subsequent comprehension test trials indicated age differences: the 16 to 17 month olds responded below chance level (47 percent correct) whilst the 18 to 19 month olds responded above chance level with 66 percent accuracy. Baldwin (1991) therefore provided modest, yet significantly above chance, evidence that the 18 to 19 month old participants correctly mapped the target word and object following non-ostensive exposures.

Tomasello and Barton (1994, Study 2) gave participants aged two years non-ostensive exposures to a single novel relation. This was introduced in one of two impending referent contexts; these were employed in order to determine whether participants' prior knowledge of the impending referent would facilitate mapping of the target relation. In each exposure trial, participants were introduced to the target object and three novel distracter objects. In the *known* condition, participants were aware of the impending object which was to be revealed following presentation of the target name; in the *unknown* condition, participants were unable to anticipate the impending object. In both conditions, the exposures were conducted eight times such that participants received 16 exposures to the word-object pairing (16 tokens of the target word presented in pairs, each pair associated with one presentation of the target object).

In comparison to Baldwin (1991), Tomasello and Barton (1994) found weak, yet significantly above chance, evidence of mapping of the novel relation. Participants in both conditions responded above chance level on comprehension test trials: 50 percent (marginally above chance) and 70 percent correct in the known and unknown conditions respectively. The authors conclude that the participants demonstrated "excellent learning" in both conditions and that, surprisingly, prior knowledge of the impending object did not facilitate participants' performance on the subsequent comprehension tests.

In two similar studies, Akhtar and Tomasello (1996) and Tomasello, Strosberg, and Akhtar (1996, Study 2) investigated word learning following non-ostensive exposure trials in which the impending object was anticipated by the participants -- thus replicating Tomasello and Bartons' (1994) known condition. In both studies, the target object was labelled nine times (nine tokens of the target word dictated in triplets, each triplet associated with one presentation of the target object). Akhtar and Tomasello found that 75 percent of their two year old participants selected the target object on at least one of the two comprehension test trials conducted. Significantly above chance performance was also evidenced with younger children -- aged 18 months -- by Tomasello et al. (1996): 60 percent of the participants in this study selected the target object on at least one of the two comprehension test trials conducted.

Tomasello and Barton (1994, Study 4) also introduced participants, aged two years, to a single novel relation in one of two non-ostensive contexts. In both contexts, participants were presented with a target object, which was labelled nine times (corresponding with three presentations of the target object), and four novel distracter objects. In the *without search* condition, the target object was immediately revealed following presentation of the target word. In a more complex *with search* condition, the experimenter first revealed two novel distracter objects and then the target object following the presentation of the target word. Again Tomasello and Barton found weak but significantly above chance mapping of the target relation. In the two conditions respectively, 66.6 percent and 40 percent of the participants selected the target object on the comprehension test; there was no significant difference between the two groups' performance.

This study was replicated by Tomasello et al. (1996, Study 1) with younger participants aged 18 months. A simpler procedure was employed in which the number of novel distracter objects presented in the exposure phase was reduced to three. This resulted in only one distracter object being revealed before the target object in the with search exposure trials. In addition, the number of exposures to the target relation was doubled. In comparison to Tomasello and Barton (1994), the authors did not find a significant difference between the two groups' performance on comprehension test trials: 10/16 and 9/16 participants in each condition respectively selected the target object on at least one of the two comprehension test trials conducted; both of these response accuracies exceeded chance level.

In a similar procedure, Baldwin (1993b) found stronger evidence of learning with participants aged 19 to 20 months. (Note that Baldwin presented only one novel distracter object, and imposed a delay of 10 seconds between presentation of the target word and object.) Participants selected the target object on 70 percent and 67 percent of comprehension test trials[3] in contexts that paralleled the without search and with search conditions described above.

[3] Half of the participants in this study were given preference control trials. The significance of these trials, and the related performance outcomes, are discussed in Chapter 2.

In summary so far, all the above studies employed a lexical training paradigm in which participants were presented with non-ostensive exposures to a single target relation. Although varying in procedural specifics, participants were exposed to a novel word and object in an impending referent context. As in the ostensive paradigm, (described in Section 1.1.1), comprehension and/or extension test trials were conducted in order to determine whether participants formed a mapping between the novel stimuli. Results from these studies led authors to claim that normally developing children from 18 months of age (e.g., Baldwin, 1991; Tomasello et al., 1996) are able to demonstrate immediate comprehension of a novel word-referent relation exposed in a non-ostensive context. It still remains an open question, however, whether young children are able to comprehend new words exposed in a non-ostensive impending word context.

1.1.3. The Fast Mapping Paradigm

A third exposure learning paradigm -- the *fast mapping* paradigm[4] -- is often employed in cognitive/developmental research in order to investigate word learning following unreinforced exposures. This paradigm is so called because participants are given unreinforced fast mapping exposures to novel word-referent relations. Fast mapping exposures, like ostensive and non-ostensive exposures, have also been proposed to account for rapid word learning because they provide a means of acquiring new receptive vocabulary from contexts in which direct reinforcement for appropriate

[4] The use of the term "fast mapping" in cognitive/developmental literature can be confusing: it has been used to describe both a process and a procedure. Fast mapping has been referred to as a process whereby children are able to gain a quick, initial, and partial understanding of the referent of a new word following limited unreinforced exposure to the novel stimulus pair (e.g., Carey, 1978, 1982; Rice, 1990), and thus ostensive and non-ostensive procedures have frequently been included in such terms. However, "fast mapping" has also been referred to as a procedure whereby participants in lexical training studies are given fast mapping exposures to novel stimulus pairs in contrast to familiar word-referent relations. The term fast mapping is used in this context in this thesis: to refer only to research in which a *fast mapping procedure* has been employed.

responding is not provided (Mervis and Bertrand, 1993, 1994; Golinkoff et al., 1992, 1994).

Although fast mapping exposure trials involve the introduction of a new word-referent relation, they differ from both ostensive and non-ostensive exposure trials in that participants have to infer the referent of the new word themselves. The experimenter does not explicitly act upon the target visual stimulus: he or she does not explicitly indicate, single out, or direct participants' attention to the target referent. Rather, it is the participant himself or herself that identifies the target referent; this is because fast mapping exposures are characterised, specifically, by the introduction of novel word-referent relations in contrast to word-referent relations that are familiar to the child. These kinds of exposures are evident in early language learning circumstances and everyday situations in which children interact with adults in conversational contexts.

For example, a child may be shown a set of three objects, a cup, a saucer, and a spoon, two of which he or she is already able to name -- the "cup" and the "spoon". When the adult then says, "Look, there's a saucer," the child is able to look among the objects in view, find the saucer, and give it to the adult; he or she is able to do this by rejecting the familiar objects. The child is able to do this even though he or she has no prior experience of this object or word, and the adult has not pointed to, or singled out, the saucer.

As is shown in this example, in fast mapping exposures the relation between the word and its referent is not made explicit by the adult. Despite this, children are able to select the correct referent and in doing so they, in effect, expose themselves to the novel relation. Therefore exposure of the novel relations is dependent upon participants' identification of the correct corresponding referent. This is in contrast to ostensive and non-ostensive exposures in which the experimenter identifies the target referent for the participants. Thus selection of the correct novel referent in these situations indicates that participants have been exposed to the stimulus pairing; further, it may appear that they have formed a mapping between the novel auditory and visual stimuli. It is exactly these kinds of exposures that are presented in the fast mapping paradigm (outlined below) in order to assess whether such word learning is possible (see Figure 1.1).

Like the ostensive and non-ostensive procedures described earlier, the fast mapping paradigm is conducted within the context of a lexical training study. Multiple choice tasks (described in Section 1.1) are employed in which to present the fast mapping exposure trials. In order to parallel natural language learning situations, the procedures are presented within the context of a game or ongoing social interaction. Novel stimuli typically comprise unfamiliar objects (e.g., Golinkoff et al., 1992; Mervis & Bertrand, 1994) or pictures of novel referents (e.g., Hutchinson, 1986; Golinkoff, Shuff-Bailey, Olguin, & Ruan, 1995), and their corresponding conventional names (e.g., Hutchinson, 1986) or nonsense words or syllables (e.g., Golinkoff et al., 1992). As with the ostensive and non-ostensive paradigms, fast mapping studies have focused predominantly on the acquisition of a single novel word-referent relation; where additional relations have been exposed these have been introduced in succession over the course of the experiment, and have not been juxtaposed against one another (Wilkinson & Green, 1998). The fast mapping paradigm is as follows.

First, participants are typically presented with *familiar test trials* (in the context of a fast mapping paradigm these have been termed baseline or receptive matching trials). In these participants are requested to select a referent from an array of two or more familiar visual stimuli (i.e., visual stimuli to which participants have already assigned a stable name). These trials are conducted to ensure that participants are indeed familiar with the baseline relations. Further, they ensure that participants understand the nature of the basic multiple choice task itself (e.g., responding to an experimenter's request, scanning several comparison stimuli, and selection of a single visual stimulus in response to a corresponding auditory stimulus).

Second, participants are given *fast mapping exposure trials* in which they are introduced to the target novel relation within the established baseline of the familiar relations (see Figure 1.1). In these participants are presented with an array of visual stimuli comprising the target novel referent, and one or more familiar referents (i.e., referents to which participants have already assigned a stable name); the corresponding target novel word is then presented in a carrier phrase in which participants are requested to select the novel referent. This carrier phrase may include a linguistic contrast with a familiar word-referent relation, for example, "Give me the X. Not the Y, the X," (where X is the novel target word, and Y a familiar word, e.g., Carey & Bartlett, 1978).

Upon hearing the novel word, participants may infer a match between the novel auditory and visual stimuli. This may be achieved either by rejecting assignment of the new word to a familiar referent, which Markman (1989) has termed the principle of *mutual exclusivity* and Clark (1983, 1987) has termed the principle of *contrast*, or by searching out a visual stimulus that shares the feature of novelty with the new word, which Golinkoff et al. (1992, 1994) and Mervis and Bertrand (1993) have termed the *novel name - nameless category* (NNNC or N3C) principle. Whatever the basis for participants' responses on these trials, the behavioural outcome is the same: the selection of the correct corresponding novel target referent. This response tendency has been termed the *disambiguation effect* (Merriman & Bowman, 1989).

A participant's selection of the correct visual stimulus on fast mapping trials may be taken as indication that he or she has inferred a match between the target novel word and referent. The body of cognitive/developmental research published to date has suggested that fast mapping is a robust phenomenon: studies have shown that normally developing children over the age of approximately two years virtually always select the novel referent when presented with the corresponding novel word on fast mapping trials (Wilkinson & Green, 1998; Wilkinson et al., 1996, 1998). This body of research conducted with normally developing participants is outlined below.

The earliest studies of relevance to the fast mapping paradigm were conducted by Vincent-Smith, Bricker, and Bricker (1974) and Golinkoff, Hirsh-Pasek, Lavallee, and Baduini (1985); their observations established the foundations for the subsequent body of research conducted on fast mapping. Although these were not fast mapping studies per se, and thus differed in their intended hypotheses, they provided preliminary evidence of children's ability to form initial word-referent mappings on fast mapping trials.

Vincent-Smith et al. (1974) presented participants with fast mapping trials of novel word-object relations. On these trials the two groups of participants -- aged 20 to 24 months and 25 to 31 months -- showed a strong tendency to select the novel objects; both groups responded above chance level (selecting the correct referent on a mean of 8.32 and 9.14 out of 10 trials respectively). Similar effects were found by Golinkoff et al. (1985, cited in Markman and Wachtel, 1988; and Hutchinson, 1986) who found that participants aged 30 months selected the novel object on fast mapping trials in which an array of four visual stimuli were presented (i.e., the novel object and three familiar objects).

However, in contrast to procedures employed in the traditional fast mapping paradigm, both these early studies presented participants with corrective feedback and reinforcement for correct responses on fast mapping trials; thus their selection of the novel referents was explicitly trained. The convention in studies employing a fast mapping paradigm is to present unreinforced fast mapping exposure trials. It is these studies that have constituted the main body of recent fast mapping research, and that are relevant to the present thesis.

The earliest experimental study to include the term *fast mapping*, and designed specifically to investigate the acquisition of vocabulary as a result of fast mapping exposure trials, was conducted by Carey and Bartlett (1978). They introduced participants aged three years to one novel relation. On the single unreinforced fast mapping exposure trial presented, participants were requested to, "Bring me the chromium one. Not the red one, the chromium one," where the target word was "chromium" and the corresponding referent was the unfamiliar colour olive. All but one of the participants selected the corresponding novel referent on this trial.

The use of a new colour term as the target relation has been criticised (Dockrell & Campbell, 1986[5]; Rice, 1990); this is because the colour lexicon is considered to be complex and colour vocabulary emerges relatively late in childhood (Miller & Johnson-Laird, 1976). More recent studies, and those with younger participants, have thus centred on the acquisition of novel word-object relations.

One of these earlier studies was conducted by Hutchinson (1986). She presented participants, aged 14, 29, and 36 months, with 2 fast mapping trials of each of 5 novel word-picture relations (introduced successively). In order to demonstrate mapping of the novel stimuli in each relation, participants were required to respond correctly on both fast mapping trials of that relation. Based on this criterion, all three groups of participants performed above chance level. The results also indicated an improvement in performance on fast mapping trials with age: the 14, 29, and 36 month olds responded with 68 percent, 86 percent, and 95 percent accuracy respectively. Hutchinson concludes that "normally developing children as young as late 1 [sic] were able to rule out one object they already knew a word for, and correctly pick a novel object as the referent of a new word" (1986, p. 51). Similarly, Merriman and Schuster (1991) found that two and four year old participants were able to demonstrate

[5] Dockrell and Campbell (1986) presented participants aged three and four years with a single fast mapping exposure, to a new animal term, in a context similar to that of Carey and Bartlett (1978). However, the participants' performance on the fast mapping trial is not noted. One must assume that all of the participants selected the correct referent on this trial based on their continuation throughout the remainder of the study. This is also the case for Dickinson (1984) and Heibeck and Markman (1987).

immediate mapping of a new word and object; participants in both age groups selected the novel referents on fast mapping trials with an accuracy exceeding chance level.

In a similar study with older children, Markman and Wachtel (1988, Study 1) found three year olds to have a "striking tendency to select a novel object as the referent for the novel term [on fast mapping trials]" (p. 128). Participants were given one fast mapping exposure trial to each of six novel relations. Overall, they were found to select the novel object on 82 percent of these trials; this is significantly greater than chance and is consistent with the selection of the novel object on a mean of 4.9 out of 6 fast mapping trials. Au and Glusman (1990) also presented older participants -- aged three to six years -- with fast mapping trials. These differed from convention in that the familiar referent presented on the fast mapping trial was an object that had previously been labelled ostensively, by the experimenter, in the context of the study. Nonetheless, when shown this object and a target novel object (that had not been labelled), and presented with a nonsense word, the participants selected the novel object with an accuracy that exceeded chance level (94 percent selected the novel object on these trials). In a second study all 16 of their participants selected the correct novel object on the fast mapping trials.

Although these studies have claimed to find evidence that children aged two years and above can infer a match between novel words and referents on fast mapping trials, the evidence is inconsistent. Merriman and Bowman (1989) gave children, aged two, three, and four years, fast mapping exposure trials to eight novel word-object relations (introduced successively). The results indicated age differences in performance on these trials. The two year olds, who selected the correct novel object on 60 percent of the trials, did not respond above chance level; the three year olds performed marginally above chance level, selecting the novel object on 69 percent of trials; the four year olds, however, greatly exceeded chance level, selecting the novel object on 94 percent of fast mapping trials.

In a second study, with participants aged two, two-and-a-half, and three-and-a-half years, Merriman and Bowman found comparable results. Again the two year olds did not respond above chance level on fast mapping trials; the performance of the two older groups differed significantly from the two year olds, with both older groups responding significantly above chance level (77 percent and 85 percent selection of the novel objects). Merriman and Bowmans' results are comparable with those of Markman and Wachtel (1988), whose three year old participants performed better than the three year olds but not as well as the four year olds in Merriman and Bowmans' study. However, both these conflict with Hutchinson's (1986) and Merriman and Schusters' (1991) findings that children aged late one and early two years can select the novel object on fast mapping trials.

In a more recent study, Mervis and Bertrand (1994) gave participants, aged between 15 and 20 months, fast mapping trials of four novel relations. In contrast to Hutchinson's (1986) findings, only 50 percent of the participants demonstrated the inference of a mapping between the novel words and referents: of the 32 participants, 16 performed above chance level (producing a mean of 3.6 out of four correct responses). In a following longitudinal study, the 16 participants who initially failed to respond correctly on these trials were monitored biweekly. Upon showing evidence of a vocabulary spurt interval (operationally defined as the production of 10 new words in a two week interval) they were again administered the fast mapping trials. This time 12 of the participants now responded above chance level, producing a mean of 3.06 correct responses.

Golinkoff, Hirsh-Pasek, Bailey, and Wenger (1992) gave participants, aged two years, three fast mapping trials of each of two novel word-object relations. On each test trial, participants were presented with an array of four objects (in this respect this study is similar to those of Mervis and Bertrand, 1994, and Golinkoff et al., 1995). On these trials the participants demonstrated evidence of having mapped the target words and objects: they selected the novel objects significantly above chance, responding with 78 percent accuracy.

In summary so far, cognitive/developmental researchers have developed a third exposure learning paradigm in which participants are introduced to novel word-referent relations in the absence of ostensive input or direct reinforcement for appropriate responding. In contrast to the exposure contexts described earlier, fast mapping trials do not involve the manipulation or explicit indication of the target referent by the experimenter. Rather, participants identify the target referents by contrasting the novel stimuli with familiar word-referent relations. Participants' selections of the target referents on these trials may be taken to indicate that they have mapped the related novel auditory and visual stimuli together. Studies that have employed a fast mapping paradigm have shown that children aged two years and above can select the novel referents on fast mapping trials (Golinkoff et al., 1992; Hutchinson, 1986; Merriman & Schuster, 1991), thus possibly demonstrating immediate novel word-object mappings in the absence of direct reinforcement.

1.2. Behaviour Analytic Paradigms

As stated earlier, behaviour analytic researchers have developed parallel procedures and paradigms that are relevant to the study of the exposure learning of novel word-referent relations. In behaviour analysis, the research focus has not been directly upon word learning and the acquisition of vocabulary. Rather, the general framework has been the investigation of how arbitrary stimuli become related without explicit instruction or reinforcement -- the emergence or derivation of stimulus-stimulus relations that have not been directly trained. Further, in contrast to the group studies conducted within the cognitive/developmental tradition (described in Section 1.1), behaviour analytic studies typically employ single-case methodology. In the studies outlined below, individual participants' behaviours have been observed, recorded, and continually assessed over time (e.g., Huntley & Ghezzi, 1993; Kazdin, 1982).

The behaviour analytic research outlined below has employed *matching-to-sample procedures*. These are used in order to train, and test for the acquisition of, novel stimulus relations. Matching-to-sample procedures are similar to the multiple choice procedures employed in cognitive/developmental studies: on both matching-to-sample trials and multiple choice tasks, participants are presented with a *sample* stimulus and are required to select a corresponding (i.e., related) stimulus from an array of *comparison* stimuli. Typically, participants are initially, through matching-to-sample procedures, trained a series of conditional relations between novel stimuli. Throughout training participants' comparison responses produce feedback such that correct comparison selections are reinforced. Their subsequent acquisition of these relations, or the emergence or derivation of additional untrained relations, is then assessed through the use of matching-to-sample trials.

More recently, however, behaviour analytic studies have provided preliminary evidence which suggests that the acquisition of novel stimulus relations may occur as a result of mere *exposure* to pairs of arbitrarily related stimuli (Lipkens, Hayes, & Hayes, 1993). This evidence suggests that during the training phase, direct reinforcement for appropriate responding is not required in order for acquisition of the novel relations to occur. Therefore behaviour analytic researchers have, like cognitive/developmental researchers, developed procedures which may be used to investigate the exposure learning of novel word-referent relations.

As stated earlier, the focus of behaviour analytic research has not concerned the processes underlying natural vocabulary acquisition, and thus, unlike the cognitive/developmental paradigms, research has not been conducted in naturalistic social contexts. Instead, studies have typically been conducted in situations in which social interaction has been minimised, and test trials, for example, have been presented on computers with touch sensitive screens (Huntley & Ghezzi, 1993; Wilkinson et al., 1996, 1998). Further, such studies have not always used linguistically relevant stimuli in their investigations. Although these do not appear to be directly applicable to the study of vocabulary acquisition, their relevance is discussed below. A few researchers, however, have employed linguistically relevant stimuli in their investigations and these are thus ostensibly relevant to lexical acquisition.

The behaviour analytic paradigms of relevance to exposure learning have mirrored the cognitive/developmental paradigms described in Section 1.1. These are outlined below in three sections that directly parallel the cognitive/developmental literature presented earlier -- *ostensive* procedures, *non-ostensive* procedures, and *exclusion* procedures (the exclusion paradigm is procedurally similar to the cognitive/developmental fast mapping paradigm).

1.2.1. The Ostensive Paradigm

Although it was not the intended focus of their studies, Lipkens, Hayes, and Hayes (1993, Study 1) serendipitously uncovered preliminary evidence which suggests that young children can comprehend novel word-referent relations from ostensive exposure trials (see Section 1.1, and Figure 1.1, for a description of ostensive exposure trials). Further, their procedures were methodologically similar to the multiple choice procedures employed in cognitive/developmental ostensive paradigms.

Lipkens et al.'s (1993, Study 1) original intention was to train, and test for the acquisition of, novel arbitrary stimulus relations with a single participant -- Charlie -- aged 16 months at the start of the study. Lipkens et al. used linguistically relevant stimuli such that the trained and tested relations were novel word-referent relations; the novel target stimuli comprised pictures of prehistoric animals and corresponding nonsense names. Throughout the study, Charlie was given picture-name training trials (i.e., he was trained to produce a novel name when shown the corresponding novel picture), and was tested for acquisition of these relations with name-picture test trials (i.e., test trials assessed whether he was then able to select the correct novel picture when given a corresponding novel name).

Initially, Charlie was presented with pre-testing; this was in order to ensure that he possessed the prerequisite skills in order to successfully negotiate matching-to-sample trials. These pre-testing trials involved the presentation of auditory-visual matching-to-sample test trials, and free recall naming trials, of familiar word-referent relations. Charlie responded with 100 percent accuracy on these pre-testing trials.

Following pre-testing, Charlie was given picture-name training and name-picture testing of two novel target relations. On picture-name training trials, Charlie was trained, with reinforcement for correct responses, to produce a novel name upon presentation of the corresponding novel picture. On each trial, Charlie was presented with one of the (two) novel target pictures and was asked, "What is this?" If Charlie produced the correct name (either "Tak" or "Os") he received reinforcement. If he produced an incorrect name, or made no response, then reinforcement was not provided and the experimenter produced the correct name for him. The two novel relations were trained concurrently in this way such that each experimental session comprised equal numbers of training trials of both of the novel relations. (This diverges from the cognitive/developmental paradigms in which additional novel relations are introduced successively over the course of the study.)

Charlie was then tested for the acquisition of the novel relations with blocks of unreinforced name-picture test trials. On each trial, Charlie was presented with both the novel (target) pictures which were laid on the table before him. He was then requested to select one of the pictures upon presentation of the corresponding novel name: the experimenter requested, "Where is X?" (where X was a novel target name). Within each block of name-picture test trials, each of the novel target words was presented as the sample on half of the trials; thus each block of test trials consisted of an equal number of test trials of both of the target relations.

The convention in behaviour analytic studies is that participants are required to demonstrate criterion level responding (this is typically set at or around 80 percent correct responding) on training trials before testing trials are conducted. However, Lipkens et al.'s procedure departed from this convention: both the training and testing trials were conducted concurrently. Thus in each experimental session Charlie was given both training *and* testing trials (except in the initial two sessions in which only training trials were presented). As a result, Charlie was not required to demonstrate criterion level responding on the training trials before the testing trials were conducted.

Charlie's responses on the testing trials indicated that he had acquired the novel name-picture relations: he selected the correct picture on 91.6 percent (11/12 correct responses) of the test trials presented, thus responding above criterion level. What is important here is Charlie's performance on the related picture-name training trials. Although Charlie passed the name-picture tests, he had not, in fact, responded above criterion level on the related training trials: his responding was around chance level on training trials of both of the target relations -- he responded with 40 percent and 58.3 percent accuracy on these trials respectively. Therefore, Charlie passed the name-picture (auditory comprehension) tests *before* achieving criterion on the corresponding training trials. What this means is that, when shown the novel pictures during training, Charlie did not produce the correct name, and thus did not receive subsequent reinforcement, on all of the trials. This was particularly evident in the earlier sessions: in the initial four sessions he produced the correct name on only 1 of the 12 training trials presented; despite this, he responded correctly on all the corresponding testing trials presented in these sessions.

This pattern of responding was also evidenced when the procedure was repeated with two new target relations (novel words "Kiekie" and "Boesch" and corresponding pictures). Again, Charlie passed the name-picture tests *before* achieving criterion on the picture-name training trials: he responded with 83.3 percent accuracy on the testing trials; at the same time he responded below criterion level on the related training trials (58.3 percent accuracy overall). Charlie was 17 months and 7 days old when he passed the name-picture (auditory-comprehension) tests. Thus overtly naming the pictures correctly during training, and receiving reinforcement for doing so, was not necessary for Charlie to acquire the novel relations; how can his success on the name-picture tests be accounted for?

A possible explanation may lie in the specific training procedure employed. In order to correct Charlie's incorrect responses on picture-name training trials (i.e., producing the incorrect name, or making no response at all), the experimenter presented the correct novel name in the carrier phrase, "This is X. Can you say X? This is X," (where X was the correct novel name). Therefore Charlie repeatedly heard the novel name presented in the presence of the corresponding novel picture. When the novel name was presented in this manner Charlie was not required to make a response, and therefore did not receive any reinforcement for doing so. Thus it may be argued that he was *exposed* to the correct relations between the novel words and referents, and that the learning evidenced can be accounted for by unreinforced exposures to the novel relations. Indeed, Lipkens et al. (1993), state their results show that:

> actually producing the names in training is not necessary for the derivation of name-picture relations. Hearing the name produced by the experimenter in the presence of the picture during training (picture → name spoken by experimenter) controlled selecting that picture in the presence of the name spoken by the experimenter (name spoken by experimenter → picture). (p. 214)

If this is the case, then the results provide evidence that young children are able to learn novel word-referent relations from exposures to novel stimulus pairings. The exposures employed in Lipkens et al.'s study were presented ostensively: the experimenter presented only one novel picture at a time, thus singling out the target referent, and simultaneously labelled the picture three times with the novel word. As yet, this has been the only behaviour analytic study that demonstrates the acquisition of novel stimulus relations from unreinforced ostensive exposures.

1.2.2. The Non-Ostensive Paradigm

Within the behaviour analytic tradition there is no research that suggests that preschool children are able to acquire novel word-referent relations following unreinforced non-ostensive exposures that parallel the cognitive/developmental non-ostensive exposures described in Section 1.1.2 (see Figure 1.1).

Recently, however, a series of studies conducted by Barnes, Smeets, and Leader (1996) and Smeets, Leader, and Barnes (1997) have, like Lipkens, Hayes, and Hayes (1993), shown that explicit reinforcement for correct responding during training is not required for the acquisition of novel relations to occur. These authors have shown that adults and normally developing children aged five years are able to learn novel stimulus relations as a result of non-ostensive exposure trials (termed by the authors a "respondent-type training procedure"). However, the novel relations exposed and tested in these studies were visual-visual relations: all the stimuli employed were presented in the visual modality and comprised two-dimensional line drawings of abstract figures or symbols. Participants were shown one novel figure on a piece of card which was then flipped over to reveal the corresponding novel figure on the opposite side. As auditory stimuli were not employed in these studies, participants were required to relate two visual stimuli together as a result of the exposure trials.

Although these studies provide preliminary evidence that five year old children are able to learn novel stimulus relations from non-ostensive exposures, there have thus far been no behaviour analytic studies of non-ostensive exposure learning conducted with very young normally developing children and, in addition, with novel auditory-visual relations.

1.2.3. The Exclusion Paradigm

The behaviour analytic *stimulus exclusion* paradigm (Dixon, 1977) or *learning by exclusion* paradigm (McIlvane & Stoddard, 1981) provides another means whereby new arbitrary stimulus relations may be learned without explicit training or direct reinforcement for appropriate responding during training. The exclusion paradigm directly parallels the cognitive/developmental fast mapping paradigm because exclusion exposure trials are identical in nature to fast mapping trials (described earlier in Section 1.1.3; see Figure 1.1).

The exclusion paradigm initially comprises the presentation of two trial types; these are identical in nature to the multiple choice trials presented in the fast mapping paradigm. Both of these trial types are presented in a matching-to-sample format in which participants are presented with a sample stimulus and are requested to select a corresponding, or related, stimulus from an array of two or more comparison stimuli.

First, participants are presented with *baseline trials*, in which they are shown an array of two or more familiar visual stimuli and are requested to select one when the corresponding sample is presented (these are identical in nature to the familiar test trials presented in cognitive/developmental research). These trials are conducted in order to ensure that participants are familiar with the baseline relations, and to verify the prerequisites for auditory-visual matching-to-sample tasks. In contrast to fast mapping procedures, unfamiliar stimulus relations are often directly trained throughout the baseline phase in order that these then become the familiar or "defined" stimuli (i.e., experimentally defined by the reinforcement contingencies).

Second, participants are given exclusion trials in which novel stimulus relations are exposed within the context of the previously established baseline performance. These are identical to fast mapping trials (see Figure 1.1): participants are shown one novel comparison (an undefined stimulus) and one or more familiar comparisons (defined stimuli), and are requested to select the novel comparison upon presentation of a corresponding novel sample. The term exclusion is thus used to describe participants' "responding away from or excluding the stimulus choice trained in the presence of one spoken word to select the untrained stimulus choice in the presence of an untrained spoken word" (Dixon, 1977, p. 434). In contrast to the fast mapping paradigm, in behaviour analytic studies correct responding on exclusion trials is typically established through training, that is, differential reinforcement of participants' responses on exclusion trials.

In comparison to the fast mapping research, behaviour analytic research has shown that participants select the novel stimulus on exclusion trials without having been explicitly trained to do so. (In cases where reinforcement has been provided, participants will also show correct first-trial performance on exclusion trials.) Selection of the novel stimulus may be a result of rejection of the defined stimuli; this is termed *S-control* and parallels Markman's (1989) principle of mutual exclusivity. Alternatively, selection of the undefined stimulus may be a result of a positive relation of shared novelty between the target stimuli; this is termed *S+ control* and parallels Golinkoff et al.'s (1992, 1994) and Mervis and Bertrands' (1993) N3C principle. However, despite the different bases for comparison selections, the behavioural outcome is the same: selection of the novel stimulus on exclusion trials.

Specific claims have been made regarding both fast mapping and exclusion research with young children. It is argued that exclusion, and thus similarly fast mapping, is a robust phenomenon (Wilkinson et al., 1996, 1998; Wilkinson & Green, 1998). Wilkinson et al. (1996) state:

> virtually all subjects over the cognitive age level of 2 years, across both research programs, select the unnamed comparison in the exposure trials . . . These outcomes are robust regardless of whether the procedure targets arbitrary relations presented by a human interactant, as is common in the fast mapping research, or by an automated apparatus such as a computer, as in much of the exclusion research. (p. 133)

As stated earlier, the focus of behaviour analytic exclusion research has not been the acquisition of receptive vocabulary in normally developing children. Rather, the primary focus has been the development of techniques to enable participants to learn novel stimulus relations more efficiently in order to aid communication. Thus much of the exclusion research has been conducted with participants with mental retardation, and has employed stimuli that are not considered to be specifically linguistically relevant. Attempts to link exclusion findings to these processes of lexical acquisition have thus been neglected. Despite these ostensible differences, the convergence in experimental methods employed, and behavioural outcomes reported, suggests that both traditions have in fact been studying the same phenomenon (Huntley & Ghezzi, 1993; Wilkinson et al., 1996, 1998).

A whole body of research has shown that participants reliably select the undefined stimulus on exclusion trials: upon hearing a novel word, participants select the novel stimulus in the absence of ostensive input, explicit instruction, or reinforcement for appropriate responding. Such performances have been demonstrated in studies in which adolescents and adults with mild to severe mental retardation have been exposed to novel auditory-visual relations (Dixon, 1977; McIlvane et al., 1992;

Wilkinson & McIlvane, 1994) or visual-visual relations (Stromer, 1986); in studies in which adolescents and adults with severe to profound mental retardation have been exposed to novel auditory-visual relations (McIlvane & Stoddard, 1981; McIlvane, Bass, O'Brien, Gerovac, & Stoddard, 1984; McIlvane, Kledaras, Lowry, & Stoddard, 1992; Stoddard, 1982; Wilkinson & Green, 1998); and in studies in which normally developing adults have been exposed to novel visual-visual relations (McIlvane, Kledaras, Munson, King, de Rose, & Stoddard, 1987).

Due to the focus of exclusion research, studies of normally developing participants, particularly children, have been relatively neglected. There have, however, been a number of more recent studies that have investigated normally developing children's performance on exclusion trials in which novel auditory-visual relations are exposed (Ferrari, de Rose, & McIlvane, 1993; Lipkens, Hayes, & Hayes, 1993; McIlvane, Munson, & Stoddard, 1988; Wilkinson & McIlvane, 1997). These studies and the related performance outcomes are outlined below.

Ferrari, de Rose, and McIlvane (1993) investigated the exclusion performances of older normally developing children aged between eight and twelve years. This was a replication of Vincent-Smith, Bricker, and Brickers' (1974) study: Ferrari et al. compared participants' performance on exclusion and selection (trial and error) trials. Following criterion level responding (91.6 percent accuracy) on baseline trials, participants were given exclusion exposure trials of eight novel word-picture relations; these trials were four choice matching-to-sample trials in which participants were requested to select the novel stimulus from an array of four visual comparisons (i.e., the corresponding novel stimulus and three familiar visual comparisons). All seven participants responded without error, selecting the novel object on every exclusion trial presented; thus they may have mapped the novel words and referents. In comparison to the findings of Vincent-Smith et al. (1974), participants made many errors on the selection trials, even in cases where they were prompted to make the correct response on the first trial of each novel relation.

McIlvane, Munson, and Stoddard (1988) gave exclusion exposure trials to younger normally developing children aged between three and five years. Following errorless performance on baseline trials, participants were given exclusion exposures to two novel auditory-visual relations; these comprised novel nonsense words and novel pictures. McIlvane et al. also found that these younger participants performed without error on the exclusion trials. Similarly, errorless exclusion trial performance was found by Wilkinson and McIlvane (1997) with participants aged three to five years. In this study participants were given one exclusion exposure trial of one novel auditory-visual relation.

In contrast with the fast mapping literature, the behaviour analytic studies outlined above provided participants with reinforcement for correct responses on exclusion trials; this reinforcement may have influenced participants' responses after the first exclusion trial of each relation. However, for all the participants, their first-trial performance on each novel relation was correct, and thus the reinforcement may not have been responsible for their errorless performance.

The only behaviour analytic exclusion study to have been conducted with a very young child presented unreinforced exclusion trials. Lipkens, Hayes, and Hayes, (1993, Study 4) presented their participant -- Charlie, a normally developing boy aged 16 months and 26 days at the start of the study -- with unreinforced two-choice exclusion exposure trials of two novel auditory-visual relations; these stimuli comprised pictures of unfamiliar prehistoric animals and their corresponding nonsense names, and thus were linguistically relevant. Charlie responded with 94.1 percent and 93.8 percent accuracy on exclusion trials of each of the novel relations; this testing commenced when he was aged 16 months and 26 days and ended when he was aged approximately 26 months.

Although the behaviour analytic research presented demonstrates that participants aged two years and above immediately select the correct referent on exclusion trials in the absence of an explicit history of reinforcement for doing so, Lipkens, Hayes, and Hayes' (1993, Study 4) is the only study of exclusion that has been conducted with a young normally developing participant. No studies of exclusion have been conducted with younger participants whose ages parallel those of the fast mapping literature.

1.3. Summary

Both cognitive/developmental and behaviour analytic researchers have developed experimental paradigms that have been, or may be, used to investigate the acquisition of receptive vocabulary. Specifically, these have investigated how children relate novel words and their referents together in the absence of explicit reinforcement for doing so.

In both fields, the three paradigms outlined have investigated the acquisition of novel word-referent relations following ostensive, non-ostensive, or fast mapping/exclusion exposure trials. These paradigms have been used concurrently yet independently, and, despite the differing research philosophies, have shown a convergence in the experimental procedures employed. The authors of such studies, conducted in both fields, claim to have shown that children of 13 months of age and above are able to learn new word-referent relations from these exposure trial types.

However, these claims are contentious. On closer inspection the identification of methodological limitations of these studies casts doubt upon these claims. Specifically, the authors' failure to implement adequate control procedures questions whether participants' accurate performances on fast mapping and comprehension test trials indicate evidence of real word learning. The question remains of whether selection of the correct referent on these trials indicates that participants have acquired a one-to-one mapping between the specific novel word and its referent. The methodological limitations and criticisms of these studies are presented in Chapter 2.

CHAPTER 2

METHODOLOGICAL LIMITATIONS OF COGNITIVE/ DEVELOPMENTAL AND BEHAVIOUR ANALYTIC EXPOSURE LEARNING PARADIGMS

Chapter 1 outlined cognitive/developmental and behaviour analytic exposure learning paradigms that have been employed in, or are of relevance to, the study of lexical acquisition. These paradigms focused upon the presentation of three types of exposure trials: ostensive exposure trials (e.g., Dollaghan, 1985; Lipkens, Hayes, & Hayes, 1993, Study 1); non-ostensive exposure trials (e.g., Akhtar & Tomasello, 1996; Tomasello & Barton, 1994); and fast mapping (e.g., Carey & Bartlett, 1978; Markman & Wachtel, 1988) or exclusion exposure trials (e.g., Lipkens, Hayes, & Hayes, 1993, Study 4; McIlvane, Munson, & Stoddard, 1988). The authors of these independent yet parallel lines of research claim to have shown that young children, from the age of 13 months and above, are able to acquire novel arbitrary word-referent relations following limited unreinforced exposures to novel stimulus pairings (e.g., Hutchinson, 1986; Lipkens et al., 1993; Woodward, Markman, & Fitzsimmons, 1994).

However, these claims are contentious. In order to demonstrate *real word learning* -- the acquisition of specific items of vocabulary -- it must be shown that participants have acquired *one-to-one mappings* between the novel stimuli exposed, and thus that their correct responses on test trials are controlled by the *specific* novel words presented. Limitations and weaknesses pertaining to the paucity of methodological control employed in these studies render the authors' conclusions regarding word learning equivocal: much of the research has failed to demonstrate control by the specific target auditory stimuli on test trials.

The methodological criticisms of the research outlined in Chapter 1 are presented in this chapter. In conjunction with a discussion of each of these issues, the resulting necessary control procedures required in order to afford unequivocal evidence of children's word learning are outlined.

2.1. *Fast Mapping/Exclusion Trials: Evidence of Word Learning?*

Cognitive/developmental and behaviour analytic researchers have presented fast mapping or exclusion trials, respectively, of novel word-referent relations. These trials are procedurally identical: participants are presented with a visual array comprising a novel target stimulus and one or more familiar stimuli, and are requested to select the novel comparison upon presentation of a corresponding novel word (see Figure 2.1).

Research from both traditions has shown that normally developing young children correctly select the novel visual stimuli on these trials (e.g., Hutchinson, 1986; Lipkens et al., 1993). Participants' accurate selections of the novel visual stimuli on fast mapping/exclusion trials give the impression that they have learned a specific relation, or formed a one-to-one mapping, between the novel target word and referent. That is, it appears that they have selected the target visual stimulus conditionally upon presentation of the corresponding target word. Indeed, it is argued that the ability to respond correctly on fast mapping trials may be related to lexical acquisition -- and in particular, the vocabulary spurt -- because such responding provides a method of rapidly acquiring vocabulary in the absence of ostensive input or explicit training (Mervis & Bertrand, 1994).

Nevertheless, these claims are questionable. On closer inspection it is apparent that accurate responses on fast mapping/exclusion trials do not necessarily indicate the acquisition of a one-to-one mapping between the target novel stimuli exposed: there is no unequivocal evidence that participants' comparison selections on these trials are controlled by the specific novel word presented. In fact, participants need not even have attended to the novel auditory sample in order to accurately select the corresponding novel target stimulus; correct comparison selections may be the result of a response bias towards the target referent. Participants may find the target novel visual stimulus more salient than other stimuli present in the comparison array. This may be the result of one of two factors.

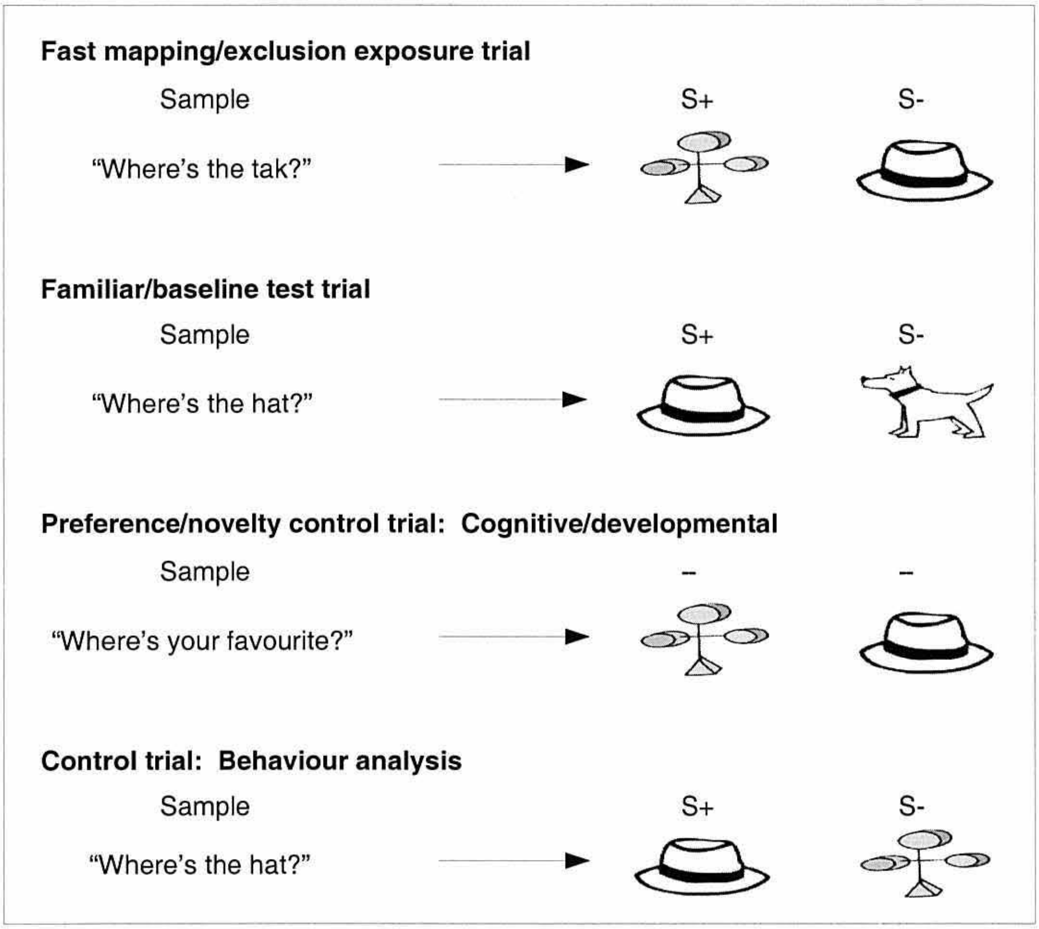

Figure 2.1. Fast mapping/exclusion trials and control trials employed by cognitive/developmental and behaviour analytic researchers in order to verify control by the novel samples.

First, participants may select the target visual stimulus as a function of its novelty per se; they may find this referent more appealing as it is the only novel stimulus present in the visual array. Indeed, Merriman and Bowman (1989) found that stimulus novelty biased young children's performances on fast mapping trials.

Second, participants may select the novel comparison as a result of a stimulus preference: they may prefer the target stimulus because of some appealing physical property or characteristic of the object or picture itself.

Both cognitive/developmental psychologists and behaviour analysts acknowledge this to be the case. They have thus taken measures to ensure that participants' correct comparison selections on fast mapping/exclusion trials are controlled by the novel auditory samples presented.

2.1.1. Controls Employed in Fast Mapping/Exclusion Paradigms

The controls employed in fast mapping and exclusion paradigms have taken the form of multiple choice or matching-to-sample tasks respectively. These are typically conducted concurrently with fast mapping/exclusion trials, and are as follows.

Familiar test trials. Within both fast mapping and exclusion paradigms, participants are administered *familiar* or *baseline test trials* (e.g., Carey & Bartlett, 1978; Golinkoff, Hirsh-Pasek, Bailey, & Wenger, 1992, Study 2; Lipkens et al., 1993, Study 4; Mervis & Bertrand, 1994). On these trials, participants are requested to select a corresponding referent from an array of two or more familiar visual stimuli (see Figure 2.1). It might be assumed that correct responding on these trials, coupled with correct responding on fast mapping trials, indicates that participants' responses are controlled by the auditory samples presented. However, this evidence is inadequate. As novel visual stimuli are not presented as comparisons on familiar test trials, there is no evidence that participants would not continue to select these novel stimuli when presented with the familiar auditory samples. Thus, even where familiar test trials are conducted, there is no evidence that correct responses on fast mapping/exclusion trials are not false positive responses as a result of a response bias towards the novel stimuli.

Preference/novelty control trials. Cognitive/developmental researchers typically conduct *preference control* or *novelty control trials* in order to assess non-linguistic stimulus preferences (e.g., Golinkoff et al., 1992, Study 3; Hutchinson, 1986; Markman & Wachtel, 1988; Merriman & Schuster, 1991). On these trials, participants are presented with a visual array identical to that of the fast mapping trials; they are then requested to "Pick one" or are asked, for example, "Which one is your favourite?" (see Figure 2.1). It might be assumed that participants' selections of the novel stimuli at chance level on these trials indicate that their selection of the novel referents on fast mapping trials are not a result of stimulus preferences, and thus that their responses on fast mapping trials are controlled by the novel auditory samples presented.

Preference/novelty control trials have been employed by Markman and Wachtel (1988), Merriman and Schuster (1991), and Golinkoff et al. (1992). In these studies, preference control trials were given to a control group of participants; their selections of the novel visual stimuli on these trials were compared to the experimental group's selections of the novel stimuli on fast mapping trials. In each study, the control group selected the novel visual stimuli at chance level. Further, the control group's selection of the novel stimuli on preference control trials was significantly lower than the experimental group's selection of these stimuli on fast mapping trials.

In these studies preference control trials were employed as a between-subjects condition. As a result, there is no direct evidence that participants in the experimental group did not prefer the novel visual stimuli, or perceive them to be particularly salient.

In contrast, Hutchinson (1986) implemented preference control trials as a within-subjects condition. Each participant was given two preference control trials for each of the novel target relations; participants who selected the novel comparison on both of these trials were considered to prefer that particular target stimulus, and their performances on the fast mapping trials for that novel relation were not included in the analyses. A mean of less than one of the five novel stimuli was removed from the analyses. Consequently, the participants' correct responses on fast mapping trials were not considered to be the consequence of a bias to attend to the novel stimuli.

Control trials. Behaviour analytic researchers have typically interspersed exclusion trials with *control trials.* On these trials, participants are presented with comparison displays that are identical to those encountered on exclusion trials; however, on these trials they are requested to select the defined (i.e., familiar) visual stimulus (see Figure 2.1). Correct responses on control trials, coupled with criterion level responding on corresponding exclusion trials, might be taken to indicate that participants' responses are conditional upon the auditory samples presented. This is because correct responding on control trials cannot be negotiated by responding on the basis of novelty or a stimulus preference alone. In order to produce correct responses on control trials, participants must attend to the auditory sample and note that, in contrast to the exclusion trials, they are required to select a defined stimulus.

Control trials have been employed in the exclusion studies described in Chapter 1. Both Ferrari, de Rose, and McIlvane (1993) and McIlvane, Munson, and Stoddard (1988) found that participants performed above criterion level on exclusion trials and corresponding control trials. Note, however, that both trial types were reinforced in these studies, and thus correct responding may have been trained.

In contrast, Lipkens, Hayes, and Hayes (1993, Study 4) gave their participant unreinforced exclusion trials and corresponding unreinforced control trials of two novel word-referent relations. The participant responded without error on exclusion trials, and with 75 percent accuracy on control trials. Although this response accuracy on control trials was marginally below criterion level, it greatly exceeded chance level (i.e., 50 percent) responding. Thus it appeared that the participant's responses were controlled by the novel auditory stimuli presented on exclusion trials.

2.1.2. Fast Mapping/Exclusion Trials: Further Methodological Considerations

As stated above, participants' selections of the novel visual stimuli at chance level on cognitive/developmental preference control trials, or their selection of the familiar visual stimuli on behaviour analytic control trials, might be taken to indicate that their correct responses on corresponding fast mapping/exclusion trials are controlled by the novel auditory samples presented. However, even where participants have produced such a pattern of responding, this does not demonstrate unequivocally that they have formed a one-to-one mapping between the target novel word and referent. Such responding demonstrates only that participants have attended in *some part* to the auditory samples -- that their responses are controlled by *some* aspect of the target novel word.

In order to successfully negotiate these trials, participants are not required to note the *specific defining characteristics* of the novel stimuli. It may simply be the novelty of the target stimuli per se that controls participants' responses: participants need only note that the target auditory and visual stimuli are both novel. In doing so, correct comparison selections on fast mapping/exclusion trials may be based on a feature of shared novelty between the target stimuli, or may be dependent on the presence of the familiar visual stimuli from which to exclude. For example, participants need only respond according to a general rule such as "hear novel word then select novel object" and/or "hear novel word then reject familiar objects". Accurate fast mapping/exclusion trial performance does not, therefore, guarantee that participants have attended to the defining features of the novel stimuli, or have formed a relation linking the *specific* word and referent. This is frequently acknowledged by behaviour analytic researchers who have studied the exclusion phenomenon (e.g., Dixon, 1977; McIlvane, Munson, & Stoddard, 1988; Soraci, Deckner, Baumeister, & Carlin, 1990). For example, McIlvane and Stoddard (1981) state:

> The subject may detect that the sounds of the novel [target] and trained [familiar] words differ, and exclude the trained choice [familiar visual stimulus] on this basis. However, discrimination and rejection of the trained choice does not require that the subject observe specific, identifying characteristics of the novel word or of the correctly chosen visual stimulus. For this exclusion-only outcome, correct performance depends on the presence of the trained choice as an alternative; the performance *does not* [emphasis added] include learning the new matching relation between the novel word and its corresponding visual stimulus. (p. 34)

Although correct responding on fast mapping/exclusion trials does not guarantee acquisition of the novel relations, this is not to say that such learning is not possible. McIlvane, Munson, and Stoddard (1988, p. 474) write "conditional relations can be learned if, in addition to excluding the original S+ [familiar stimulus], the subject does observe relevant distinguishing features of the novel word and its corresponding stimulus". In order to determine whether participants have demonstrated an "exclusion-only outcome", or have attended to the specific characteristics of the novel stimuli, further tests are required. The necessity for further testing is acknowledged by both cognitive/developmental and behaviour analytic researchers. They have thus presented subsequent tests of acquisition of target relations. In the exclusion paradigm, behaviour analysts have presented *learning outcome* or *discrimination test trials* (e.g., Dixon, 1977; Ferrari et al., 1993; Lipkens et al., 1993, Study 4; McIlvane et al., 1988); these are outlined and discussed in Section 2.3.2. In the fast mapping paradigm, cognitive developmental researchers have presented *comprehension* or *extension test trials* (e.g., Carey & Bartlett, 1978; Golinkoff et al., 1992, Study 2; Mervis & Bertrand, 1994); these test trials, and their related performance outcomes, are discussed in the following section.

2.1.3. *Comprehension Tests Following Fast Mapping Trials*

Within the cognitive/developmental tradition, tests of acquisition of the target relations, following fast mapping exposure trials, have taken the form of comprehension or extension test trials. The procedural specifics of these trials were outlined in Chapter 1 with reference to ostensive and non-ostensive paradigms. To reiterate: on comprehension test trials, participants are presented with a visual array comprising the target stimulus and one or more novel distracter stimuli that have not been labelled in the context of the study (in some cases this array may also include one or more familiar stimuli), and they are requested to select the target visual stimulus upon presentation of the corresponding target novel word. Extension test trials are procedurally identical; however, a new exemplar of the target visual stimulus is presented (this is typically of a different colour to the original target stimulus). Comprehension tests are considered to be appropriate tests of word learning in fast mapping paradigms. This is because responding on fast mapping/exclusion trials may lead to the acquisition of a receptive mapping between the novel auditory and visual stimuli presented (Wilkinson & Green, 1998).

The performance outcomes on comprehension tests following ostensive and non-ostensive exposure trials are discussed in Chapter 1 (see Sections 1.1.1 and 1.1.2). We turn now to the performance outcomes on comprehension test trials conducted following fast mapping exposure trials. Have young children passed comprehension tests following fast mapping exposure trials?

Of the fast mapping studies introduced in Chapter 1 (Section 1.1.3), Dockrell and Campbell (1986),[1] Hutchinson (1986), Markman and Wachtel (1988), Merriman and Bowman (1989), Merriman and Schuster (1991), and Au and Glusman (1990) did

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[1] Dockrell and Campbell (1986) claim to have conducted a comprehension test trial following the fast mapping trial. However, the visual array comprised the target visual stimulus and familiar visual stimuli alone; no additional novel distracter visual stimuli were presented as visual comparisons. As a result, this trial, in effect, constituted nothing more than a fast mapping trial, and thus did not assess acquisition of the target relation.

not conduct comprehension tests following fast mapping trials. (In some cases, this is because acquisition of the novel relations was not the original focus of the studies.)

In contrast, in three of the studies outlined in Chapter 1, comprehension test trials were presented. Carey and Bartlett (1978) presented participants with one comprehension test trial following a single fast mapping exposure trial. Participants were shown the target referent, a novel distracter referent, and seven familiar referents; of the 19 three year olds, 42 percent selected the target referent. Carey and Bartlett thus claimed to find weak evidence of mapping of the novel word and referent. It might be assumed that, as nine referents were presented in the visual array on this test trial, chance level responding was 11.1 percent, and thus strong evidence of word-referent mapping was provided. However, as the target visual stimulus and only one additional novel distracter stimulus were presented, chance level responding is strictly 50 percent; this is because, as has been demonstrated on fast mapping trials, participants are able to reject selection of the remaining seven familiar referents by responding by exclusion alone. The evidence for comprehension of the target relation in this study is thus weak. The minimal learning evidenced may be a result of the complexity of the task itself (i.e., the inclusion of nine stimuli in the visual array), or a result of a temporal delay of one week between the exposure and testing phases of the study.

In the following studies more immediate comprehension tests were conducted. Mervis and Bertrand (1994) gave participants aged 15 and 20 months fast mapping exposures to four novel relations. In order to assess acquisition, participants were given one extension test trial of each of the novel relations. On these trials they were shown a new exemplar of the target visual stimulus, a novel distracter visual stimulus not encountered before in the context of the study, and three familiar visual stimuli. Recall that half of the participants responded above chance level on the fast mapping trials; these participants also went on to pass the extension test: they selected the target object with an accuracy exceeding chance level (a mean of 3.2 out of four correct responses). Again, chance level in this study is strictly 50 percent; although five visual stimuli were presented on test trials, only two of these were novel stimuli; participants were able to reject selection of the remaining three familiar stimuli by responding on the basis of exclusion alone. The remaining half of the participants who did not exceed chance level responding on fast mapping trials also, not surprisingly, failed to pass the extension tests (a mean of 1.5 out of four correct responses).

However, the participants' correct responses on the extension test trials in Mervis and Bertrands' (1994) study might be attributed to ostensive definition. In cases where participants selected an incorrect object or made no response on fast mapping exposure trials, the experimenter manually indicated the target referent and simultaneously labelled it three times. Likewise, in cases where participants selected the correct referent, the experimenter also labelled it three times whilst singling it out; debatably, this was in order to "reinforce the child's correct mapping" (Mervis & Bertrand, 1994, p. 1625). Thus one cannot be certain whether the participants' performance on test trials, when above chance, was a result of fast mapping or ostensive exposure trials, or a combination of both.

The final fast mapping study provided a more controlled investigation than those previously discussed. Golinkoff, Hirsh-Pasek, Bailey, and Wenger (1992, Study 2) gave participants fast mapping exposure trials of one novel relation, on which they responded above chance level. The participants were then presented with an extension test trial; on this they were shown a new exemplar of the target visual stimulus, a novel distracter visual stimulus that had not been encountered before in the context of the study, and two familiar visual stimuli. Golinkoff et al. found significantly greater above chance performance than was evidenced in previous studies: the participants selected the target object on 69 percent of these trials (again, chance level here was strictly 50 percent).

The evidence regarding children's ability to pass comprehension tests following fast mapping exposure trials is thus limited. Despite this, the results outlined above have led authors to conclude that young normally developing children are able to acquire new word-referent relations following fast mapping exposures.

Again these claims are questionable. We turn now to a critique of comprehension test trials in general. Where these have been presented in ostensive, non-ostensive, and fast mapping paradigms, methodological criticisms of these trials in general make conclusions regarding word learning in all these studies equivocal.

In the next section it is shown that even where participants have responded accurately, and significantly above chance level, on comprehension test trials, this does not provide conclusive evidence of real word learning.

2.2. Comprehension Test Trials: Evidence of Word Learning?

As stated earlier, in ostensive, non-ostensive, and fast mapping paradigms, participants are presented with comprehension test trials in order to assess acquisition of the target novel relations. The performance outcomes on these trials following ostensive and non-ostensive exposures are presented in Chapter 1 (Sections 1.1.1 and 1.1.2), and the performance outcomes on these trials following fast mapping exposures are presented above (in Section 2.1.3). However, even if participants have responded significantly above chance level on comprehension test trials, the authors' conclusions regarding word learning are equivocal.

In order to provide evidence of *real word learning* it must be demonstrated that participants' selections of the target referents on comprehension test trials are a direct response to (i.e., are controlled by) the corresponding novel word presented, and are thus a direct result of the exposure trials. However, participants' accurate selections of the target visual stimuli on comprehension test trials may be false positive responses. Possible sources of false positive responding are identified below, and the resulting necessary controls are outlined.

2.2.1. Preferential Responding

Participants may produce false positive responses on comprehension test trials as a result of a response bias towards the target referent (i.e., a preference for the selection of the target visual stimulus). Participants may exhibit a non-linguistic preference for the target visual stimulus. That is, they may find the target referent more appealing as a result of some physical characteristic of the stimulus itself, and therefore select this on test trials irrespective of the auditory sample presented (e.g., Huttenlocher, 1974).

An additional source of bias is present in ostensive and non-ostensive procedures: participants may find the target referent particularly salient because it is the only novel object that has been presented in the exposure phase (e.g., Dollaghan, 1985; Dunham, Dunham, & Curwin, 1993; Oviatt, 1980). Moreover, even in cases in which the novel distracter stimuli have been encountered in the exposure phase (e.g., Baldwin, 1993a; Chapman, Kay-Raining Bird, & Schwartz, 1990; Tomasello & Barton, 1994) participants may find the target stimulus particularly salient as a function of its being labelled (i.e., associated with a novel label within the context of the study). A number of studies have shown the attentional facilitation effect of labelling (Baldwin & Markman, 1989; Roberts & Black, 1972; Robertson & Suci, 1980).

Baldwin and Markman (1989) found that when a target novel object was labelled within a carrier phrase -- typical of those employed in exposure learning paradigms -- this facilitated 10 to 14 month old participants' attention to the object during the course of labelling; this was compared to a condition in which the target object was not labelled or referred to, and no language models were provided. In a second study, Baldwin and Markman found that labelling also served to maintain participants' interest in the target object during a subsequent period of play with the objects; this was compared to a condition in which the target object was not labelled, but the participants' attention was directed to it by pointing alone. Although the magnitude of the effect was small, Baldwin and Markman write "the enhanced attention due to labelling reflects a general bias to remain interested in labelled objects rather than a direct response to comprehending a label being uttered" (1989, p. 395).

In order to eliminate the facilitating effects of labelling, and equalise the saliency of the target and distracter visual stimuli, a number of ostensive and non-ostensive studies have introduced novel distracter stimuli in the exposure phase. In these studies, the novel distracter stimuli are commented upon, and referred to, in the same manner as the target stimulus (Akhtar & Tomasello, 1996; Baldwin, 1991, 1993b; Tomasello, Strosberg, & Akhtar, 1996; Woodward et al., 1994). For example, Woodward et al. presented participants with ostensive exposures to one novel word-referent relation. The target novel object was labelled with the carrier phrase, "That's a X. See, it's a X. Look, it's a X" (where X was the novel word). Likewise, a novel distracter object was referred to with the phrase, "Oooo, look at that. Yeah, see it? Wow, look at that."

However, despite the inclusion of this control, it is possible that participants remain more engaged by the target stimulus. Although their attention is directed equally to both the target and distracter visual stimuli, the target stimulus is the only one to which a *novel label* is attached; it may be this labelling per se that facilitates participants' attention. Recall also that participants may still prefer the target visual stimulus because of some appealing physical property of the stimulus itself (this is applicable to each of the three paradigms). Therefore, in order to assess the existence of a target stimulus preference in each of the paradigms, preference control trials are required.

On preference control trials participants are shown visual arrays that are identical to those presented on comprehension test trials; however, on these trials they are requested simply to "Pick one" (see Figure 2.2). These trials are conducted in order to determine that participants' selections of the target referents on test trials are not the result of a bias to select the target visual stimuli.

A number of studies in which an ostensive paradigm (Baldwin, Markman, Bill, Desjardins, Irwin, & Tidball, 1996; Chapman et al., 1990; Dollaghan, 1985; Dunham et al., 1993; Woodward et al., 1994, Studies 2 & 4), a non-ostensive paradigm

(Tomasello & Barton, 1994, Study 4), or a fast mapping paradigm (Vincent-Smith, Bricker, & Bricker, 1974; Mervis & Bertrand, 1994) have been employed did not include preference control trials; thus there is no evidence that participants' correct responses on comprehension test trials were anything other than false positive responses resulting from a target stimulus preference.

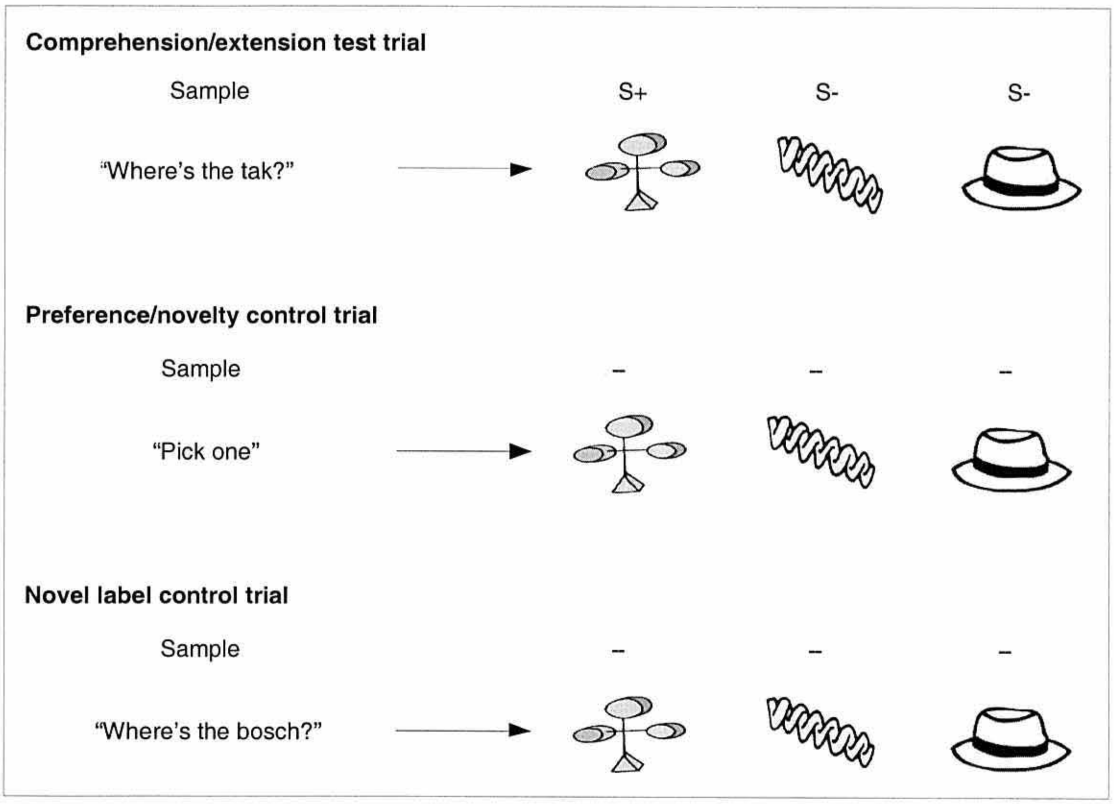

Figure 2.2. Comprehension test trials and control trial types employed in cognitive/developmental exposure learning paradigms.

In contrast, a number of studies in which an ostensive paradigm (Baldwin 1991, 1993a; Tomasello & Barton, 1994, Study 2; Woodward et al., 1994, Studies 1 & 3), a non-ostensive paradigm (Akhtar & Tomasello, 1996; Baldwin, 1991, 1993b; Tomasello & Barton, 1994, Studies 2 & 4; Tomasello et al., 1996), or a fast mapping paradigm (Carey & Bartlett, 1978; Dockrell & Campbell, 1986; Golinkoff et al., 1992, Study 3) have been employed have assessed preferential responding.

Further, although this study was more controlled than the studies described in Chapter 1, it differs from these in a number of ways. First, Schafer and Plunkett (1998) investigated the acquisition of novel word-picture relations rather than word-object relations as has typically been the convention in cognitive/developmental studies. Second, due to the age of the participants and the nature of the stimuli, a preferential looking paradigm was employed; typically, multiple choice procedures have been employed in cognitive/developmental studies and have been found to be appropriate for children aged as young as 13 months (e.g., Woodward et al., 1994). Third, Schafer and Plunkett did not examine exposure learning in a naturalistic language learning context such as has been employed in previous studies: the experimental context was far removed from typical first language learning situations, and the social contact the participant received was minimised. Thus the questions remain of whether young children are able to learn multiple novel word-object relations from ostensive exposures presented in naturalistic language learning situations, and, more specifically, of whether young children are able to do so in stringently controlled conditions that eliminate false positive responding on the basis of URCS and experimenter cueing.

Non-ostensive paradigm. Only one cognitive/developmental study has been conducted to investigate non-ostensive exposure learning of multiple novel relations. Moreover, this is the only study to have investigated exposure learning in an impending-word context. Whitehurst, Kedesdy, and White (1982) gave participants exposures to 15 novel relations in three contexts: five were exposed in an ostensive context; five in a non-ostensive impending-object context, in which the novel object was presented 10 seconds after the novel word; and five in a non-ostensive impending-word context, in which the novel word was presented 10 seconds after the novel object was removed from view. Each novel object was labelled a total of 27 times (which coincided with nine presentations of the corresponding object). On subsequent comprehension test trials, five target objects were presented in the visual array. The results indicated and Farrar found an effect of exposure context: for relations exposed in the attention-following context, participants responded with 50 percent accuracy overall, thus exceeding chance level; for relations exposed in the attention-switching context, participants responded with 32 percent accuracy overall and this did not differ from chance level. This pattern of responding was also evidenced in a delayed comprehension test conducted two weeks following the final exposure session. It is possible that, when multiple relations are exposed and tested, and thus a more rigorous test of word learning is conducted, the context in which ostensive exposures are provided affects acquisition of the target relations.

Second, Ross et al. (1986) introduced participants, aged 20 months, to five novel relations in an ostensive context. Their subsequent acquisition of the novel relations was assessed with comprehension test trials, in which the visual array comprised three of the target objects; participants received between six and eight comprehension test trials per target relation. Overall, weak but above chance performance was evidenced: participants responded with 56.32 percent accuracy on these trials. However, that there were significant differences between participants' performance on test trials of the various novel relations: on test trials of three of the target relations, participants performed with 64 percent accuracy or above; on the remaining two relations, they performed at or below 57 percent accuracy. Such patterns of responding indicate stimulus preferences. (As stated earlier, in order to demonstrate the absence of stimulus preferences participants must pass learning outcome tests of each of the target relations.) Indeed, the authors found that the response accuracies for each target relation increased with object specificity: the number of different types of activities participants performed that were functionally specific to the object. Therefore the most engaging objects were selected more often than less appealing objects, corroborating the view that participants' responses were subject to stimulus preferences. This study differed from conventional cognitive/developmental exposure learning paradigms in that participants were provided

In a number of these studies this control measure was employed as a between-subjects condition. After experiencing the exposure trials, a control group of participants were given preference control trials; their performance was compared to that of an experimental group's which was given comprehension test trials (Baldwin, 1991, 1993a, 1993b; Golinkoff et al., 1992, Study 2; Woodward et al., 1994, Study 3). Alternatively, a control group of participants, who had not experienced the exposure trials, were given comprehension test trials (Akhtar & Tomasello, 1996, Study 1; Carey & Bartlett, 1978; Dockrell & Campbell, 1986; Tomasello & Barton, 1994, Study 2; Tomasello et al., 1996; Study 1). With two exceptions (i.e., Carey & Bartlett, 1978, and Dockrell & Campbell, 1986[2]), the control group's selection of the target stimuli in these studies indicated that the experimental group's responses on comprehension/ extension test trials were not a result of a preference for, or heightened interest in, the target visual stimuli. This is because the control group's selection of the target stimuli did not differ from chance level, and, further, was significantly less than the experimental group's selection of these stimuli.

Although these studies aimed to assess preferential responding, preference control trials were administered to a group of participants different from those who responded on comprehension test trials after having received the exposure trials. Therefore, they do not provide conclusive evidence that the experimental group participants did not prefer the target visual stimuli.

A more stringent control is occasioned by presenting preference control trials as a within-subjects condition. In doing so, the experimental group's preferences are directly assessed (see Schafer & Plunkett, 1998). Only one study -- Woodward, Markman, and Fitzsimmons (1994, Study 1) -- employed such a control. In this study

[2] It is not surprising that in Dockrell and Campbell's (1986) study the control group's selection of the target stimulus on the comprehension test trial did not differ from that of the experimental group. This is because, as stated earlier, the comprehension test trial did not differ in nature from a fast mapping exposure trial as a result of the omission of novel distracter visual stimuli in the comparison array (see Section 2.1.3).

the 18 month old participants who responded above chance level on comprehension test trials were also found to select the target visual stimuli at chance level on corresponding preference control trials. Further, their selection of the target visual stimuli on comprehension test trials was significantly greater than their selection of these stimuli on preference control trials.

In summary, cognitive/developmental researchers have conducted preference/novelty control trials in an attempt to verify control by the target novel words on comprehension test trials. These have almost always indicated that participants' selections of the target referents on comprehension test trials are not a result of a preference for, or heightened interest in, the target visual stimulus.

2.2.2. Responding by Novelty Alone

Even with the inclusion of preference control trials, the cognitive/developmental studies outlined in Chapter 1, have demonstrated, at best, only that participants' responses are controlled in *some part* by the novel auditory stimuli. This controlling aspect may be the novelty of the word per se. As only one novel relation is exposed[3], participants do not need to note any specific defining characteristics of the novel word in order to respond correctly on comprehension test trials; rather, they need only note that the word is novel and, in response, select the only novel object that has been labelled with a novel word within the course of the study. Responding on this basis does not bias participants to select the novel visual stimuli on preference control trials; thus, where preference control trials are conducted, it may appear that participants have acquired the target relation.

[3] In some cognitive/developmental studies, more than one target novel relation has been exposed (e.g., Baldwin, 1993a; Golinkoff et al., 1992; Mervis & Bertrand, 1994). However, in all these studies, these have been introduced consecutively such that each relation is exposed and tested before the introduction of the next. Thus target relations are not contrasted with each other (i.e., tested within the same block of trials).

In order to assess whether participants have noted the specific distinguishing features of the target word, a novel distracter auditory stimulus must be presented. This is achieved by the presentation of *novel label control trials.* On these trials participants are presented with the same visual array as comprehension test trials, and a second novel word, not encountered before in the context of the study, is presented as the auditory sample (see Figure 2.2).

If participants have not noted the specific defining features of the target word, they will also select the target visual stimulus on these trials; this is because they will select the only novel object that has been labelled with a novel word within the course of the study. If they have, however, formed a mapping between the target stimuli then they should respond away from this stimulus (i.e., select one of the remaining visual stimuli). In addition, the inclusion of novel label control trials obviates the need for preference control trials: in cases in which participants have a preference for the target stimulus they will also select this stimulus on novel label control trials.

Only one cognitive/developmental study outlined in Chapter 1 employed novel label control trials -- that of Oviatt (1980). In this study, participants' time spent looking at the target visual stimulus in response to comprehension questions and novel label questions was recorded. This was compared to participants' baseline rates of looking at the target stimulus in order to ensure that they were not looking spuriously at the target stimulus, rather than in direct response to the auditory sample. In order to have demonstrated comprehension of the target word, Oviatt required participants to look towards the target visual stimulus on comprehension test trials, and not to look at this stimulus on novel label trials. Only 2 of the 10 participants aged 9 to 11 months satisfied these criteria; 6 of the 10 participants aged 12 to 14 months, and all of the 10 participants aged 15 to 17 months also satisfied these criteria.

Woodward, Markman, and Fitzsimmons (1994; see also Schafer & Plunkett, 1998) criticise Oviatt's methodology. They argue that participants may have avoided looking at the target stimulus in response to novel label questions as a result of looking at the experimenter/parent in confusion when they heard the distracter novel word dictated (i.e., recognising it as unfamiliar within the context of the study). However, this criticism is contradictory: in order for the participants to look towards the experimenter in confusion only upon hearing the (distracter) novel label, they are required to note that it differs from the target word. Such responding indicates that participants have, in fact, noted some aspect of the target novel word, and thus suggests that their correct responses on comprehension test trials were not based on novelty alone. Although Woodward et al.s' criticism is unsound, there remain critical weaknesses in this study. These methodological shortcomings are also applicable to virtually all the cognitive/developmental research outlined earlier, and are discussed below.

2.2.3. Unreinforced Conditional Selection

A further potential source of false positive responding on multiple choice tasks is identified in the behaviour analytic literature: that of *unreinforced conditional selection* (URCS). On comprehension/extension test trials participants may consistently select the correct visual stimuli conditionally upon the auditory samples in the absence of direct reinforcement, or without prior experience of the stimulus relations (i.e., the correct stimulus pairings). Behaviour analytic research has demonstrated that, following an experimental history of conditional responding, participants may then go on to show consistent conditional selections with new stimulus sets in the absence of a training history for those particular stimuli. This has been shown in procedures employing visual-visual stimulus pairings with normally developing children and adults (e.g., Harrison & Green, 1990; Saunders, Drake, & Spradlin, 1999; Williams, Saunders, Saunders, & Spradlin, 1995) and mentally retarded participants (e.g., Saunders, Saunders, Kirby, & Spradlin, 1988; Saunders & Spradlin, 1990). Unreinforced conditional responding has also been found with young children aged 25 to 26 months, on auditory-visual tasks similar in nature to the multiple choice tasks employed in cognitive/developmental exposure learning paradigms; further, this occurred in the absence of an experimental history of reinforcement for conditional responding on such multiple choice test trials (Dugdale & Johnson, in press).

It is possible then that selections of the target visual stimuli on comprehension test trials may be URCSs. Although such responding may not be responsible for every participants' selection of the target visual stimulus on these trials, URCSs may inflate the group mean score in cognitive/developmental studies, perhaps even to the level of statistical significance. This is especially likely when there are few visual comparisons on test trials, for example, when there are only two visual stimuli presented on multiple choice tasks (e.g., Baldwin, 1993a; Baldwin et al., 1996; Woodward et al., 1994).

Participants would be more likely to make URCSs of the target visual stimulus on these trials as a result of a response bias to attend to the novel stimuli. Participants, upon presentation of the novel word, may conditionally select the only novel object to have been labelled in the context of the study, and hence form unreinforced conditional relations between the stimuli.

In order to assess responding on the basis of URCSs, comprehension pre-tests may be presented. These are conducted to confirm that participants do not have any prior associations between the novel auditory and visual stimuli, and thus that their correct responses on subsequent comprehension tests are a product of the exposure trials presented.

2.2.4. Experimenter cueing

A final source of false positive responding it that of *experimenter cueing*. In the majority of the studies outlined above, the experimenter(s) has been aware which novel word and object have been paired together as the target stimuli on exposure trials. In addition, parents have often been present throughout the exposure and assessment phases (e.g., Akhtar & Tomasello, 1996; Oviatt, 1980; Tomasello, Strosberg, & Akhtar, 1996; Woodward et al., 1994). Thus is it possible that participants may have been inadvertently cued the correct responses on test trials. These cues may be subtle, or even unintentional: participants may respond to the experimenter's or parent's line of regard towards the correct stimulus on test trials, or may respond to subtle changes in the experimenter's tone of voice or body posture, and so forth.

In only two of the studies outlined above -- Baldwin et al. (1996) and Woodward et al. (1994) -- was a control for experimenter cueing implemented. In both of these studies this was achieved by the participation of two experimenters. One of the experimenters presented only the exposure trials, and the second experimenter conducted only the test trials. As a result, the second experimenter, who was not present in the exposure phase, was unaware of the correct stimulus pairings and was thus unable to cue correct responses. In studies in which such a control was not implemented, there is no evidence that participants were not cued the correct responses on test trials.

2.2.5. Summary

Cognitive/developmental researchers acknowledge that participants' correct responses on comprehension test trials may not be a direct result of exposure to the target relations; rather, they may be a result of a preference for the target visual stimulus. In order to assess responding on this basis, in exposure learning paradigms preference/novelty control trials have frequently been conducted. In virtually all these studies participants have been found to select the target novel visual stimuli at chance level on these trials, thus suggesting that participants' above chance performance on comprehension test trials is not a result of preferential responding.

However, even in the absence of preferences there remain further sources of false positive responding. Patterns of URCSs may inflate the group mean scores in these studies, and experimenter cueing may also influence participants' comparison selections. Further, participants may also respond accurately on comprehension test trials without having noted the specific defining features of the novel target word; this may be a result of responding on the basis of novelty alone.

Although some authors have employed measures to control for, or to assess, such false positive responding, none of these has implemented all of the necessary controls. The cognitive/developmental research outlined in Chapter 1 has thus failed to provide unequivocal evidence that participants' responses on comprehension test trials are controlled by the specific novel words presented. However, even if all of these controls had been employed in the studies outlined in Chapter 1, these studies would still be subject to a more fundamental criticism. This is discussed in Section 2.3.

2.2.6. Rationale for Study 1

At this point it is appropriate to briefly direct attention to Study 1 of the thesis (see Chapter 4 for a more detailed rationale). This preliminary study aimed to replicate cognitive/developmental exposure learning paradigms. That is, a single novel target relation was introduced to participants in three consecutive exposure contexts: non-ostensive, ostensive, and fast mapping exposures. Participants' acquisition of the target relation was assessed following each exposure trial type; this assessment comprised the presentation of comprehension test trials.

Of paramount importance was the implementation of a number of stringent control measures. From the discussion of the methodological limitations of the studies outlined above, necessary controls were identified and were thus incorporated in Study 1. Specifically, these were employed in order to identify preferential responding, URCSs, and responding on the basis of novelty alone, and in order to control for experimenter cueing. These controls permit more concrete conclusions regarding word learning to be drawn.

2.3. *Exposure of a Single Novel Relation: Evidence of Word Learning?*

Sections 2.1 and 2.2 present criticisms of the cognitive/developmental paradigms outlined in Chapter 1; these pertain to the paucity of methodological control employed. In this section, a more fundamental limitation of this research is discussed: the exposure and testing of a single target novel relation.

In all the cognitive/developmental studies outlined in Chapter 1, a single target novel word-referent relation was exposed and tested. Where more than one target relation was exposed (e.g., Baldwin, 1993a; Golinkoff et al., 1992, Study 2; Mervis & Bertrand, 1994, Study 1) these were introduced in succession throughout the duration of the study; they were not directly juxtaposed against, or contrasted with, each other -- one relation was exposed and tested before the next was introduced in a repetition of the procedure. Hence, on comprehension test trials, each target referent was contrasted only with novel distracter visual stimuli that had not been labelled in the course of the study.

As a result, participants' correct selections of the target visual stimuli on comprehension test trials may represent false positive responses, rather than their acquisition of the target relation. Aside from responding on the basis of novelty alone (see Section 2.2.2), participants are able to produce correct responses on comprehension test trials on the basis of *shared familiarity*. Responding on this basis does not require participants to have noted the specific defining features of the target stimuli. Instead, they need only have noted enough of the novel target auditory and visual stimuli to recognise that they are *equally familiar* (see Schafer & Plunkett, 1998; Wilkinson, Dube, & McIlvane, 1996, 1998; Wilkinson & Green, 1998). In other words, participants need only have noted that they have just seen and heard the target visual and auditory stimulus in the preceding exposure trials, and thus note that these stimuli are equally familiar within the context of the study. Therefore, on comprehension test trials, when presented with the novel target and distracter visual stimuli, participants may produce correct comparison selections by responding according to a general rule -- for example, "if I hear the novel word that I heard a moment before, then I select the novel object that I saw labelled a moment before". Participants therefore need only recognise that the target word and referent are the ones that were presented during exposure trials and match them on this basis.

Responding on the basis of shared familiarity, unlike responding on the basis of novelty alone (see Section 2.2.2), requires that participants have noted *some* features of the target stimuli; this is in order to note that they are equally familiar. However, this does not necessitate that they have formed a one-to-one relation between the specific novel stimuli exposed, and, therefore, that their responses on comprehension test trials are controlled by the specific target word. As Wilkinson, Dube, and McIlvane (1996) write:

> Strictly, if a subject is exposed to only a single new relation, his or her selection of the correct comparison . . . can only be interpreted to mean that the child recognises both the word and the referent as the stimuli that have most recently been defined (somehow) within the learning context. It does not imply that a one-to-one map has been established between that specific word and its related comparison. (p. 141)

Even in studies in which novel label control trials have been presented, unequivocal conclusions regarding word learning may not be drawn; this is because correct responding on such control trials may also be negotiated on the basis of shared familiarity. On novel label control trials participants are shown the same comparison array as comprehension test trials, but are presented with a novel distracter auditory stimulus as the sample (see Figure 2.2). In order to correctly respond away from the target visual stimulus, participants need only note that the novel label dictated differs from the one previously heard in the exposure phase, and thus select an object that differs from the one previously labelled in the exposure phase.

In order to verify control by the specific novel auditory samples on comprehension test trials, and to determine unequivocally that participants have formed one-to-one mappings between the specific novel stimuli exposed, multiple novel relations must be exposed and tested concurrently (Wilkinson et al., 1996, 1998; Schafer & Plunkett, 1998). This is noted by Wilkinson et al. (1996) who state "to infer that a one-to-one map has been established, one must evaluate whether or not the newly defined relation is maintained in the presence of other novel relations" (p. 141). As is highlighted by this quotation, the most important aspect of the introduction of more than one novel relation is the contrast of these relations against each other during testing. Target relations must be exposed and tested *concurrently* such that comprehension test trials of each novel relation involve the presentation of more than one target novel stimulus in the visual array. In behaviour analytic research this has been the convention and such test trials have been termed *learning outcome* or *discrimination outcome* trials (see Figure 2.3). These test trials, and the related performance outcomes, are discussed in detail in Section 2.3.2.

The testing in this way of multiple relations obviates the need to present a variety of test and control trial types. In order to demonstrate the absence of stimulus preferences, participants must respond above chance level (or at criterion level in behaviour analytic studies) on learning outcome trials of *each* of the novel relations. The exposure and testing of multiple relations eliminates responding on the basis of novelty alone and heightened interest in the target visual stimulus as a function of labelling -- this is because all novel objects have been labelled within the course of the study. Further, in relation to this, responding on the basis of shared familiarity is eliminated because all the novel visual stimuli have been labelled in the exposure phase of the study and are thus equally familiar. Correct responding on learning outcome trials requires that participants have noted the specific defining features of the novel words and referents, and therefore demonstrates the acquisition of specific one-to-one mappings between the target stimuli.

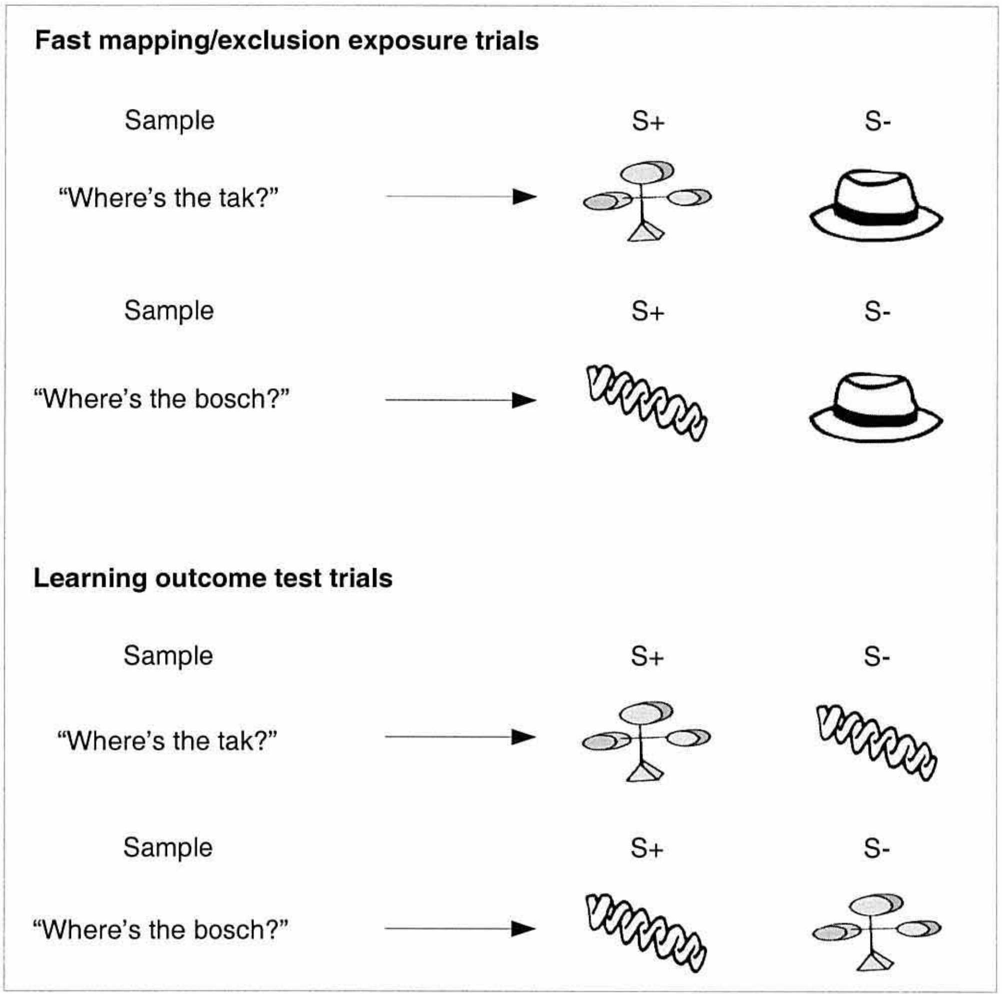

Figure 2.3. An example of the test trials employed in studies in which multiple novel relations are exposed and tested concurrently. In this example a fast mapping/exclusion paradigm is depicted. Learning outcome test trials may also be conducted following ostensive and non-ostensive exposure trial types.

With regard to this issue, it has previously been stated that some cognitive/developmental researchers have suggested that the ability to learn new words from unreinforced exposures is related to the rapid acquisition of vocabulary in the second year of life -- in particular, the vocabulary spurt (e.g., Mervis & Bertrand, 1993, 1994). If such learning is instrumental in the rapid acquisition of vocabulary, then it is necessary to demonstrate that young children are able to map multiple novel words, each to their own referents, in quick succession; it must be shown that new relations are maintained in the presence of other new relations (Wilkinson et al., 1998). In comparison, Bates (1993, cited in Wilkinson et al., 1996) argues that there may be a period of acceleration in the number of new word-referent relations that can be mapped and maintained; this culminates at a point in development in which children are able to map multiple new relations simultaneously and thus increase their vocabulary size rapidly. As Wilkinson and Green (1998) write, with particular reference to fast mapping exposures:

> it is possible that the process of establishing an initial partial map may not be the same as the processes involved in maintaining that relation while learning one or more other words. If fast mapping is, in fact, involved in rapid vocabulary acquisition, this distinction is of the utmost importance. It is essential to study how fast mapping progresses when more than one word is to be learned. (p. 164)

Despite the theoretical and methodological importance of studying the acquisition of multiple word-referent relations, this has been relatively neglected in cognitive/developmental research. Where studies have been conducted (Lucariello, 1987; Ross, Nelson, Wetstone, & Tanouye, 1986; Schafer & Plunkett, 1998; Tomasello & Farrar, 1986; Whitehurst, Kedesdy, & White, 1982), these have been few in number and, again, are subject to methodological criticisms (these criticisms are discussed in Section 2.3.1). In contrast, behaviour analytic research has typically focused on the concurrent exposure and testing of multiple novel relations (e.g., Lipkens et al., 1993); this research is discussed in Section 2.3.2.

2.3.1. Exposure of Multiple Novel Relations: Cognitive/Developmental Studies

A number of cognitive/developmental studies have exposed and assessed the acquisition of multiple novel target relations. Importantly, in each of these studies, the target referents have been contrasted against each other as comparison stimuli on comprehension test trials; thus these trials parallel the learning outcome trials employed in behaviour analytic research. These cognitive/developmental studies are reviewed below.

Ostensive paradigm. Four cognitive/developmental studies have concurrently exposed and assessed the acquisition of multiple novel relations within an ostensive paradigm. The first of these -- Lucariello (1987) -- introduced participants to five novel relations. The exposures were provided by participants' parents who were instructed to label the target objects as they would do normally. Following exposure sessions, participants were given eight comprehension test trials of each of the novel relations; these were three-choice trials in which three of the target objects were presented in the visual array. The criteria for having demonstrated acquisition of a target relation were two consecutive correct responses, or three out of four correct responses, on test trials for that specific relation. The learning evidenced in this study was minimal: participants classed as beginner speakers (10 to 40 words in production) learned a mean of 1.2 out of 5 relations, and advanced speakers (50 or more words in production) learned a mean of 2.8 out of 5 relations. Further, because parents provided participants with the exposures in this study, these were not controlled with regard to frequency, exposure type, and reinforcement; thus participants may have been reinforced for mapping the target words and objects, and the learning evidenced may have been a result of a combination of exposure trial types.

Greater above chance performance was evidenced in the following three studies.

First, Tomasello and Farrar (1986) gave participants, aged two years, 16 ostensive exposure trials of each of four novel relations -- two were exposed in an attention-following context and two in an attention-switching context (these contexts are described in Section 1.1.1). Participants were then given four comprehension test trials in which the visual array comprised the four labelled target objects. In contrast to the 18 month olds in Baldwin's (1993a) and Baldwin et al.s' (1996) studies, Tomasello with immediate feedback for their responses on test trials, and thus the correct responding that was evidenced may have been trained.

Criticisms can be made of the above studies. All failed to include an assessment of unreinforced conditional responding (e.g., a comprehension pre-test of the novel relations), and all failed to implement a control for experimenter cueing. As a consequence, where participants demonstrated evidence of learning, albeit limited, it is possible that such evidence comprised false positive responses.

The final cognitive/developmental study to have concurrently exposed, and tested the subsequent acquisition of, multiple novel relations is that of Schafer and Plunkett (1998). The authors conducted a preferential looking study of the ostensive exposure learning of two novel word-picture relations by children aged 15 months. Participants were given six ostensive exposures of each target relation. On each exposure trial, the target auditory stimulus was presented, and following a short delay, the corresponding target visual stimulus was shown on a monitor. In subsequent comprehension test trials, the visual array comprised the two target referents (shown on monitors, one on each side of the participant's visual field) and each target word was presented as the sample on six trials. Participants' time spent looking at each target visual stimulus was recorded. The results indicated acquisition of the target relations: when a target word was presented, participants looked more at the correct corresponding target referent than the incorrect target stimulus. The authors also implemented a control for possible cues to correct responses that may have been provided by either the experimenter or parent, and thus participants' responses were unlikely to have been prompted.

However, the authors did not provide convincing evidence of acquisition of *both* of the target relations: participants, on average, demonstrated acquisition of at least one of the novel relations. Thus observation of participants' correct line of regard on test trials of the target relation acquired may have been the result of a stimulus preference.

significantly better acquisition of the novel relations following ostensive exposures trials than exposure trials presented in either non-ostensive context. Participants' responses exceeded 80 percent accuracy on comprehension test trials following ostensive exposure trials; response accuracies following non-ostensive exposure trials were significantly lower -- approximately 40 percent or below. Thus, when more stringent tests of word learning are conducted, even with participants aged two to three years, there is no convincing evidence that participants are able to comprehend novel words following non-ostensive exposures.

However, a second explanation may be offered. Whitehurst et al. (1982) imposed a 10 second delay between the presentation of the novel auditory and visual stimuli on non-ostensive exposure trials; this has been criticised as artificial and unlike natural language learning contexts (Tomasello & Barton, 1994). Perhaps participants are able to pass stringent tests of word learning following more naturalistic non-ostensive exposure trials in which the temporal delay between the presentation of the auditory and visual stimuli is reduced. Note also that the authors of this study did not include controls for URCS and experimenter cueing.

Fast mapping paradigm. Only one cognitive/developmental study -- that of Golinkoff, Hirsh-Pasek, Bailey, and Wenger (1992) -- has exposed multiple novel relations in a fast mapping paradigm. Although it is claimed that this study provided a controlled test of word learning by concurrently introducing and testing two relations (Wilkinson et al., 1996), this claim may be criticised. Although two novel target relations were introduced within a block of four multiple-choice trials, on closer inspection these trials, in effect, constituted only fast mapping exposure trials, extension test trials, and novel label control trials. The two target referents were not directly contrasted against one another on test trials in which each novel target word was presented as the alternating auditory sample: traditional learning outcome trials were not conducted. Therefore, a pattern of correct responding across all of the four trial types may have been achieved by responding on the basis of shared familiarity and novelty alone. As a result, there are no cognitive/developmental fast mapping studies in which multiple novel relations have been concurrently exposed and assessed.

Further methodological considerations. Although the above studies (with the exception of Golinkoff et al., 1992) have concurrently exposed and assessed the acquisition of multiple novel relations, these have failed to include essential controls for unreinforced conditional responding and/or experimenter cueing. Further, where these controls have been implemented, and a more stringent test of word learning conducted, the authors have not employed a naturalistic language learning context as has been typically employed in earlier cognitive/developmental research.

In addition, all of the cognitive/developmental research has adopted a group study methodology in which small numbers of test trials have been presented to large groups of participants; their performance has then been statistically averaged and presented as a reflection of the group's performance as a whole (e.g., Huntley & Ghezzi, 1993). Although the data from such studies indicate how children perform in general, they provide no indication as to an individual's performance on comprehension test trials. For example, when a group of participants has responded above chance level on average, it is possible that some participants have responded correctly on all test trials of all novel relations, whereas some have failed to respond correctly on any trial; alternatively, all participants may have responded correctly on some test trials of some of the novel relations, thus not demonstrating reliable evidence of acquisition of the novel relations. This is an important consideration when exposing and testing multiple novel relations: the acquisition of multiple relations in the absence of stimulus preferences, on learning outcome trials, is demonstrated by criterion level responding on trials of each of the target relations.

In contrast to these studies, behaviour analytic research adopts a single case methodology; these studies are outlined in the following section.

2.3.2. Exposure of Multiple Novel Relations: Behaviour Analytic Studies

Behaviour analytic studies applicable to the exposure learning of novel auditory-visual relations have employed single-case methodology. In these studies, an individual participant's performance is observed and recorded repeatedly over time, thus permitting a reliable assessment of his or her performance on test trials (Huntley & Ghezzi, 1993; Kazdin, 1982).

In addition, the behaviour analytic research presented in Chapter 1 provides a more stringent assessment of word learning than the cognitive/developmental research outlined; this is because the convention in behaviour analytic research is to concurrently train and test multiple stimulus relations. As a result, tests of acquisition of these relations comprise learning outcome trials in which the comparison array comprises target visual stimuli alone, and the alternating auditory samples comprise the corresponding target auditory stimuli (see Figure 2.3). Thus these studies have assessed the derivation of specific one-to-one relations between the target stimuli.

Although these studies are more stringently controlled than much of the cognitive/developmental research they are relatively limited in number. In fact, only one series of studies -- that conducted by Lipkens et al. (1993) -- parallels those of the cognitive/developmental exposure learning paradigms. This is because, as stated earlier, the specific research focus has not been the acquisition of vocabulary in young children; rather, such research has concerned aiding and promoting efficient learning and communication, and has thus centred on mentally retarded populations. Behaviour analytic studies directly relevant to lexical acquisition, and parallel to the cognitive/developmental exposure learning paradigms, are outlined below.

Ostensive paradigm. Lipkens et al. (1993, Study 1) conducted the only behaviour analytic study of relevance to exposure learning in ostensive conditions. They introduced their participant to four novel word-picture relations. These were introduced and tested in pairs such that the comparison array on learning outcome trials comprised two target visual stimuli; each novel target word was the sample on half of these trials. The participant responded above criterion level on learning outcome trials of both novel relations, thus demonstrating the acquisition of two new specific word-picture mappings.

Nonetheless, a number of criticisms may be levelled at this study. These question whether the learning evidenced was a result of the exposure/training trials or was an experimental artefact.

First, the same experimenter conducted both the training and test sessions; she was thus aware of the novel stimulus pairings and of the accuracy of the participant's responses on test trials. As the participant was seated on the experimenter's lap throughout the experimental sessions, he may have been cued, albeit unintentionally, to make correct selections on test trials (e.g., the participant may have followed the experimenter's line of regard, or responded to changes in the experimenter's tone of voice or body posture).

Second, the participant's criterion level responding may have been a result of a pattern of URCS. The participant may have, by chance, formed the correct relations and consistently selected each picture conditionally upon presentation of the correct corresponding auditory sample. This is likely to have occurred by chance: as only two novel relations were introduced concurrently, there was a 50:50 chance of the participant relating them correctly. As a consequence of these considerations, it is questionable whether the learning outcome exhibited was a result of the exposures the participant received to the novel target relations, or was an artefact of experimenter cueing or URCS. Further, no behaviour analytic studies have been conducted with young children in which novel word-object relations have been introduced.

Non-ostensive paradigm. As stated in Chapter 1, no behaviour analytic studies of non-ostensive exposure learning have been conducted with linguistically relevant stimuli.

Exclusion paradigm. The convention in behaviour analytic studies of exclusion has been the concurrent exposure or training of multiple novel stimulus relations. Participants have been given exclusion trials of more than one novel relation within one experimental session. As stated earlier, behaviour analysts have frequently acknowledged that correct responses on exclusion trials do not verify control by the novel samples: they do not unequivocally demonstrate that participants have acquired a one-to-one mapping between the specific stimuli introduced. Even with the inclusion of control trials, they show only that participants have attended in *some part* to the auditory samples.

As a result, in order to determine whether participants have derived specific relations between the novel stimuli, they are presented with *learning outcome* or *discrimination* test trials (see Figure 2.3). To reiterate: on these trials participants are shown two or more of the novel target referents as visual comparisons, and are requested to select one upon presentation of the corresponding novel auditory stimulus. Test sessions therefore comprise blocks of learning outcome trials in which each of the target novel words is presented as the auditory sample on an equal number of trials. Acquisition of the novel relations on such trials is evidenced by criterion level responding on test trials of *each* of the novel relations; this indicates correct responding in the absence of stimulus preferences.

In contrast to the cognitive/developmental fast mapping research, behaviour analytic exclusion research thus provides more controlled studies of word learning; this is by virtue of the concurrent exposure/training and learning outcome testing of multiple novel relations. The findings of exclusion studies lead one to question the proposition that the ability to pass tests of fast mapping is related to the rapid acquisition of vocabulary (e.g., Mervis & Bertrand, 1994). This is because such studies have shown that correct responding on exclusion (i.e., fast mapping) trials does not guarantee acquisition of the novel relations. Typically, these studies have shown that, although participants respond above criterion level -- and in many cases without error -- on exclusion trials, not all participants will go on to pass subsequent learning outcome tests; this has been so even in cases in which correct responses on exclusion trials have been reinforced. Such behavioural outcomes have been found with adults and adolescents with mental retardation (e.g., Dixon, 1977; McIlvane & Stoddard, 1981, 1985; Wilkinson & Green, 1998; Wilkinson & McIlvane, 1994) and normally developing participants (e.g., McIlvane et al., 1988).

As was outlined in Chapter 1, a handful of studies have been conducted with normally developing children (Ferrari et al., 1993; Lipkens et al., 1993, Study 4; McIlvane et al., 1988). However, only one of these studies was conducted with a normally developing child of an age parallel to the participants in the cognitive/ developmental research presented earlier, and has presented unreinforced exclusion trials -- that of Lipkens et al. (1993, Study 4). To reiterate, Lipkens et al. gave their participant Charlie -- aged approximately 24 months -- unreinforced two-choice matching-to-sample exclusion trials of two novel relations; Charlie responded above criterion level on these trials, producing response accuracies of 94.1 percent and 93.8 percent overall. Charlie was then given 20 learning outcome trials; on these he was shown both of the novel pictures and was asked to select one upon presentation of the corresponding novel word. He was given 10 trials of each novel relation: each novel word was presented as the auditory sample on 10 trials. Lipkens et al. conclude that Charlie derived the novel relations: he responded above criterion level on learning outcome trials producing response accuracies of 100 and 90 percent on each relation tested.

Although Lipkens et al. (1993, Study 4) demonstrated acquisition of novel word-picture relations following unreinforced exclusion trials, it is questionable whether the learning outcome evidenced was a result of the exclusion exposure trials, or was a pattern of false positive responding. Charlie's correct responses may have been a result of either unreinforced conditional responding or experimenter cueing. As this is the only behaviour analytic exclusion study conducted with a young normally developing child, it remains an open question whether participants are able to acquire multiple novel word-referent relations following exclusion trials in more tightly controlled conditions.

A further finding of behaviour analytic exclusion studies is of interest. It has been shown that where participants have performed above criterion on exclusion trials, yet have failed to pass subsequent learning outcome tests, a modified procedure of *successive introduction* of the novel relations has improved responses on learning outcome trials. The facilitatory effect of this procedure, over the traditional exclusion procedure, has been shown with participants with moderate to severe mental retardation (Wilkinson & Green, 1998; Wilkinson & McIlvane, 1994a, 1994b; see also Wilkinson et al., 1996). Although the successive introduction procedure was originally an adaptation of Golinkoff et al.s' (1992) procedure, it provides a more controlled study of word learning in that, despite the name given to the procedure, the novel relations are introduced concurrently. Thus the term *successive introduction* is misleading: it does not mean that novel relations are exposed and tested in succession; rather, the novel relations are introduced successively on exclusion trials, but are still contrasted with one another in subsequent learning outcome testing.

In the traditional behaviour analytic exclusion procedure (depicted in Figure 2.3), participants are given exclusion trials of each of the novel relations in the same experimental session. In contrast, in the modified successive introduction procedure (depicted in Figure 2.4), participants are given exclusion trials of the novel relations in different sessions such that the introduction of the second relation is contrasted with the first.

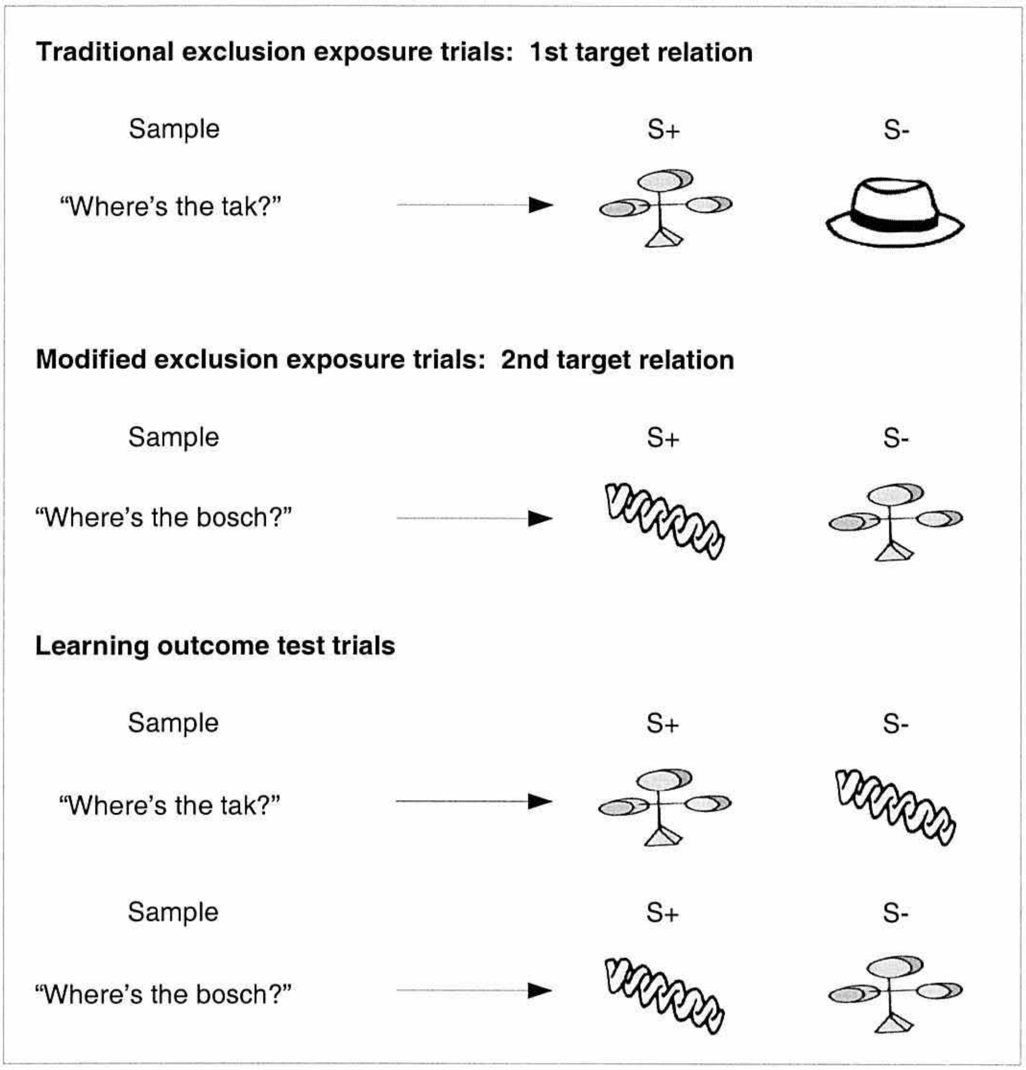

Figure 2.4. An example of the "successive introduction" procedure used by behaviour analytic researchers to study learning by exclusion.

The procedure may be summarised as follows.

In an initial phase, participants are given exclusion trials of one of the novel relations. Following criterion level responding on these trials, the second relation is introduced in *modified exclusion trials*. In these, the first target referent is presented as the now defined, or familiar, comparison (see Figure 2.4). Criterion level responding on these trials thus requires only that participants exclude the original target referent; correct responding may therefore be based on shared familiarity. In order to determine whether this is the case, participants are given learning outcome trials; these are identical to those described earlier (see both Figures 2.3 and 2.4). Thus this procedure differs from that of Golinkoff et al. (1992) in that learning outcome trials, in which the target relations are contrasted against one another, are conducted; it also differs from the traditional exclusion paradigm in that the target relations are contrasted in the second phase (modified exclusion trials) as opposed to only at the end of the study. This procedure is proposed to facilitate learning first because it allows participants experience with the first target relation before the second is introduced; and second because discrimination between the novel referents is required in some part prior to their juxtaposition on learning outcome trials (Wilkinson & Green, 1998).

Although this procedure is in its preliminary stage, and has only been piloted with individuals with moderate to severe mental retardation, it is possible that a successive introduction procedure may facilitate learning by exclusion (and thus fast mapping) in young children.

The experimental work in the present thesis provides an opportunity to assess such an issue.

2.4. Summary

Cognitive/developmental researchers have, in exposure learning paradigms, presented participants with comprehension test trials. The limitations of these trials in demonstrating evidence of specific one-to-one mappings between the target stimuli were discussed, and the resulting necessary controls required to permit such conclusions to be drawn were presented. A further, more fundamental methodological criticism was also levelled at these studies: the exposure and testing of a single novel relation.

In studies in which only one novel relation has been exposed and tested, as is the typically the case in cognitive/developmental research, no unequivocal conclusions regarding the acquisition of specific word-referent relations may be drawn. The necessity of the concurrent introduction of multiple novel relations, and the presentation of subsequent learning outcome testing, was discussed; studies from both traditions in which such procedures have been employed were also outlined. The behaviour analytic literature is superior in this respect and provides more controlled studies of word learning. However, these are limited in number. Only one such study has been conducted with a normally developing child in contexts which parallel those of the cognitive/developmental ostensive and fast mapping paradigms.

Further, even in cases in which multiple novel relations were concurrently exposed and tested in both traditions, there exist further possible sources of false positive responding: URCS and experimenter cueing. No studies have been conducted of the exposure learning of novel word-referent relations in which all the necessary controls have been implemented. Consequently, it remains an open question whether young children are able to demonstrate acquisition of multiple novel word-referent relations from ostensive, non-ostensive, and fast mapping/exclusion exposures in tightly controlled conditions.

In Chapter 3, a further and more fundamental limitation of much of the research is discussed: where participants have passed learning outcome tests, there is no evidence that the specific one-to-one mappings acquired have symbolic properties -- one of the key characteristics of language. The stimulus equivalence paradigm is thus introduced as a method for assessing the symbolic properties of such relational responding.

CHAPTER 3

STIMULUS EQUIVALENCE: A BEHAVIOUR ANALYTIC PARADIGM FOR ASSESSING SYMBOLIC RESPONDING

Chapter 1 outlined the cognitive/developmental and behaviour analytic paradigms that have been employed to investigate, or are of relevance to, the exposure learning of novel word-referent relations. Research conducted employing these paradigms has investigated the acquisition of novel stimulus relations following ostensive, non-ostensive, or fast mapping/exclusion exposures to new words and their referents. Many authors of such studies claim that young normally developing children are able to comprehend new words following limited, unreinforced exposure to novel words and their corresponding referents (e.g., Lipkens, Hayes, & Hayes, 1993; Mervis & Bertrand, 1994; Tomasello, Strosberg, & Akhtar, 1996; Woodward, Markman, & Fitzsimmons, 1994).

Chapter 2 levelled numerous criticisms at these studies; these pertain to the paucity of methodological control employed. In particular, a fundamental limitation of the majority of the cognitive/developmental research was discussed: the exposure and testing of a single novel relation. In studies in which a single novel relation is introduced, it is questionable whether participants' success on comprehension/extension tests demonstrates evidence of the acquisition of one-to-one mappings between the specific stimuli exposed; thus the authors of such studies have failed to demonstrate unequivocally that participants have acquired a specific lexical item. In contrast, in the behaviour analytic research, participants have been introduced to multiple novel relations; most importantly, these relations have been exposed and tested concurrently, thereby providing a more stringent assessment of word learning (this was the case in only a few cognitive/developmental studies -- e.g., Lucariello, 1987; Whitehurst, Kedesdy, & White, 1982). However, due to the focus of the behaviour analytic research, studies relevant to the exposure learning of novel stimulus relations have rarely been conducted with young normally developing children. Further, in cases in which such studies have been conducted, within both traditions, the authors' failure to implement adequate control procedures leads one to question whether the participants' accurate performance on learning outcome tests is a direct result of the exposure trials, or is a pattern of false positive responding.

There remains a further fundamental limitation of the cognitive/developmental research. Even in studies in which multiple novel relations have been exposed and tested concurrently (e.g., Lucariello, 1987; Whitehurst, Kedesdy, & White, 1982; Schafer & Plunkett, 1998), and participants have demonstrated learning outcome of these relations, such results do not provide unequivocal evidence of *real word learning*. The authors of cognitive/developmental studies have failed to demonstrate that participants' one-to-one mappings between the target auditory and visual stimuli are *symbolic* relations, and thus they have failed to demonstrate that participants have learned that the target word *stands for*, or *refers to*, the target visual stimulus. Consequently, the results of such studies do not provide unequivocal evidence of *comprehension* of the new words and the acquisition of new items of vocabulary.

Behaviour analytic researchers have developed an experimental paradigm for assessing the symbolic properties of relational responding: the *stimulus equivalence* paradigm (Sidman, 1971). This paradigm provides an experimental methodology for determining whether participants' accurate responses on comprehension test trials are the result of the acquisition of symbolic relations between the target auditory and visual stimuli exposed: whether the relations acquired are, specifically, *word-referent* relations.

The stimulus equivalence paradigm is described in this chapter, and studies of stimulus equivalence that have been conducted with normally developing young children are outlined; this is with particular reference to the exposure learning of novel stimulus relations.

This chapter concludes with a rationale for the experimental work presented in this thesis. This shows how, in the present studies, procedural elements from the cognitive/developmental and behaviour analytic exposure learning paradigms outlined in Chapter 1 are combined; how possible sources of false positive responding identified in Chapter 2 are controlled for by the concurrent exposure and testing of multiple novel relations, and the implementation of necessary control procedures; and how participants' criterion level performance on comprehension tests are shown to be the result of the derivation of symbolic relations -- equivalence relations -- between the target stimuli.

* * *

3.1. Cognitive/Developmental Studies: Evidence of Comprehension?

The focus of this chapter is highlighted by Lock (1980), who states:

> The child's early learning of words presents two main problems for investigation. Firstly, how does the child come to *associate* specific sounds with specific objects. Secondly, when does he transcend these associations and come to use these sounds to *refer* to objects; for transcend these associations he must if his use of sound is to qualify as language. (p. 108; emphasis original)

With reference to the first area of study proposed by Lock, cognitive/developmental researchers have developed three paradigms for the investigation of the exposure learning of novel stimulus relations -- those outlined in Chapter 1. In studies in which these paradigms have been employed, participants have typically been exposed to, and tested for their subsequent acquisition of, a single novel relation (e.g., Mervis & Bertrand, 1994; Tomasello et al., 1996; Woodward et al., 1994). In a minority of studies conducted within this tradition, participants have been concurrently exposed to, and tested for their acquisition of, multiple novel relations in an ostensive paradigm (Lucariello, 1987; Ross, Nelson, Wetstone, & Tanouye, 1986; Tomasello & Farrar, 1986; Whitehurst et al., 1982) or a non-ostensive paradigm (Schafer & Plunkett, 1998; Whitehurst et al., 1982); as yet, however, no cognitive/developmental studies have investigated the acquisition of multiple novel relations in a fast mapping paradigm. As was discussed in Chapter 2, studies in which multiple novel relations are concurrently exposed and tested provide more controlled studies of word learning.

In each of the cognitive/developmental studies outlined in Chapter 1, the authors' measure of word learning was the assessment of participants' comprehension of the novel target words; these assessments take the form of comprehension/extension test trials conducted within the format of standard multiple choice tasks. In these, participants are presented with an auditory stimulus -- the target word -- and are requested to point to, act upon, or manually select the corresponding (i.e., related) target stimulus from an array of two or more visual stimuli. (As stated in Chapter 1, multiple choice comprehension tasks are procedurally similar to behaviour analytic auditory-visual matching-to-sample trials.) In other cognitive/developmental studies, preferential looking methods have been employed (Oviatt, 1980; Schafer & Plunkett, 1998); these are procedurally identical to comprehension test trials but the required response is the participants' visual orientation towards the target referent. Correct responses on comprehension test trials, in studies in which multiple novel relations have been concurrently exposed and tested, indicate that participants have formed one-to-one mappings between the specific target auditory and visual stimuli.

We now turn to the second issue of early word learning highlighted by Lock (1980): how does one determine that participants' mappings of the target auditory and visual stimuli are, specifically, *word-referent* relations, that participants understand that the target words *refer to* the corresponding target objects or pictures?

The test trials presented in cognitive/developmental exposure learning paradigms are so called because participants' correct selections of the target visual stimuli, in response to the corresponding target auditory stimuli, might be taken as evidence of their comprehension of the new words. Whilst such responses demonstrate that participants have mapped (i.e., formed a relation linking) the specific target auditory and visual stimuli, cognitive/developmental researchers also interpret these responses as indicating that participants have learned new lexical items, and have thus comprehended the new words (Gerken & Shady, 1996; Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987; Harris, Barlow-Brown, & Chasin, 1995; Markman & Hutchinson, 1984; Reznick, 1990; Taylor & Gelman, 1988). In other words, where participants have responded above chance on comprehension tests their performance is taken to indicate that they have acquired *symbolic word-referent relations* in which the target auditory stimuli have the status of words: *linguistic symbols* that *stand for* or *refer to* the corresponding target objects or pictures. This is widely accepted by cognitive/ developmental researchers, and they have typically adopted such test trials as a method of assessing comprehension in infants and young children.

Despite this, there is a fundamental limitation of assessing comprehension in this way. In order to provide evidence of real word learning, it must be shown that participants have formed *symbolic*, or bi-directional, relations between the target stimuli: that participants understand that the words and the corresponding objects/pictures are symbols that are functionally interchangeable. If participants have acquired symbolic relations between the target stimuli then they have learned that the visual stimuli are the referents of the corresponding words, and, vice versa, that the novel auditory stimuli stand for, or refer to, the corresponding visual stimuli. On comprehension test trials, although participants' accurate responses indicate that they have formed one-to-one relations between the specific words and referents, the nature of these relations is questionable: it is not evident from their performances on comprehension test trials that the mappings they have acquired are symbolic.

Participants' accurate responses on comprehension test trials may be simple conditional responses: participants may have formed only *conditional relations* between the target auditory and visual stimuli. Conditional relations may be described as associative responses: simple stimulus-response chains, or "if-then" relations, in which participants learn to select one stimulus conditionally upon the presentation of another related stimulus. Such conditional relations are uni-directional and are devoid of symbolic properties; they are thus non-linguistic. As participants' accurate responses on comprehension test trials may be simple conditional responses, the evidence for word learning provided by cognitive/developmental researchers is equivocal.

The limitation of the use of comprehension test trials in demonstrating evidence of real word learning -- symbolic responding -- is more recently acknowledged by cognitive/developmental researchers (Schafer & Plunkett, 1998; Woodward et al., 1994). Woodward et al. (1994) write:

> responses [on comprehension test trials] do not . . . necessarily differentiate between learning a nonlinguistic associate and learning a linguistic symbol. Although no one seriously doubts whether preschoolers understand words as linguistic entities . . . a more stringent test for comprehension of a linguistic symbol in 1-year-olds may be required. (p. 564)

On comprehension test trials, the behavioural outcome of the acquisition of both symbolic relations and conditional relations is the same: the accurate selection of the target visual stimulus in response to the presentation of the corresponding target word. Therefore correct responses on these trials do not differentiate between participants' acquisition of symbolic bi-directional relations between the target stimuli, or their acquisition of simple uni-directional conditional discriminations. In order to determine whether the relations participants have formed involve symbolism, in addition to conditionality, further testing is required.

Woodward et al. (1994) note that, within the cognitive/developmental tradition, criteria for the assessment of symbolic word use in infants have been proposed. These include the use of words in the absence of the corresponding referents (Pettito, 1988), the use of words to describe and categorise classes of referents (Macnamara, 1982; Pettito, 1988), and the use of words for the intention of communicating (Grice, 1975; Premack, 1990). However, these authors ignore comprehension; instead, they propose tests of symbolic word use in which the production of new words is assessed. Woodward et al. (1994) conclude "an important direction for future research is to develop comparable criteria for comprehension" (p. 564).

Such criteria have been developed within the behaviour analytic tradition: the *stimulus equivalence paradigm*. This is an experimental methodology that may be employed in order to assess the symbolic properties of relational responding; thus it is directly applicable to word learning and enables an assessment of nature of the relations acquired following exposures to novel word-referent relations. It is to this paradigm that we now turn.

3.2. The Stimulus Equivalence Paradigm

The behaviour analytic stimulus equivalence paradigm has its origins in research conducted on the functional analysis of reading comprehension in individuals with severe mental retardation (Sidman, 1971, 1977; Sidman & Cresson, 1973). Since its conception in the early 1970s, the paradigm has been extensively employed by behaviour analysts and has been closely linked to the study of language. This is because the stimulus equivalence paradigm provides an empirical methodology for studying emergent behaviour and symbolic functioning -- characteristics that are readily evidenced in human language.

In the early 1970s, stimulus equivalence research was couched within the terminology of paired associate learning (Sidman, 1994), and the stimulus equivalence paradigm was then termed a *mediated transfer paradigm* (e.g., Sidman & Cresson, 1973). A more rigorous definition of stimulus equivalence was later proposed. Sidman and Tailby (1982) applied the mathematical principles of equivalence to behavioural relations and presented an experimental methodology for the identification of equivalence relations. This became the basic paradigm employed in subsequent research.

Studies of stimulus equivalence typically employ conditional discrimination or arbitrary matching-to-sample procedures in order to establish conditional relations among physically different sets of stimuli during training, and, in addition, to test for the derivation of further untrained -- emergent -- relations. In these procedures, participants are presented with a sample stimulus and are required to select a corresponding, or related, stimulus from an array of comparisons. (As stated in Chapter 1, matching-to-sample tasks are procedurally similar to cognitive/ developmental multiple choice tasks.) For example, on a stimulus-response panel, participants are initially shown a sample stimulus on the centre key of the display. Once participants have made a sample response (i.e., touched the centre key on which the sample stimulus is displayed), indicating that they have attended to this stimulus, the comparison stimuli appear on the outer keys of the response panel. Participants are then required to select the comparison stimulus that corresponds to the sample stimulus; this is the comparison response (i.e., touching the key on which the corresponding stimulus is displayed).

The basic stimulus equivalence paradigm requires that participants are initially trained two conditional relations which have one set of stimuli in common; this necessitates the introduction of a minimum of three stimulus sets (Saunders & Green, 1999). Thus, in the basic experiment, participants are presented with three sets of novel arbitrary stimuli -- typically termed Sets A, B, and C. Visual-visual procedures involve the presentation of purely visual stimulus sets in which participants are trained arbitrary conditional relations between two visual stimuli (e.g., Barnes, Smeets, &

Leader, 1996; Devany, Hayes, & Nelson, 1986; Saunders, Drake, & Spradlin, 1999); alternatively, auditory-visual procedures may be employed in which participants are trained conditional relations between auditory and visual stimuli (e.g., Green, 1990; Sidman, Cresson, & Willson-Morris, 1974).

Participants are initially trained a series of conditional discriminations between these stimuli on matching-to-sample training trials; these are established via differential reinforcement in which correct comparison selections are reinforced. In a typical experiment participants may be trained A-B and B-C conditional relations: selection of the B stimuli conditionally upon presentation of the A stimuli as samples, and selection of the C stimuli conditionally upon presentation of the B stimuli as samples, respectively (see Figure 3.1).

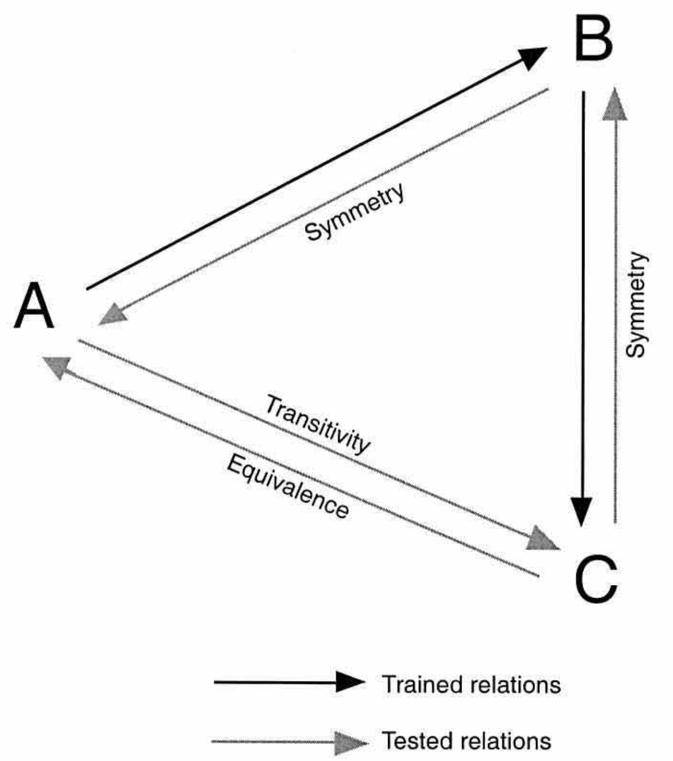

Figure 3.1. Schematic representation of the stimulus equivalence paradigm. A, B, and C represent stimulus sets. Arrows point from sample to comparison stimuli.

Following criterion level responding on training trials of both conditional relations, participants are then tested for emergent relations: the derivation of new stimulus relations that have not been directly trained or reinforced. This unreinforced testing determines whether the trained relations are simple conditional discriminations, devoid of symbolic properties, or are equivalence relations. Based upon the mathematical definition of equivalence, Sidman and Tailby (1982; see also Sidman, 1990, 1992) proposed four behavioural tests for equivalence relations; three of these are tests of the properties of equivalence relations, and the fourth is a combined test for all three properties. These are as follows.

1. *Reflexivity.* If the trained A-B and B-C conditional relations are indeed equivalence relations, the participants must be able to match each stimulus to itself without further training (i.e., if A=B and B=C, then A=A, B=B, and C=C); the stimuli should be matched irrespective of their positions as samples and comparisons. Thus the behavioural test for reflexivity is *generalised identity matching.*

2. *Symmetry.* If the trained A-B and B-C conditional relations are indeed equivalence relations they must be bi-directional, or symmetrical: sample and comparison stimuli must be functionally interchangeable (i.e., if A=B then B=A; similarly, if B=C then C=B). Thus symmetry tests comprise tests of the reversal of the trained relations (see Figure 3.1). In the above example, symmetry tests assess the emergence of the untrained B-A and C-B relations: matching-to-sample trials in which participants are required to select the A stimuli conditionally upon presentation of the corresponding B stimuli as samples, and the B stimuli conditionally upon the C stimuli as samples.

3. *Transitivity.* If the trained A-B and B-C conditional relations are indeed equivalence relations, then the three sets of stimuli must be related transitively (i.e., if A=B and B=C, then A=C). In the above example, the behavioural test for transitivity would be a test for the emergence of A-C relations (see Figure 3.1): matching-to-sample trials in which participants are required to select the C stimuli conditionally upon presentation of the A stimuli as samples. Note that transitivity requires the uni-directional combination of relations: relations are combined transitively in the same

direction in which they were trained. Thus, it is possible for participants to pass a transitivity test even if the baseline training had established only uni-directional conditional relations.

4. *Equivalence.* Sidman and Tailby (1982) proposed a final test for equivalence. This is a combined test for each of the three properties of equivalence relations. In the above example, the behavioural test for equivalence would be a test for the emergence of C-A relations (i.e., if A=B and B=C, then C=A; see Figure 3.1): matching-to-sample test trials in which participants are required to select the A stimuli upon presentation of the C stimuli as samples. An equivalence test differs from a test of transitivity; this is because, in order to pass a C-A test in the above example, the relations must be equivalence relations that posses all three properties of reflexivity, symmetry, and transitivity: criterion level responding on C-A equivalence tests requires the participants to match the stimuli irrespective of their positions as samples or comparisons (reflexivity); to reverse the trained A-B and B-C relations to derive emergent B-A and C-B relations (symmetry); and to combine the symmetrical B-A and C-B relations (transitivity).

When participants have demonstrated derivation of the reflexive, symmetrical, and transitive relations, or have passed an equivalence test, then it is concluded that they have formed an equivalence class between the stimuli; that the stimuli are equivalent and are functionally interchangeable. Participants will pass such tests only if the conditional discrimination training has generated equivalence relations between the stimulus sets. Thus, if participants fail one of the prerequisite tests of equivalence they should also go on to fail the equivalence test; conversely, if participants have passed each of the prerequisite tests of reflexivity, symmetry, and transitivity, they should go on to pass the equivalence tests. These outcomes are robust irrespective of the stimuli employed, and the conditional relations initially trained; inconsistencies in such results have been attributed to experimental artefacts or to inadequate descriptions of the experimental procedures or controlling stimuli (Iversen, Sidman, & Carrigan, 1986; Sidman, 1980, 1992, 1994; Stikeleather & Sidman, 1990).

3.3. Stimulus Equivalence and Language

As was stated earlier, the study of stimulus equivalence has been closely related to the study of language and verbal behaviour. This is because symbolic responding, emergent behaviour, and the functional interchangeability between corresponding stimuli -- precisely the characteristics of responding that the stimulus equivalence paradigm assesses -- are considered by behaviour analysts and cognitive/developmental psychologists to be the key characteristics of language (e.g., Catania, 1986; Hockett, 1958; Osgood, 1980; Sidman, 1994; Sidman, Rauzin, Lazar, & Cunningham, 1982).

The relation of stimulus equivalence to language is ostensible in studies in which the stimulus sets utilised are linguistically relevant (e.g., de Rose, de Souza, & Hanna, 1996; Lipkens, Hayes, & Hayes, 1993; Sidman & Cresson, 1973): the stimuli employed are words and their corresponding referents that are related by social convention. To participants who do not have functional language, and are not familiar with these relations, these stimuli are initially nothing more than meaningless auditory or visual patterns that are arbitrarily related; these physically dissimilar stimuli are only related, and are thus only made meaningful, by social convention and the reinforcement contingencies arranged by the verbal community (Green, Mackay, McIlvane, Saunders, & Soraci, 1990).

Spoken words, corresponding pictures or objects, and the corresponding printed words may be employed as Sets A, B, and C stimuli respectively (e.g., Sidman & Cresson, 1973; see Figure 3.2). In this example participants may initially be trained A-B (spoken word-picture) conditional relations (see Figure 3.2).

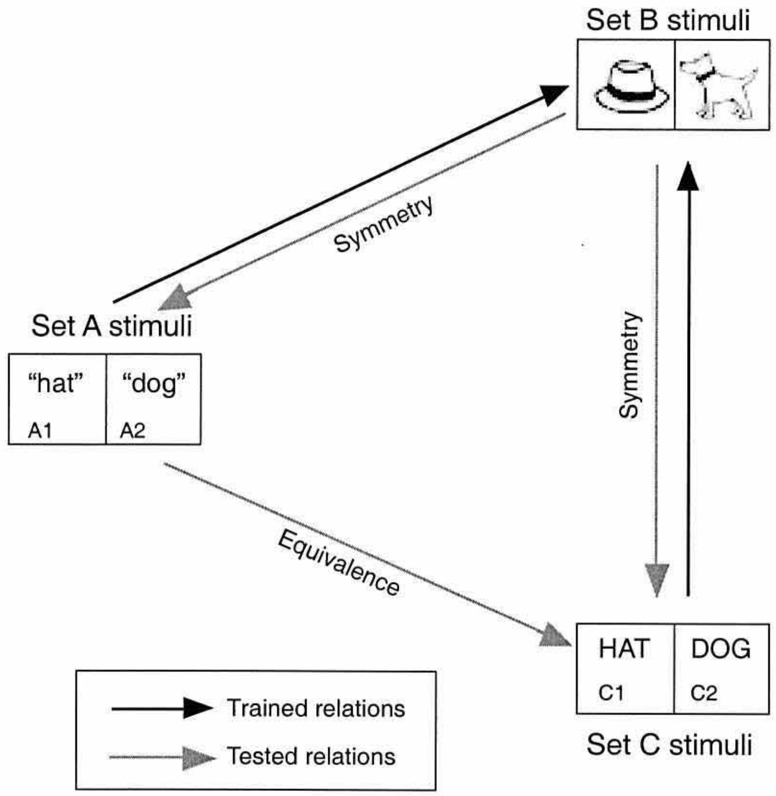

Figure 3.2. Schematic representation of a stimulus equivalence paradigm in which the stimulus sets A, B, and C comprise dictated words, pictures, and corresponding written words respectively. Arrows point from sample to comparison stimuli.

On matching-to-sample trials, upon presentation of the spoken word "hat" participants are trained to select the corresponding picture of a hat, this being the A1-B1 relation; similarly, participants may be trained to select the picture of a dog upon presentation of the corresponding spoken word "dog", this being the A2-B2 relation.

Criterion level responding on A-B training trials indicates that participants are selecting the pictures conditionally upon presentation of the specific corresponding words; this performance is behaviourally identical to participants' accurate responses on cognitive/developmental comprehension test trials. Because of this it might appear, and it is tempting to assume, that participants are demonstrating auditory comprehension of the dictated words; this is what is assumed by cognitive/developmental researchers. However, at this point it is not clear whether participants have formed symbolic relations between the words and corresponding pictures, or whether their responses are non-symbolic conditional selections. Indeed, non-human participants are capable of performing at criterion level on such matching-to-sample tasks; the establishment of conditional responding has been demonstrated with non-human species and it is not assumed that such conditional responding by non-human participants provides unequivocal evidence of comprehension. This is widely acknowledged by behaviour analytic researchers (e.g., Sidman, 1994; Terrace, 1985). For example, Sidman (1992, p. 15) writes "watching a monkey and a child doing this task we cannot see any difference. And yet, we want to believe that something different is happening in the two cases". (The difficulty in demonstrating equivalence relations in non-human populations is discussed shortly.) Thus the critical question remains: having responded above criterion level on these trials, can participants now be said to comprehend the dictated words?

The stimulus equivalence paradigm provides a methodology for determining whether comprehension or understanding is involved in this performance. In order to determine whether the trained relations are indeed symbolic, further training and testing is required. This involves the training of a second set of conditional discriminations. In the present example C-B (written word-picture) relations are trained: on matching-to-sample trials participants are trained via differential reinforcement to select the pictures conditionally upon presentation of the corresponding written words. Again, criterion level responding is established on these trials, and it is tempting to assume that participants have acquired symbolic relations between the written words and pictures -- that their criterion level performance indicates reading comprehension.

In order to determine whether the trained A-B and C-B relations are conditional relations, or whether participants have formed equivalence relations between the stimuli, subsequent unreinforced test trials are conducted. In the present example participants would be tested for the derivation of the symmetrical B-A and B-C relations (picture-spoken word and picture-written word matching, see Figure 3.2). In order to test for all these properties, a combined equivalence test may be presented; in the present example this comprises A-C (spoken word-written word matching) test trials: on unreinforced matching-to-sample trials participants are required to select the written words conditionally upon presentation of the spoken words as comparisons. This comprises a behavioural test for equivalence because criterion responding on A-C trials requires participants to have demonstrated all three properties of equivalence relations: participants are required to match the stimuli irrespective of their positions as samples and comparisons (reflexivity), to reverse the trained C-B relations to derive B-C relations (symmetry), and to combine the trained A-B and emergent B-C relations (transitivity).

Criterion level responding on these trials demonstrates that participants' responses have transcended simple conditional relations. Passing the equivalence test provides evidence of emergent relations that have not been directly trained; further, it indicates that participants have formed two three-member equivalence classes in which each stimulus is equivalent to the other.

These characteristics of symbolism, functional interchangeability, and emergent behaviour are essential features of language, and are key characteristics that distinguish linguistic or verbal behaviour from non-linguistic conditional responding (e.g., Catania, 1992; Horne & Lowe, 1996; Sidman, 1994). In the above example, the stimuli within each equivalence class are arbitrarily and bi-directionally related; the stimuli have the status of symbols that are equivalent to or are capable of standing for each other, and are thus functionally substitutable or interchangeable. The same can be said of linguistic stimuli and their referents: words and their referents form classes of equivalent and functionally substitutable stimuli. Word-referent relations are thus equivalence relations: a word is a symbol of its corresponding referent, and the referent is the meaning of the corresponding word, only when the auditory and visual stimuli are related by equivalence (Devany, Hayes, & Nelson, 1986; Sidman, 1986, 1994). Devany et al. (1986) write:

> The relations among the members of an equivalence class appear to approximate what psycholinguists and others mean when they say that a word represents or "stands for" its referent in a way that a conditionally related response does not. (p. 244)

The stimulus equivalence paradigm thus provides a method for specifying whether behaviour is verbal (Hayes & Hayes, 1989). In order to determine whether participants' accurate responses on comprehension test trials actually indicate evidence of comprehension it must be unequivocally shown that participants have formed equivalence relations between the target stimuli exposed. Sidman (1994) writes:

> Our basic experimental paradigm provides a method for defining "comprehension": when the relation between words (written or spoken) and things can be shown to be an equivalence relation, then we can say that the words are understood. We have, here, an empirically verifiable method for distinguishing between meaningful and meaningless behaviour-environment relations. (p. 14)

The stimulus equivalence paradigm is thus proposed to be closely related to language and verbal behaviour. This relationship has been repeatedly empirically tested and supporting evidence has been widely documented. Thus:

1. Equivalence relations have been extensively demonstrated in a variety of human populations who have functional language. These include normally functioning adults (Bentall, Dickins, & Fox, 1993; Bentall, Jones, & Dickins, 1998; Mandell & Sheen, 1994; Randell & Remington, 1999; Wulfert & Hayes, 1988), mentally retarded adults and adolescents (Dixon & Spradlin, 1976; Dube, McIlvane, Maguire, Mackay, & Stoddard, 1989; Green, 1990; Mackay & Ratti, 1990; Sidman, 1971; Sidman & Cresson, 1973; Stromer & Mackay, 1992; Stromer & Osborne, 1982), normally

developing children (Devany, Hayes, & Nelson, 1986; Dugdale & Lowe, 1990; Lipkens, Hayes, & Hayes, 1993; Pilgrim, Chambers, & Galizio, 1995; Saunders, Drake, & Spradlin, 1999; Sidman & Tailby, 1982; Wetherby, Karlan, & Spradlin, 1983), and mentally retarded children (Devany, Hayes, & Nelson, 1986; Eikeseth & Smith, 1992).

2. Stimulus equivalence has not been demonstrated in human participants without functional language (Devany et al., 1986; Barnes, McCullagh, & Keenan, 1990).

3. Equivalence relations, as yet, have not been demonstrated in non-human participant populations. Rhesus monkeys and baboons (D'Amato, Salmon, Loukas, & Tomie, 1985; Sidman, Rauzin, Lazar, Cunningham, Tailby, & Carrigan, 1982), chimpanzees (Dugdale & Lowe, 1990, 2000), and pigeons (Kendall, 1983; Holmes, 1979; Lipkens, Kop, & Matthijs, 1988; Rodewald, 1974) have failed tests of equivalence. The authors of a number of studies claim to have found evidence of equivalence, or its constituent relations, with non-human participants: monkeys (McIntire, Cleary, & Thompson, 1987), pigeons (Vaughan, 1988; Zentall & Urcuioli, 1993), or sea lions (Schusterman & Kastak, 1993). However, these have been variously criticised (see Dugdale & Lowe, 1990; Hayes, 1989; Horne & Lowe, 1996; Saunders, 1989), and it is generally accepted that stimulus equivalence has not been unequivocally demonstrated in non-human participants.

The source of stimulus equivalence remains a matter of conjecture, and various conflicting theories have been posited concerning the relationship between stimulus equivalence and language. For example, Sidman (1990, 1992) argues that stimulus equivalence is a primitive stimulus function that underpins language, and Hayes (1991, 1992, 1994) argues that stimulus equivalence is a derived stimulus function -- an instance of learned behaviour -- that underpins language. However, other researchers have stressed the primacy of language over stimulus equivalence: language, it is claimed, is necessary for, and enables the emergence of, stimulus equivalence (Dugdale & Lowe, 1990; Horne & Lowe, 1996).

In summary so far. A number of cognitive/developmental psychologists have more recently acknowledged the limitation of the use of comprehension test trials as a measure of word learning (Schafer & Plunkett, 1998; Woodward et al., 1994): these trials do not unequivocally demonstrate that participants have formed symbolic word-referent relations between the target stimuli introduced in exposure learning paradigms. In order to determine the nature of the relations acquired, and thus the nature of participants' accurate responses on test trials, the behaviour analytic stimulus equivalence paradigm was introduced as a method for assessing the symbolic properties of relational responding. Studies of stimulus equivalence that are relevant to this thesis are now outlined.

3.4. Studies of Stimulus Equivalence and Exposure Learning in Young Children

This section details studies of stimulus equivalence and exposure learning in young children. As stated earlier, no cognitive/developmental studies have been conducted that parallel studies of stimulus equivalence; neither have any assessed the symbolic nature of participants' responses on comprehension test trials. Despite this, one cognitive/developmental exposure learning study may have demonstrated some of the constituent properties of equivalence relations; this is discussed in Section 3.4.1. Similarly, very few behaviour analytic studies of stimulus equivalence have been conducted with normally developing young children; due to the predominant focus of such research, studies of stimulus equivalence have typically been conducted with children over two years and those with mental retardation and impairments (e.g., Barnes, McCullagh, & Keenan, 1990; Devany et al., 1986; Dugdale & Lowe, 1990; Eikeseth & Smith, 1992; Grayson Osbourne & Gatch, 1989). There is, however, one series of studies, also relevant to the exposure learning of word-referent relations, in which the development of derived relations was investigated in a young normally developing child; this is outlined in Section 3.4.2.

3.4.1. Cognitive/Developmental Research

Woodward et al. (1994) state that there have been no exposure learning studies in which participants' responses on comprehension test trials have been directly investigated to determine the existence of symbolic functioning. It might be assumed that participants' responses on extension test trials indicate evidence of symbolic responding because they are required to match the target auditory stimulus to a new exemplar of the target visual stimulus. However, this is not the case. In studies in which extension test trials have been employed (e.g., Baldwin, Markman, Bill, Desjardins, Irwin, & Tidball, 1996; Woodward et al., 1994), the new exemplars of the target visual stimuli have been functionally and physically similar to the original visual stimuli; in such studies these have differed only on one dimension: colour, size, or texture. The same cannot be said of words and their referents: these do not bear any physical similarity, and are related only by social convention: "If convention permitted, a 'ball' could just as easily be called a *bat*. Lexical learning entails the detection of arbitrary but conventional relations between labels and specific objects and events in the environment" (Gogate & Bahrick, 1998, p. 134; emphasis original). Thus participants' accurate responses on extension test trials do not provide unequivocal evidence of symbolic responding.

The Akhtar and Tomasello (1996) study introduced in Chapter 1, however, may have demonstrated some of the basic properties of equivalence relations, although this was not the intended focus of the study. The authors introduced participants to a single novel word-referent relation in one of two conditions. In one of these conditions -- the *absent referent* condition -- participants' accurate responses on comprehension test trials suggest the derivation of transitive relations between the target stimuli; this is because the authors serendipitously introduced a third stimulus related to the target word and referent.

Participants were shown three novel distracter objects and a target object within the context of a repeated hiding and finding game. The distracter visual stimuli were always located and found in one of three identical plastic buckets; in contrast, the target visual stimulus was always located and found in a toy barn. During initial script training, designed to familiarise participants with the locations of each of the visual stimuli, participants were given six non-ostensive exposures to the location-object stimulus pairings. In each exposure trial, the experimenter said "Let's see what's in here" and opened each of the locations in turn to reveal the corresponding object hidden inside. Following this, participants were then given three non-ostensive exposures to the word-location stimulus pairings. In each exposure trial, the novel word was presented preceding the indication of the corresponding location: the experimenter said, "Now let's find the toma. Where's the toma? Let's find the toma," and attempted to open the toy barn; in the absent referent condition the barn was locked and the novel object was not revealed. These exposure trials were thus non-ostensive.

At this point in the procedure participants had received both location-object and word-location non-ostensive exposures. To relate this to the stimulus equivalence paradigm, the target location, object, and word may be labelled the A, B, and C stimuli respectively. Thus participants had at this point in the procedure received A-B and C-A non-ostensive unreinforced exposure trials. In order to assess word learning, participants were given two comprehension test trials. In these they were presented with the target word and were requested to select the corresponding object from a visual array comprising the target object and the three novel distracter objects. Thus the comprehension test trials comprised C-B test trials: word-object matching trials. These, in effect, constituted a test for the emergence of transitive relations (i.e., C-A and A-B relations were exposed and C-B relations tested).

Participants responded above chance level on the comprehension test trials: 13/16 (81.25 percent) of the participants responded accurately on one or two of the test trials. This was significantly higher than a control group of 16 participants, of whom 5 produced accurate responses on 1 or 2 trials (the control group received the initial script training, but did not receive word-object exposures; for these participants, the novel word was not presented during training).

Although this study provided evidence of transitivity, it did not demonstrate evidence of the derivation of equivalence relations. Further, participants' derivation of the transitive relations may be questioned; this study was not without methodological limitations. Participants' responses on test trials may have been cued, albeit inadvertently, by either the experimenter or the parent present, and unreinforced conditional selections may have accounted for some of the participants' accurate responses. Further, and more fundamentally, only one novel relation was exposed and tested; the limitation of the exposure and testing of a single target relation was outlined in Chapter 2 (see Sections 2.2 and 2.3 for a detailed discussion of these issues). Consequently, this study failed to provide unequivocal evidence of word learning.

3.4.2. Behaviour Analytic Research

Despite its close relationship with language, there have been few studies of stimulus equivalence conducted with very young normally developing children. However, one series of studies -- Lipkens et al. (1993) -- investigated the development of emergent relations in a young normally developing child. This is the only behaviour analytic study that provides preliminary evidence that participants are able to derive novel auditory-visual relations from exposures alone to novel stimulus pairings. The study also parallels that of the cognitive/developmental exposure learning paradigms: unlike traditional stimulus equivalence studies, it was conducted in a naturalistic language learning context and employed linguistically relevant stimuli.

Like the cognitive/developmental exposure learning paradigms, Lipkens et al. (1993) presented their participant -- a young normally developing boy (Charlie) aged approximately 17 months at the start of the study -- with ostensive exposures and subsequent auditory-visual comprehension test trials (see Chapter 1, Section 1.2.1). In addition, they presented a third stimulus set and further training and testing, in accordance with the stimulus equivalence paradigm, in an attempt to demonstrate that Charlie's responses on the comprehension tests were the result of the derivation of equivalence relations between the target stimuli.

The initial procedures and related performance outcomes (A-B training and B-A testing as outlined in Chapter 1) are briefly restated here in order to show how the authors tested for equivalence relations. The stimuli employed were linguistically relevant and comprised Sets A, B, and C: pictures, nonsense names, and corresponding sounds respectively. Stimulus relations between such stimuli are readily evident in infancy -- during picture-book reading a parent might indicate a picture of a dog and say, "This is a dog, it goes woof," for instance. The novel relations trained and tested by Lipkens et al. (1993) are represented in Figure 3.3.

Initially, Charlie was trained A-B (picture-name) relations (see Figure 3.3). In each experimental session he was given reinforced training trials of two novel relations: A1-B1 and A2-B2. On each trial he was shown one of the novel pictures and was asked: "What is this?" From the third session onwards he was also given unreinforced B-A (name-picture) test trials in order to assess derivation of the symmetrical relations (see Figure 3.3). In these, he was shown both novel pictures and was requested to select one upon presentation of the corresponding novel word; each novel word was presented as the sample on half of these trials. These were thus learning outcome trials (as described in Chapter 2) in that two novel relations were concurrently trained and tested. Despite failing to achieve criterion level on the A-B training trials, Charlie passed the B-A tests (91.6 percent accuracy or above on test trials of each relation); at this point Charlie was aged 17 months and 7 days.

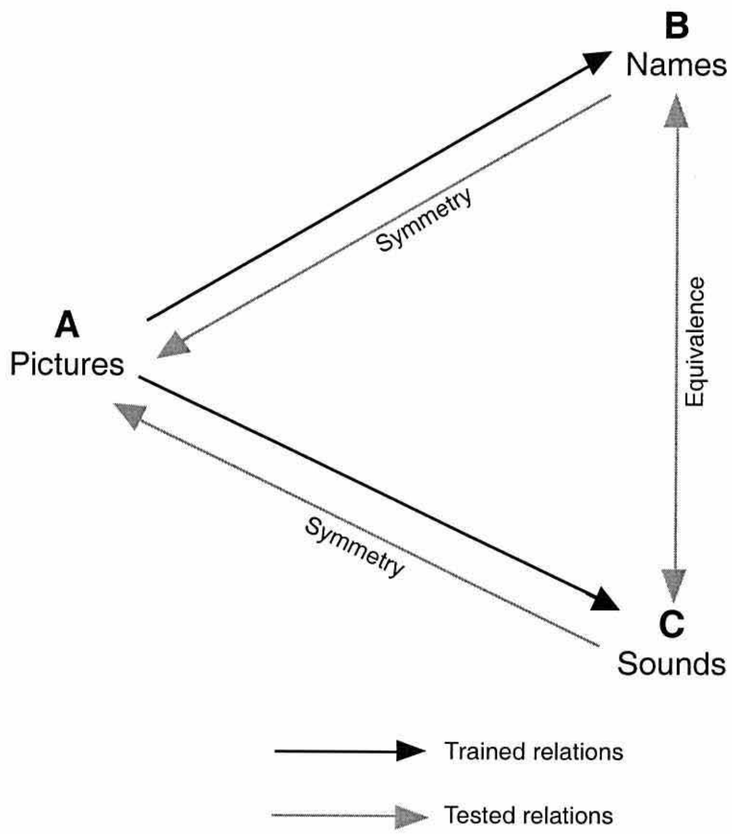

Figure 3.3. Schematic representation of the novel relations trained and tested in Lipkens, Hayes, & Hayes (1993). Arrows point from sample to comparison stimuli.

In order to conduct an equivalence test, Set C stimuli -- novel sounds -- were introduced when Charlie was aged 20 months and 20 days. In each experimental session he was given A-C (picture-sound) training trials of two novel relations: A1-C1 and A2-C2 (see Figure 3.3). In these, he was shown one of the novel pictures and was requested to produce the corresponding novel sound when the experimenter asked: "What does this say?" or "What does this do?" Charlie was then given C-A (sound-picture) symmetry test trials. In these, he was shown both novel pictures and was requested to select one upon presentation of one of the novel sounds. Again, despite not achieving criterion level on the A-C training trials, Charlie passed the related C-A tests (responding with 77 percent accuracy or above on both C1-A1 and C2-A2 test trials), thus demonstrating derivation of the symmetrical C-A relations.

Finally, Charlie was given B-C and C-B equivalence tests. On B-C (name-sound) test trials he was presented with one of the novel words, dictated by the experimenter, and was requested to produce the corresponding novel sound; on C-B (sound-name) test trials he was presented with one of the novel sounds, dictated by the experimenter, and was requested to produce the corresponding name. Both of these trial types were unreinforced. Charlie initially failed to achieve criterion level on these trials. However, following repeated training and testing he passed both B-C and C-B tests (producing overall response accuracies of 85 percent or above on both test trial types); at this point he was aged 23 months and 20 days old. Thus Charlie had apparently formed two three-member equivalence classes. This is thus far the youngest participant to have demonstrated symmetry or equivalence in the published literature.

As stated in Chapter 1, this study is also relevant to the exposure learning of novel stimulus relations. Although this was not the intended focus of their study, Lipkens et al. (1993), by virtue of their training procedure, provided preliminary evidence of the derivation of equivalence relations following exposures alone. In the initial stage of the study Charlie was given A-B and A-C training trials. In contrast to conventional procedures, Lipkens et al. introduced the related B-A and C-A symmetry test trials before Charlie had achieved criterion level on the training trials; recall that he passed both the B-A and C-A tests from the outset. Thus actually producing the names and sounds, and being reinforced for doing so, was not required in order for Charlie to derive the symmetrical relations. The authors considered this to be a result of exposure to the conditional relations during training. On both A-B and A-C training trials, Charlie was shown one of the pictures and was requested to produce the corresponding name or sound. In trials in which Charlie did not make a response, or produced the incorrect name or sound, the experimenter presented the corresponding auditory stimulus for him. On A-B trials this was by saying, "This is X, can you say X, this is X" (where X was the target name); and on A-C trials this was by saying, "This says X, can you say X, this says X" (where X was the target sound). Thus Charlie received A-

B and A-C ostensive exposures: the auditory stimulus was presented whilst the corresponding visual stimulus was still in view and thus singled out. When the auditory stimuli were presented in this manner no reinforcement for appropriate responding was provided. Lipkens et al. (1993) therefore claim that their results demonstrate the derivation of equivalence relations following ostensive exposure trials, and, further, indicate that the participant's responses on the auditory-visual matching-to-sample trials were indeed the result of the acquisition of symbolic word-referent relations.

However, as stated earlier, this study provides only preliminary evidence of ostensive exposure learning; methodological limitations of this study question whether the learning outcome evidenced was a result of the ostensive exposures, or was an experimental artefact. These limitations were discussed in Chapter 2, and are briefly reiterated here.

First, unreinforced conditional selection (URCS) is a potential source of false positive responding on matching-to-sample test trials; this was discussed in detail in Chapter 2 (see Sections 2.2.3 and 2.3.2). By chance, Charlie may have formed the correct relations and consistently selected each picture conditionally upon presentation of the auditory samples on test trials. As only two novel relations were introduced there was a 50:50 chance of Charlie forming the correct stimulus pairings, and thus the likelihood of the occurrence of unreinforced conditional responding in this study was high.

Second, the authors failed to control for experimenter cueing on test trials (see Chapter 2, Sections 2.2.4. and 2.3.2). As the participant was seated on the experimenter's lap throughout the experimental sessions, he may have been cued the correct selections on B-A and C-A test trials (i.e., trials in which manual comparison selections were required). These cues may have been unintentional -- changes in the experimenter's tone of voice, body posture, visual orientation towards the correct comparison, and so forth. The authors acknowledge that this might have been the case but dismiss a cueing explanation of their results. They argue that, although Charlie performed above criterion level on name-picture (i.e., B-A and C-A) tests, it was very difficult to later train name-picture relations with new stimulus sets; the establishment of criterion level performance on these trials ultimately required modifications to the training procedure. They reason that experimenter cueing should have led Charlie to perform at criterion level with each of the stimulus sets and across both training and test trials. However, it is possible that experimenter cueing may have affected only his responses on test trials. Whilst test trials were unreinforced, correct responses on training trials were reinforced with verbal praise and tickles. This reinforcement did not serve to improve Charlie's responses on training trials, and thus it is possible that the praise actually distracted the participant. On test trials in which the praise was not given, Charlie may have responded to the experimenter's cues -- he responded at criterion level on test trials. Thus it is possible that Charlie responded to the experimenter's subtle cues only on test trials.

There is an important implication of the above criticisms: if Charlie's criterion level performance on B-A and C-A trials was established through experimenter cueing or URCS, then these were not symmetry test trials per se; criterion level performance on these trials does not demonstrate symmetrical responding. This is because these tests may have been passed without Charlie even experiencing the exposure trials/training trials. Further, if these performances were established via experimenter cueing or URCS, then the B-C and C-B tests do not strictly assess the derivation of equivalence relations: combining the trained A-B and A-C relations with the C-A and B-A relations established through cueing or URCS may have enabled Charlie to pass the C-B and B-C tests respectively. Consequently, criterion level responding on B-C and C-B tests in this study demonstrates evidence of transitivity alone; the evidence regarding the derivation of equivalence relations is equivocal.

Third, ostensive exposures were employed, albeit unintentionally, throughout both training trial types (i.e., A-B and A-C training); this is another source of uncertainly apropos the derivation of equivalence relations. As the A-B and A-C exposures were ostensive they were also bi-directional: the participant was not exposed only to picture-name and picture-sound relations, but was also exposed to the name-picture (B-A) and sound-picture (C-A) relations. These were in fact the emergent relations that were assessed on test trials. Thus if Charlie was exposed to the B-A and C-A relations by virtue of the ostensive exposures, then the authors failed to demonstrate unequivocal evidence of symmetry on B-A and C-A test trials. Moreover, as Charlie was exposed to B-A and C-A relations, the B-C and C-B tests are not strictly tests of stimulus equivalence: B-C tests may be passed by combining the B-A and A-C exposed relations transitively, and, similarly, C-B tests may be passed by combining the C-A and A-B exposed relations transitively.

In order to unequivocally demonstrate the derivation of stimulus equivalence following exposure trials alone, non-ostensive exposures must be presented in one of the, or preferably both, stages of training. In non-ostensive exposure trials, the direction of the stimulus presentations is controlled and is uni-directional; thus if A-B and A-C exposures are non-ostensive then B-A and C-A tests assess derivation of the symmetrical relations, and B-C and C-B tests assess stimulus equivalence. As was previously stated (see Chapter 1, Section 1.2.2), only one series of behaviour analytic studies has investigated the emergence of equivalence relations following non-ostensive exposure trials (Barnes, Smeets, & Leader, 1996; Smeets, Leader, & Barnes, 1997). However, this study was conducted with children aged five years -- much older than the participant populations of cognitive/developmental exposure learning research -- and employed purely visual stimulus sets such that only visual-visual relations were trained and tested.

3.5. Summary

Cognitive/developmental researchers have failed to provide evidence of real word learning in studies that have employed exposure learning paradigms. Whilst the more controlled studies have demonstrated evidence of one-to-one mappings between the target stimuli, the nature of these relations is equivocal. Such studies have not demonstrated that the relations acquired, in addition to conditionality, have symbolic properties -- the essential features of language.

The stimulus equivalence paradigm was introduced as a methodology for assessing symbolic responding. Studies of stimulus equivalence in young children are sparse. The only study that has been conducted, and is of relevance to the exposure learning of novel word-referent relations, may be criticised. The lack of methodological control in this study renders the authors' conclusions regarding word learning, and the derivation of equivalence relations, equivocal. Thus it remains an open question whether participants are able to derive equivalence relations from exposures to novel word-referent relations in tightly controlled conditions.

3.6. Rationale for the present research

The present series of studies combines elements from both cognitive/developmental and behaviour analytic research in order to provide answers to the question posited above: are young children able to demonstrate the acquisition of symbolic word-referent relations following unreinforced exposures to novel stimulus pairings in tightly controlled conditions? A number of key elements of the present studies are adopted from, and are employed in order to extend the findings of, the exposure learning paradigms identified in Chapter 1. These are as follows.

- The acquisition of novel stimulus relations is assessed following each of the exposure trial types identified in Chapter 1: ostensive exposures, non-ostensive exposures, and fast mapping/exclusion exposures. The present studies are the first to investigate young children's acquisition of novel word-referent relations following non-ostensive impending word exposures. The exposure trial types are presented consecutively: if participants are unable to form word-referent mappings following non-ostensive exposures, then ostensive exposures are presented; similarly, if they are unable to form word-referent mappings following ostensive exposures then fast mapping/exclusion exposures are presented. It is proposed that ostensive exposures and fast mapping/exclusion exposures are more beneficial to such learning conditions; this is because ostensive exposures provide more direct and explicit information regarding the referent of a new word than do non-ostensive exposures (e.g., Baldwin & Markman, 1989), and participants' accurate responses on fast mapping/exclusion trials involve the acquisition of a receptive mapping between the target stimuli, and are behaviourally identical to the responses required on subsequent comprehension test trials (Wilkinson & Green, 1998).

- In order to parallel the cognitive/developmental research, procedural elements of these studies are adopted. The conventional cognitive/developmental exposure and testing methodologies are employed in order that the present experimental procedures are conducted in naturalistic contexts that parallel early language learning situations. The exposure trials are thus presented in a manner employing essential procedural elements of the ostensive, non-ostensive, and fast mapping exposures conducted by cognitive/developmental researchers (e.g., Golinkoff et al., 1992; Tomasello & Barton, 1994; Woodward et al., 1994). Further, the stimuli utilised in the present studies are linguistically relevant and are similar to those employed by cognitive/developmental researchers: novel objects, nonsense names, and novel pictures that are arbitrarily related.

- In order to provide a controlled study of word learning, two novel target relations are exposed and tested concurrently in the present studies. As stated in Chapter 2, this obviates the need to present various control trial types, and provides unequivocal evidence that participants have acquired one-to-one mappings between the specific stimuli exposed.

- A stimulus equivalence paradigm is employed (in Studies 2, 3, and 4) in order to determine whether participants' responses on matching-to-sample test trials, in addition to being specific one-to-one mappings, are the result of the derivation of symbolic relations between the target stimuli. Thus three stimulus sets are introduced: Sets A, B, and C -- novel objects, nonsense words, and corresponding shapes respectively. In the present studies, participants are initially given A-B (object-word) exposures and B-A (word-object) tests. These exposures are presented in three successive contexts, and these initial exposure and testing procedures directly parallel the cognitive/developmental exposure learning paradigms. Following criterion level performance on B-A tests, participants are then given C-A (shape-object) exposures and B-C (word-shape) equivalence tests. The C-A exposures are invariably presented in a non-ostensive context. This is in order to avoid the methodological limitations of presenting ostensive exposures identified in Lipkens et al.'s (1993) study (see Section 3.4.2), and thus permit an unequivocal test for the derivation of equivalence relations.

- All the test trials presented in the present studies are auditory-visual matching-to-sample trials -- auditory comprehension test trials. As was stated in Chapter 1, the acquisition of receptive vocabulary precedes the acquisition of productive vocabulary in infants (e.g., Benedict, 1979). Thus the assessment of comprehension provides a more sensitive measure of word learning in young children (see Woodward et al., 1994). This point is also noted by Lipkens et al. (1993) who suggest that stimulus equivalence may be demonstrated at an earlier age with tests that do not rely on expressive speech.

- A number of essential control procedures are implemented in the present studies, the need for which were identified in Chapter 2. These control measures eliminate, or permit an assessment of, patterns of preferential responding, experimenter cueing, and unreinforced conditional selections.

The experimental work presented in this thesis is thus cross-disciplinary. Methodological and theoretical elements from cognitive/developmental and behaviour analytic research are employed in order to provide answers to the following two questions:

1. Can young children demonstrate the acquisition of novel word-referent relations following unreinforced non-ostensive, ostensive, or fast mapping/exclusion exposures in tightly controlled conditions?

2. Are the word-referent relations acquired symbolic relations? That is, can young children demonstrate the derivation of equivalence relations following exposure alone to novel stimulus pairings in tightly controlled conditions?

CHAPTER 4

STUDY 1

ACQUISITION OF A SINGLE NOVEL RELATION: A CONTROLLED REPLICATION OF COGNITIVE/DEVELOPMENTAL EXPOSURE LEARNING PARADIGMS

Although conducted within a behaviour analytic single case methodology, Study 1 directly addressed the cognitive/developmental literature presented in Chapter 1 (see Section 1.2): participants' exposure learning of a single novel word-object relation was assessed.

Exposures to the target relation were presented in three consecutive contexts: non-ostensive impending word exposures, ostensive exposures, and fast mapping/exclusion exposures (termed exclusion exposure trials in Study 1); these combined procedural elements from the three cognitive/developmental paradigms outlined in Chapter 1. Non-ostensive exposure trials were initially presented in order that derivation of symmetry could be assessed. Ostensive and exclusion exposures were conducted subsequently; these are proposed to be more facilitative of learning under such conditions (Baldwin & Markman, 1989; Wilkinson & Green, 1998), and thus may establish acquisition of the target relation where non-ostensive exposures do not.

Assessment of acquisition of the target relation comprised auditory-visual matching-to-sample test trials; these directly parallel, and are procedurally similar to, cognitive/developmental comprehension test trials.

Most importantly, Study 1 provided a more controlled investigation of the exposure learning of a single novel relation. Following a consideration of the methodological limitations of cognitive/developmental studies (identified in Chapter 2), a number of necessary controls were implemented. These measures were employed in order to eliminate, or to assess, possible sources of false positive responding inherent in studies in which a single novel relation is exposed.

First, in addition to the target object, two novel distracter objects were introduced. This measure served to reduce the attentional facilitation effect of referring to, and acting upon, a visual stimulus (Baldwin & Markman, 1989). However, as stated in Chapter 2, although such a control may reduce this effect, it does not eliminate heightened interest in the target object as a function of labelling per se. As a result, further controls were required in order to assess stimulus preferences.

Second, novel label control trials -- termed distracter comprehension test trials in Study 1 -- were interspersed among target comprehension test trials. On both matching-to-sample trial types, participants were presented with a comparison array that comprised the target visual stimulus and the two novel distracter visual stimuli. On target trials, the target novel word was presented as the sample stimulus; on distracter trials, a distracter novel word was presented as the sample stimulus -- this distracter auditory stimulus was not associated with a visual stimulus in the context of the study. In each experimental session, these were presented in 12-trial blocks comprising six trials of each type.

The repeated presentation of target and distracter comprehension test trials enabled the identification of stimulus preferences (participants consistently selecting a preferred visual stimulus on both trial types irrespective of the auditory sample presented). Further, as was stated in Chapter 2 (see Section 2.2.2), the inclusion of distracter comprehension test trials permits a more stringent assessment of the acquisition of a one-to-one mapping between the specific target stimuli exposed. If participants have not noted specific defining features of the target word then they will also select the target visual stimulus on these trials.

Third, the inclusion of two novel distracter visual stimuli, coupled with the presentation of both target and distracter test trials, permits an assessment of unreinforced conditional selection (URCS); URCSs may enable participants to produce a pattern of false positive responding across both target and distracter comprehension test trials. If a participant's accurate pattern of responding is a product of URCS, then he or she will select the target visual stimulus conditionally upon the target auditory stimulus, and one of the distracter visual stimuli conditionally upon the distracter auditory stimulus -- the remaining distracter visual stimulus will rarely, if ever, be selected, thus indicating URCS.

Fourth, exclusion exposure trials were interspersed with control trials in order to verify control by the auditory stimulus on exclusion trials (see Section 2.1.1); this, in turn, verifies that participants have attended, in some part, to the presentation of the target word.

Fifth, experimenter cueing was eliminated by the participation of two experimenters. Experimenter 1 (E1) was present for, and conducted, only the exposure trials, and Experimenter 2 (E2) was present for, and conducted, only the test trials. As a result, E2 was unaware of the accuracy of participants' responses, and was thus unable to provide feedback or cues to correct responses on test trials.

In summary, Study 1 was a preliminary experiment that directly addressed the cognitive/developmental literature. In contrast to this literature, the present study provided a more controlled investigation of the receptive learning of a single novel word-referent relation following unreinforced exposure trials.[1]

[1] Note that this study, and all others in this thesis, conformed to the guidelines of, and were approved by, the School of Psychology Research Ethics Committee. In addition, the studies were approved by the Executive Committee of Tir na n-Og Nursery and conformed to guidelines for research conducted in this establishment, and with young children in general.

METHOD

Participants

Four preschool children, aged between 23 and 30 months, were recruited from Clebran Private Day Nursery in Llandudno, North Wales (see table 4.1). Written informed consent for their participation was gained from their parents or guardians prior to the commencement of the study (see Appendix A). Each participant's parent or guardian also completed the MacArthur Communicative Development Inventory: Words and Gestures (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick, & Reilly, 1993) at the start of the study. This was administered in order to select familiar auditory-visual relations for use in the study, and to provide an assessment of the participants' receptive and expressive vocabularies (see Table 4.1). From the responses on the MCDI it was ensured that each of the participants were post-vocabulary spurt. The criterion for classifying participants as having undergone the vocabulary spurt was the acquisition of at least 50 words in production; this criterion is typically employed by a number of cognitive/developmental researchers (e.g., Mervis & Bertrand, 1994; Woodward, Markman, & Fitzsimmons, 1994). Although BC had fewer than 50 words in production, she participated in the study as she was over 18 months old; this measure has also been adopted as a criterion for post-vocabulary spurt classification (e.g., Woodward et al., 1994).

Table 4.1

Participants' gender, age, and MCDI scores at the start of the study.

Participant	Gender	Age at start Months:days	MCDI receptive	MCDI expressive
RJ	M	23:03	395	220
BC	F	24:05	127	12
CV	F	24:14	351	318
TW	M	29:04	392	375

Note. M = Male; F = Female.

Prior to the commencement of the study, the experimenters spent many informal sessions interacting with the participants within the nursery environment and the experimental room setting. These sessions were carried out in order to familiarise the participants with the experimenters, and the setting, before any experimental sessions were conducted. In addition, the administration of Phase 1 ensured that the participants were familiar with the testing procedure employed in subsequent experimental sessions.

At the end of the study, each participant's parents/guardians were debriefed as to the aims and procedures employed, and their child's performance throughout the study: parents/guardians were sent personal letters regarding only their own child's performance.

Apparatus and Materials

Setting and Apparatus

Experimental sessions were conducted in an research room provided in Clebran Day Nursery. This was equipped with a childsize table and two childsize chairs. All other furniture and toys were removed from the room, as far as possible, in order to minimise distractions. Experimental sessions were videotaped for post session analysis. To this end, a portable video camera (Panasonic M10) was mounted upon a tripod and was installed in the corner of the room so that an unobscured view of both the experimenter and the participant was provided.

A set of pre-prepared record sheets was required for each participant. For each session a record sheet detailed the order and type of exposure trials, the order of presentation of auditory samples on test trials, and the counterbalanced order of presentation of visual comparisons on test trials. The participants' responses were recorded throughout the duration of the session by the experimenter; these were noted on the record sheet by indicating the comparison stimulus selected on each test trial.

A box, large enough to contain each novel visual stimulus, was required for non-ostensive and ostensive exposure trials (15 cm x 15 cm x 15 cm). This was made of bright holographic blue cardboard designed to be appealing to the participants. The box had a lid which opened and closed securely so that the visual stimulus was obscured from view once it was placed inside.

A collection of young children's toys was also required. These were used to occupy the participants during inter-trial intervals, and at the beginning and end of each experimental session. A variety of small stickers were also required; these were presented to participants at the end of each session. The presentation of these stickers was not contingent upon the participants' performance on test trials; rather, these were given as a reward for their general cooperation and attention throughout the duration of the session.

For some individual participants a token reward system was utilised. This comprised an MB Games "Connect 4" game which consisted of a 36 piece plastic matrix, and 36 plastic tokens coloured red or yellow (see Appendix B). Tokens were dropped into the top of the matrix columns and were removed by a trap door at the bottom.

Familiar Stimuli

Familiar visual stimuli consisted of three plastic farm animals (see Appendix C). These comprised a pig (10 cm x 5 cm), a horse (12.5 cm x 9.5 cm), and a rabbit (6 cm x 5 cm). Familiar auditory stimuli consisted of their corresponding conventional names. The familiarity of these relations to each participant was determined from parents/guardians' responses on the MCDI checklist, and, in addition, from the free play session conducted at the commencement of the study.

Novel Stimuli

Novel visual stimuli. The novel visual stimuli consisted of a variety of three-dimensional multi-sensory objects and toys, namely (see Appendix C): a multi-coloured plastic "Slinky spring" (7.5 cm x 6.5 cm); a triangular "Galt Pocket Alarm", that produced lights and sounds when its button was pressed (4 cm x 4.5 cm); a pink and white concertina snail, that produced a squeak when it was depressed (4.5 cm x 19.5 cm); a multi-coloured "Koosh ball", made of thick blue, red, or yellow elastic strands (10 cm in diameter); a pair of yellow plastic castanets (6 cm in diameter); and a red spinning top, that produced music and lights when it was spun around (6 cm in diameter). These objects were selected in order that they were novel and appealing to the participants, were visually distinct from each other, and were manipulable by participants of the age range in this study. For each participant, three of these objects were selected as novel visual stimuli; one of these was then further selected, randomly, as the target novel visual stimulus; these stimuli were selected by E1. The target visual stimulus was then exposed in Phase 2, and the remaining two novel objects comprised the distracter visual stimuli.

Novel auditory stimuli. The novel auditory stimuli consisted of the nonsense words "Tak" [tak] and "Bosch" [bOS].[2] Nonsense words were selected in order that they were novel to the participants and were distinct from one another, and these words were selected on the basis of ease of pronunciation. One of these words was selected, by E1, as the target novel auditory stimulus for each participant; this was related arbitrarily to the target novel visual stimulus selected for that participant. The remaining nonsense word was then used as the distracter novel auditory stimulus: the novel word presented as the auditory sample on distracter comprehension test trials.

[2] The nonsense words "Tak" and "Bosch" were taken from Lipkens, Hayes, & Hayes (1993).

Procedure

General Procedure

The general procedure was divided into two major phases, each of which are described in detail below.

In Phase 1 of the study, pre-testing was conducted in order to select three novel visual stimuli, and, in addition, to select a target novel relation for each participant. At least one baseline pre-testing session was conducted with each participant in order to ensure that they possessed the prerequisite skills to respond on auditory-visual matching-to-sample test trials.

In Phase 2 of the study, object-word exposures and comprehension testing were conducted. Throughout this phase the participants were exposed to one novel auditory-visual relation -- the target relation -- and were tested for the acquisition of this relation through the use of auditory comprehension test trials. Phase 2 was divided into three sub-phases. Each sub-phase consisted of the same general object-word exposure and comprehension testing procedure, yet differed in the type of exposure trials employed (each exposure trial type described in detail below).

Throughout the study a blind testing procedure was employed. This was achieved by the participation of two experimenters. Experimenter 1 (E1) was present for, and conducted, only the exposure trials; Experimenter 2 (E2) was present for, and conducted, only the comprehension test trials. Consequently, E2 was unaware of which novel auditory and visual stimuli were exposed as the target relation, and, as a result, was unaware of the accuracy of participants' responses on comprehension test trials. Thus no reinforcement or feedback for correct responding was provided on comprehension test trials, and experimenter cueing was eliminated.

Post-session data analysis was conducted by E1 who scored the participants' responses on comprehension test trials; this was because E1 was aware of the accuracy of the participants' responses. E1 then provided E2 with the appropriate record sheet for the following experimental session. E2 was never aware of the accuracy of participants' responses on test trials or, further, which type of exposure trials had been conducted.

Phase 1. Pre-testing

The pre-testing phase comprised two sessions: a free play session and a baseline pre-testing session.

1.1. Free play session. A free play session was conducted by E1 in order to select three novel visual stimuli for use in Phase 2. Participants were presented with the full array of seven novel objects and were encouraged to play freely with them in an informal setting. The participants' verbal and non-verbal behaviours were observed, by the experimenter, in order to determine that the objects were unfamiliar to them, and that they did not consistently label any of the objects. The existence of stimulus preferences were identified, and three novel stimuli observed to be equally appealing were selected for each participant.

Following the selection of three novel visual stimuli, one of these was further randomly chosen as the target novel visual stimulus. A target novel auditory stimulus was also selected by E1; this was related arbitrarily to the target visual stimulus. This target auditory-visual relation was then exposed in Phase 2.

1.2. Baseline pre-testing session. A baseline pre-testing session was conducted in order to familiarise the participants with the matching-to-sample task itself, ensure that they were able to make an unambiguous manual selection from an array of three visual comparisons, and ensure that they were able to do so for 12 consecutive trials in the absence of reinforcement. In this session, the participants were presented with 12 unreinforced baseline trials: auditory-visual test trials of the familiar relations (see Table 4.2). That is, the auditory samples and visual comparisons consisted of corresponding familiar stimuli. These baseline trials employed the following matching-to-sample format.

The participant and E2 were seated opposite each other at the table. On each trial the participant was presented with three visual comparisons that were placed on the table before him or her. As these were being placed down, the auditory sample was presented; this was dictated by E2 (in the carrier phrase appropriate to the individual participant). The participant was requested to select the correct corresponding visual comparison; for example, the participant was asked, "Where is the X?" or, "Give me the X," (where X was the auditory sample). Questions were asked at least once, on each trial, before the participant was permitted to respond; test trials were conducted in this manner in order to maximise the participants' attention to the auditory sample before a response was made. Further, these requests were presented when the participant was holding either all of the novel objects, or was holding none of the objects; this was in order to avoid biasing the participants' comparison selections.

Table 4.2

Matching-to-sample trial types employed in Phases 1 and 2 of the study.

		Visual Comparisons		
Trial type	Dictated sample	S+	S-	S-
Baseline	"Pig"	pig	horse	rabbit
Comprehension: Target	"Tak"	spring	koosh	alarm
Comprehension: Distracter*	"Bosch"	spring	koosh	alarm
Exclusion	"Tak"	spring	horse	rabbit
Control	"Horse"	horse	spring	rabbit

Note. In this example the target novel auditory-visual relation is "Tak" - spring.
* There is no specific S+ on trials of this type because no "Bosch" relation has been exposed.

On each trial, the participants were required to manually indicate an unambiguous and clear choice between the three comparisons by pointing to, picking up, or giving E2 one of the stimuli. If the participants distinctly selected one comparison followed by one, or more, of the remaining comparisons, their first response was recorded. If the participants selected two or more comparisons simultaneously, the comparisons were removed, and the trial was reconducted until a clear and codeable response was produced. Once the participants produced a codeable response, the comparisons were removed and the next trial was conducted following a short inter-trial interval.

In order for the participants to progress to Phase 2 of the study, they were required to perform at, or above, baseline criterion level: at least 80 percent correct responding within one baseline pre-testing session. Baseline pre-testing sessions were repeated where necessary until the criterion for progression to Phase 2 was satisfied.

Within baseline pre-testing sessions, and indeed all subsequent comprehension test sessions, the position of visual comparisons was counterbalanced across all 12 trials: the visual stimuli appeared as correct and incorrect comparisons, with equal frequency, in the left, right, and centre locations. This served to discourage the emergence of preferential responding. All test trials were also unreinforced. (Any exceptions to this are noted in the section entitled 'modifications to the general procedure').

Phase 2. Object-Word Exposures and Comprehension Testing

Throughout this phase of the study the participants were exposed to one novel auditory-visual relation: the target relation. Their acquisition of this relation was assessed with auditory comprehension test trials (see Table 4.2). Each experimental session consisted of exposure trials conducted by E1, and subsequent comprehension test trials conducted by E2.

Phase 2 was divided into three consecutive sub-phases. Each sub-phase employed the same general procedure, as follows, yet differed in the type of exposure trials presented (described in detail below). In Session 1, the participants received one exposure trial. This was then followed by 12 comprehension test trials; these comprised 6 target trials and 6 distracter trials (see below). In the remaining sessions in each sub-phase, the participants received three exposure trials. Each set of exposure trials was followed by 12 comprehension test trials, again comprising 6 target trials and 6 distracter trials.

Dependent upon the participants' performance on comprehension test trials, these sessions were repeated where necessary. For example, if the participants performed well, although not satisfying criterion level, on one set of comprehension test trials, this session was repeated before moving onto the next. In addition, where the participants failed to respond on all 12 comprehension test trials, due to a general lack of attention and cooperation throughout the session, the session was repeated. Whilst the typical number of sessions per sub-phase was three, each participant's progression through the sub-phases differed in the number of sessions conducted.

Phase 2.1. Non-ostensive exposure trials and comprehension testing. In this phase of the study the participants were presented with non-ostensive impending word exposure trials. That is, they were firstly presented with the target novel visual stimulus and, once this was obscured from view, they were presented with the corresponding target novel auditory stimulus. This was carried out with the use of a box. On each trial the participant was presented with the target visual stimulus and were encouraged to play freely with it. The object was then placed in the box, by the participant or E1, and the lid was closed. E1 then dictated the target auditory stimulus in the carrier phrase "That was a X" (where X was the target auditory stimulus). Before the target auditory stimulus was presented, E1 ensured that the participants was looking directly at her; this was taken as indication that the participant was attending to E1. In sessions where three exposure trials were presented, the next exposure trial was conducted following a short interval where the participant interacted with E1. Following the exposure trials, E1 then presented all three novel visual stimuli to the participant and he or she was encouraged to play freely with them. This served to minimise preferential responding in subsequent test trials.

Phase 2.2. Ostensive exposure trials and comprehension testing. During this phase of the study the participants were given ostensive exposure trials to the target relation. That is, the auditory stimulus was presented whilst the visual stimulus was still in view and being directly indicated or acted upon. As with non-ostensive exposure trials, the box was utilised in order to maximise consistency between exposure trials in Phases 2.1 and 2.2. The visual stimulus was removed from the box by E1. As the participant, and E1, attended to the visual stimulus (evidenced by joint visual attention on the visual stimulus) the auditory stimulus was dictated in the carrier phrase "This is a X" (where X was the target auditory sample). The participant was then requested to replace the object in the box. In sessions where three exposure trials were presented, the object was removed from the box and labelled once more following a period of interaction between the participant and E1. Again, following the exposure trials the participant was encouraged to play freely with all three novel visual stimuli prior to the commencement of the comprehension test trials.

Phase 2.3. Exclusion exposure trials and comprehension testing. During this phase of the study the participants received exposures to the target novel relation via exclusion trials and control trials. The participants were presented with one or three exclusion trials per session; these were interspersed with an equal number of control trials. (Although this was typically the case, the number of trials of each type occasionally varied in some sessions with individual participants.) Both trial types (exclusion exposure trials and control trials) were presented in the same matching-to-sample format as the baseline and comprehension test trials (see Table 4.2). On exclusion exposure trials, the participants were presented with the target novel visual stimulus and two familiar visual stimuli. On these trials they were requested to select the target novel visual comparison upon presentation of the target auditory sample; this novel sample was presented in the carrier phrase "Where is the X?" (where X was the novel auditory stimulus). On control trials, the participants were presented with the same array of comparisons and were requested to select a familiar visual comparison upon presentation of a familiar auditory sample. Both control trials and exclusion trials were unreinforced. The participants' performance on the control trials indicated whether their correct responses on exclusion trials were controlled by the auditory sample presented.

For some participants exclusion trials and control trials were also interspersed with baseline trials (see section entitled 'modifications to the general procedure').

Auditory comprehension test trials throughout Phase 2. Throughout each sub-phase, the auditory comprehension test trials remained identical in nature. These trials were presented in the same matching-to-sample format as baseline trials, described above, with the positions of comparisons counterbalanced within each session.

In each session, the participants were given 12 comprehension test trials. On each trial they were presented with three novel visual comparisons: the target novel visual stimulus and the two distracter novel visual stimuli, and were requested to select one of the comparisons upon presentation of an auditory sample, dictated by E2. At the beginning of each session, the participants were encouraged to play freely with each of the three novel visual stimuli; this served to minimise stimulus preferences by directing the participants' attention to all of the comparisons before the trials were conducted.

Within each session, the comprehension test trials consisted of two types: target trials and distracter trials. On target trials, the participants were requested to select the target novel visual comparison upon presentation of the target novel auditory sample (see Table 4.2). On distracter trials, the participants were requested to select one of the visual comparisons upon presentation of the distracter novel auditory stimulus (see Table 4.2). As with baseline trials, comprehension test trials were unreinforced.

In some sessions, throughout the comprehension test trials, the participants repeatedly failed to produce any responses or consistently produced ambiguous responses. In these instances, a simple game was introduced into the session: the participants were requested to point to their body parts, or clothes, and were rewarded for doing so correctly; rewards took the form of verbal praise and applause by E2. Once the participant had established a pattern of doing this correctly a test trial was conducted. For example, they were asked to "Point to your nose, point to your toes, point to the X" (where X was the auditory stimulus). This served to encourage the participants to select comparisons on test trials.

Modifications to the General Procedure

Baseline trials. Throughout the comprehension test trials some participants produced ambiguous responses, or failed to produce any responses, on test trials as a result of a lack of attention in the test procedure. In these instances, baseline trials were included in order to increase the participants' general level of attention and cooperation, and thus improve their responses on test trials. On these trials participants were provided with rewards for correct responses. These trials were, initially, presented at the beginning of the comprehension test trials. However, if participants still failed to respond on comprehension test trials, then baseline trials were also interspersed among comprehension test trials throughout the session.

As with the comprehension test trials, some participants failed to produce responses on the exclusion exposure trials and control trials in Phase 2.3. Where this occurred, baseline trials were conducted at the beginning of, and were interspersed among, the exclusion trials and control trials; again, correct responses on baseline trials were rewarded. In addition to this, where these failed to increase levels of correct responding on unreinforced exclusion trials and control trials, a token reward system was introduced. Here, the participants were presented with one token, which they placed in the "Connect 4" matrix, for each correct response on baseline trials. Each column consisted of a total of six tokens. In each column five yellow tokens were initially placed in the matrix; at the top of each column a red token was inserted. At the end of the session red tokens were exchanged for large stickers of the participant's choice. On unreinforced exclusion trials and unreinforced control trials the matrix was removed from the participant's view.

Naming test sessions. Throughout Phase 2, some participants were given a naming test session. Where the participants' performance in experimental sessions indicated possible acquisition of the target relation, they were administered a naming test session at the end of that particular sub-phase. For example, they may have correctly and spontaneously labelled the target visual stimulus, or may have exhibited some evidence of acquisition of the target relation on comprehension test trials.

The naming test session comprised free recall naming trials. On each trial, a visual stimulus was presented to the participants and they were asked, "What's this?" These trials consisted of three types.

1. Familiar trials. In these, the participants were presented with one of the familiar visual stimuli and were requested to label it.

2. Target trials. In these, the participants were presented with the target novel visual stimulus and were requested to label it.

3. Distracter trials. In these, the participants were presented with one of the two distracter novel visual stimuli and were requested to label it.

Throughout these sessions correct responses on familiar trials were rewarded with verbal praise and applause in order to encourage the participants to respond on unreinforced target and distracter trials.

Distracter naming test trials were included as a control measure in order to ensure that the participants had learned a relation between the specific target auditory and visual stimuli. That is, to ensure that the participants had learned that the target auditory stimulus referred only to the target visual stimulus and was not a name for *all* novel visual stimuli.

Exposure of a second target novel relation. Where the participants failed to demonstrate any evidence of having learned the target relation by the end of the study, a second novel auditory-visual relation was exposed in a post-test session at the end of Phase 2.3. This relation comprised the novel auditory stimulus that was previously presented as the distracter auditory sample, and one of the two distracter novel visual stimuli.

(Table 4.2 depicts an example of the samples and comparisons utilised on comprehension test trials.) In this example the target relation exposed throughout Phases 2.1 - 2.3 consisted of the auditory stimulus "Tak" and the visual stimulus the spring. In this case, the second relation exposed would consist of the auditory stimulus "Bosch" and either the koosh ball or the alarm as the related visual stimulus.

In this final session the participants received three non-ostensive exposure trials to the second target relation, and were then presented with 12 comprehension test trials. Comprehension test trials now comprised six target trials of each of the target novel relations; six trials in which each novel word was presented as the auditory sample. (Only one of these sessions was conducted with each participant due to time constraints on the study.)

Participant's Vocalisations

The participants' productions of the novel target word were recorded throughout the experimental sessions. The context in which the vocalisations occurred, the visual stimuli present at the time, and the surrounding discourse was also noted in order that each vocalisation could be classified within one of the following categories.

Spontaneous labelling. This category encompasses vocalisations that appear to be controlled by the presence of a visual stimulus alone. Such vocalisations are produced in the absence of any preceding labelling of the corresponding visual stimulus by the experimenter, or a request for the participants to do so. For example, during an exposure trial, a participant may label the target novel visual stimulus before E1 produces the target auditory stimulus. A participant may also label the visual comparisons presented on comprehension test trials. In such instances this has to precede the presentation of an auditory sample by E2 to be classified as an instance of spontaneous labelling. Instances of spontaneous labelling are classified as either correct or incorrect.

Prompted labelling. This category encompasses vocalisations that appear to be controlled by the presence of a visual stimulus, and that, in addition, are preceded by a prompt, or request, to label the visual stimulus. For example, during play with the novel visual stimuli a participant may be requested "What's this?" by the experimenter. Instances of prompted labelling are classified as either correct or incorrect.

Echoing. This encompasses vocalisations where the controlling stimulus appears to be a preceding production of the same word. For example, a participant may repeat the auditory sample presented on exposure or comprehension test trials. Where the participant echoes the auditory sample presented on a comprehension test trial, he or she may also select the correct corresponding visual comparison as he or she produces the word. Such instances, in which a participant's vocalisation does correspond with their selection of the correct comparison, are classified as echoing because their vocalisation is, nonetheless, preceded by a corresponding verbal utterance.

RESULTS[3]

The participants' performances in Phase 1 of the study are initially presented. Each participant's performance throughout Phase 2 is then presented individually. (Participants' performances in individual sessions and sub-phases, and their informal vocalisation of the target auditory stimulus throughout experimental sessions, are presented in Appendix D.)

Phase 1. Pre-testing

Free Play Session

From the free play session E1 selected three novel visual stimuli for each participant; one of these was further selected as the target novel visual stimulus, and the remaining two comprised the distracter novel visual stimuli (see Table 4.3).

Table 4.3

Novel auditory and visual stimuli selected for each participant.

	Target stimuli		Distracter stimuli		
Participant	Auditory	Visual	Auditory	Visual	Visual
RJ	"Tak"	castanets	"Bosch"	snail	spring
BC	"Tak"	spring	"Bosch"	snail	top
CV	"Bosch"	top	"Tak"	alarm	castanets
TW	"Tak"	snail	"Bosch"	alarm	castanets

Note. Novel visual stimuli are described in detail in the apparatus section.

[3] In order to provide inter-rater reliability, 10% of the data for this and all other studies were coded by two independent observers. This data comprised 10% of auditory-visual matching-to-sample trials, and 10% of test trials in which the required responses were vocalisations. Over all studies, the agreement between observers for auditory-visual matching-to-sample trials (i.e., B-A, B-C, C-A, and A-C) was 98.22%; agreement for test trials in which the required responses were vocalisations (i.e., A-B and C-B trials) was 94.52%.

In addition, from the two novel auditory stimuli, one was selected as the target auditory stimulus, and the remaining was presented as the auditory sample on distracter comprehension test trials. The target relation and distracter stimuli selected for each participant are presented in Table 4.3.

Baseline Pre-testing Session

Each participant's performance in the baseline pre-testing sessions are presented in Table 4.4. All four participants progressed to Phase 2 having satisfied the criterion of 80 percent correct responding within one baseline pre-testing session. Note also that each participant achieved criterion level in the absence of feedback or rewards for correct responses on baseline test trials; this was necessary because all subsequent comprehension test trials were unreinforced.

Table 4.4

Participants' performances on baseline pre-testing sessions.

	Baseline pre-testing sessions (percentage of correct responding)		
Participant	1	2	3
RJ	81.8	83.3	91.6
BC	91.6	-	-
CV	100	-	-
TW	83.3	100	-

As is shown in Table 4.4, although RJ and TW achieved criterion level in Session 1, they were administered a further baseline pre-testing session. In the initial session, a small number of their responses were ambiguous and their attention was easily distracted; this necessitated the repetition of test trials. Thus a further session was conducted in order to ensure that they were able to satisfy the criterion level and consistently produce clear responses on the first repetition of each test trial. Both participants progressed to Phase 2 following one or two further baseline pre-testing sessions. In these sessions, criterion level responding was achieved, their responses were consistently clear and unambiguous, and their attention was focused throughout the session.

Phase 2. Object-Word Exposure and Comprehension Testing

Each participant's performance throughout Phase 2 is summarised individually (see Appendix D for a detailed session-by-session analysis of participants' responses on test trials).

In order to have demonstrated acquisition of the target relation, in the absence of false positive responding, the participants must have produced a criterion pattern of responding across target and distracter comprehension test trials. This criterion pattern of responding was as follows.

On target trials, the participants must have produced at least 80 percent correct responding. In addition, they must also have selected the target visual stimulus on no more than 20 percent of distracter trials. This ensured that the participants' correct responding on the target comprehension test trials was not a result of heightened interest in, or a preference for, the target visual stimulus alone.

If the above pattern of responding was produced, then a further criterion must have been satisfied: the participants must not have selected one particular distracter visual stimulus on 80 percent or more of distracter trials. This ensured that the participants' correct responding on the target comprehension test trials was not a result of a false positive pattern of unreinforced conditional selection; that is, that the participants had not formed two relations, the target relation and a distracter relation, by chance and were responding conditionally according to these.

If the above pattern of responding was produced, with all three criteria satisfied, then it was determined that the participants had learned a specific relation between the target auditory and visual stimuli.

Participants BC, CV, and TW were administered exposure trials to a second target novel relation at the end of Phase 2.3. The comprehension test trials that followed comprised six target trials of each novel relation. In order to have demonstrated acquisition of the target relations, the participant must have produced at least 80 percent correct responding on target trials of *both* novel relations (i.e., both "Tak" *and* "Bosch" trials); this indicated criterion level performance in the absence of stimulus preferences.

Participant RJ

RJ did not proceed beyond Phase 2.1 of the study. Despite attending to non-ostensive exposure trials throughout seven experimental sessions, he failed to produce unambiguous responses on comprehension test trials. Thus he took no further part in the study.

Participant BC

BC did not demonstrate acquisition of the target relation following 13 non-ostensive and 7 ostensive exposure trials in Phases 2.1 and 2.2 respectively; on comprehension test trials she exhibited a weak preference for the target visual stimulus. Her responses on a naming test, and her informal vocalisations, further confirmed that she had not acquired the target relation.

In Phase 2.3, despite producing criterion level responding on baseline and control trials, BC did not achieve criterion level on exclusion trials. Although no stimulus preferences were evident, BC also failed to achieve criterion level on subsequent comprehension test trials.

Finally, BC also failed comprehension tests following three non-ostensive exposures to a second target relation; her target stimulus preference was again evident in this session.

Participant CV

CV did not achieve the criteria for acquisition of the target relation following 10 non-ostensive exposure trials in Phase 2.1; she exhibited a preference for the Distracter Visual Stimulus 2 on comprehension test trials. No contradictory evidence of acquisition of the target relation was evident in her informal vocalisations.

In Phase 2.2, CV did not pass the comprehension tests following 12 ostensive exposure trials. However, her informal vocalisations of the target word suggested that she may have acquired the target relation: she accurately labelled the target visual stimulus when prompted on five occasions. Note that these vocalisations alone do not provide adequate evidence of acquisition of the target relation: as CV was not requested to label a distracter visual stimulus, one cannot be certain that her vocalisations were the result of the acquisition of a specific relation between the target stimuli, or whether she merely produced the only novel word to have been exposed in the study (i.e., false positive responses on the basis of responding by novelty alone).

In Phase 2.3, despite responding without error on both exclusion and control trials, she again failed to demonstrate acquisition of the target relation on subsequent comprehension test trials. Her performance in a naming test, in which she was requested to label both the target stimulus and a distracter stimulus, confirmed that CV had not learned the *specific* target relation; she produced the target word on both target and distracter trials. Thus it appeared that when asked to label any novel visual stimulus CV produced the target auditory stimulus -- the only novel label to have been exposed within the course of the study.

Finally, CV was given three non-ostensive exposures to a second target relation. Again, she failed subsequent comprehension tests; her responses were in accordance with the incorrect reversed relations and thus demonstrate some evidence of URCS. It is interesting to note that it appeared CV may have been beginning to understand that the target words and referents were related specifically: on comprehension test trials she was beginning to respond conditionally, albeit in accordance with the incorrect relations; and throughout her informal vocalisations, although she continued to accurately label the original target stimulus, she did not use this word to label the second target visual stimulus, instead producing no response.

Participant TW

TW did not pass the comprehension tests following eight non-ostensive exposure trials. However, his informal vocalisations of the target word suggested that he may have acquired the target relation: he accurately labelled the target visual stimulus on many occasions. As stated above, these vocalisations alone do not unequivocally differentiate between the acquisition of a specific relation or responding on the basis of novelty alone. Thus a formal naming test was conducted in which TW was requested to label both the target visual stimulus and a distracter visual stimulus. His responses in this test confirmed that he had not acquired a specific relation between the target stimuli: TW used the target auditory stimulus to label both the target and the distracter visual stimulus. Thus it appeared that when requested to label a novel visual stimulus he merely produced the target word -- the only novel word to have been associated with an exposure trial within the context of the study.

In Phase 2.2, TW again failed comprehension tests following 12 ostensive exposure trials. He demonstrated a pattern of preferential responding for the target visual stimulus; this suggests that he may have been responding on the basis of novelty alone and is consistent with his performance in the preceding formal naming test session.

In Phase 2.3, TW initially failed to achieve criterion level on exclusion trials. Following the inclusion of token rewarded baseline trials, TW responded at criterion on exclusion trials, but failed to do so on related control trials and baseline trials. Not surprisingly, TW also failed to achieve criterion level on subsequent comprehension test trials.

TW was finally given three non-ostensive exposures to a second target relation. By this point in the study TW had tired of the procedure and refused to cooperate on any comprehension test trial. Thus he took no further part in the study.

Summary of Results

One of the four participants -- RJ -- did not proceed beyond Phase 2.1 of the study after failing to produce unambiguous and codeable responses on comprehension test trials.

The remaining three participants -- BC, CV, and TW -- progressed through all phases of the study. None of these demonstrated evidence of acquisition of the target relation on comprehension test trials following non-ostensive, ostensive, and exclusion exposure trials; each participant exhibited patterns of preferential responding at some stage in the study.

Both CV's and TW's informal vocalisations throughout the study initially suggested that they had acquired the target relation. However, their performance in formal naming tests indicated that they had not, in fact, learned a *specific* relation between the target stimuli.

DISCUSSION

The results of the present study are briefly discussed with respect to the participants' acquisition of a specific relation between the target auditory and visual stimuli. In addition, where participants failed to demonstrate evidence of forming the word-referent mapping, their responses on comprehension tests are discussed; this is with respect to the identification of characteristic patterns of responding which provide important considerations for the modification of the present procedure.

In Phase 1, all the participants satisfied the baseline criterion level in the absence of rewards and feedback, thus verifying the prerequisites for responding on auditory-visual matching-to-sample trials.

Despite achieving criterion level on baseline trials in Phase 1, RJ rarely produced codeable responses on comprehension test trials in Phase 2. It appeared that he did not understand the nature of the responses required on test trials in which novel stimuli were presented. The small number of trials on which he responded unambiguously indicated the existence of both stimulus and location preferences. The study was thus ended in this early stage with RJ.

The remaining three participants -- BC, CV, and TW -- proceeded through the entirety of Phase 2, receiving at least seven exposure trials of each type. These participants failed to demonstrate acquisition of the target relation on comprehension test trials following each exposure trial type: they failed to respond with 80 percent accuracy on target test trials. Patterns of preferential responding were prevalent: BC exhibited a weak preference for selection of the target visual stimulus in Phases 2.1 and 2.2; CV exhibited a preference for Distracter Visual Stimulus 2 in Phase 2.1, and a weak preference for Distracter Visual Stimulus 1 in Phase 2.3; and TW appeared to prefer the target visual stimulus in Phases 2.2 and 2.3.

Further, there was no evidence of acquisition of the target relation in their performances on naming test trials. CV's and TW's informal vocalisations initially suggested that they had acquired the target relation: they accurately labelled the target visual stimulus both spontaneously and in response to prompts. However, conclusive evidence of acquisition is provided only in naming tests in which the participants are requested to label both the target visual stimulus and a distracter visual stimulus. Their performances in these tests provided evidence contradictory to their informal vocalisations: their responses on target and distracter naming test trials indicated that they had not acquired a specific relation between the target auditory and visual stimuli, and were thus consistent with their performances on comprehension test trials. In both cases, although they produced the target word on target naming trials, they responded with zero percent on distracter naming trials. On these distracter trials they produced the target novel word or did not respond at all. Their utterances were not controlled by the novel visual stimuli: they produced the target novel word on naming test trials irrespective of the visual stimulus presented. Thus it appeared that, rather than labelling the visual stimuli per se, CV and TW merely produced the target novel word -- the only novel word that had previously been exposed within the experimental context.

These results are inconsistent with claims, proposed by cognitive/developmental researchers (e.g., Woodward, Markman, & Fitzsimmons, 1994; Mervis & Bertrand, 1994), that young children are able to pass comprehension tests following unreinforced exposures to a single new word-object relation. None of the participants in the present study demonstrated evidence of acquisition of the target relation despite receiving many more exposure trials than have been presented in previous studies. It is thus possible, as was argued in Chapter 2, that the learning evidenced in cognitive/developmental studies, in which a single novel relation was exposed, was artefactual. In these studies, participants' accurate selections of the target object on comprehension test trials may have been false positive responses unidentified due to the paucity of methodological control employed. If the earlier cognitive/developmental studies were stringently controlled, as was the present study, participants in those studies may also have failed to demonstrate acquisition of the target relation.

Empirical support for the proposition that false positive responses may account for some of the learning evidenced in cognitive/developmental studies is provided in

TW's performance on comprehension test trials in Phases 2.2 and 2.3. Take, for instance, his responses on comprehension tests in Phase 2.2. Following ostensive exposure trials, TW responded with 66.6 percent accuracy on target comprehension test trials. In the present study, although this exceeded the 33.3 percent chance level, it did not satisfy the 80 percent criterion level. However, this response accuracy would, for example, satisfy Woodward et al.'s (1994) criterion -- above chance responding -- for acquisition of the novel relation. Based on this criterion then, TW's responses on the target comprehension test trials would have demonstrated acquisition of the target relation. However, he also selected the target visual stimulus on 86.6 percent of distracter comprehension test trials. This indicates that his comparison selections were not controlled by the auditory samples presented; that his selections of the target visual stimulus on target comprehension test trials were not controlled by the target word. Rather, TW simply selected the only visual stimulus to have been labelled within the context of the study. This is consistent with his responses on related naming test trials on which he produced only the target word -- the only novel word exposed within the context of the study. Thus TW's performance demonstrates that false positive responses can indeed account for participants' accurate comparison selections on comprehension test trials in studies in which a single novel relation is exposed.

At the end of the present study, participants were exposed to a second target relation. Of interest here are CV's responses on comprehension test trials in this session. It appeared that CV was beginning to respond conditionally, albeit according to the incorrect -- reversed -- relations: on Tak target trials she selected the Bosch visual stimulus on 4/6 trials; on Bosch target trials she selected the Tak visual stimulus on 5/6 trials. Had the relations been exposed in this way, CV's responses would have approached criterion level responding (75 percent). Thus it appeared that she was beginning to relate the specific novel auditory and visual stimuli. This is also reflected in her informal vocalisations in this session. When requested to label the original (Bosch) visual stimulus she did so correctly on two occasions. These instances alone do not provide evidence of the acquisition of a specific relation: as in previous phases she may simply be producing this target word in response to prompts to label any novel visual stimulus. However, when requested to label the second target visual stimulus, in contrast to previous phases, she did not produce a response and, in addition, did not produce the first target novel word. Thus it appeared that she was beginning to learn that the target word "Bosch" was related to only one of the visual stimuli; in conjunction, it might be suggested that she was also beginning to learn that the remaining target visual stimulus was related, specifically, to another target word. It is possible that she did not produce this second target word ("Tak") as a result of limited exposure to it at this point in the study; perhaps she was beginning to understand that the second target visual stimulus was related to a specific novel word but was unable to recall that word following only three exposure trials. Thus it might be argued that although she had not acquired the novel relations -- as evidenced in her responses on comprehension test trials -- she was beginning to learn that the novel words were related to the specific novel objects.

CV's responses in this session provide preliminary evidence to suggest that it is possible that the exposure of a single novel relation is, in effect, too simple a context in which to study such exposure learning. It appeared that the exposure of the second novel relation facilitated CV's formation of specific word-object relations, albeit the incorrect ones. It is possible that exposing a second novel relation indicated to CV that the original target word was related to only one of the visual stimuli; perhaps, in order to acquire one-to-one word-referent mappings, participants need to not only be shown that the target word corresponds to a specific target visual stimulus, but also that it does not correspond to other visual stimuli; that the other visual stimuli correspond to other specific novel words. CV's responses are consistent with such a proposition. The exposure of multiple relations may thus facilitate such one-to-one word-referent mappings. It is possible that CV's correct responding on comprehension test trials may have improved markedly, and she may have demonstrated acquisition of the target relations had further exposures and testing been conducted. However, this was not possible in the present study due to time constraints and the participants' increasing disinterest in the experimental procedure.

In conjunction with the possible benefit of the concurrent exposure and testing of multiple word-referent relations identified in CV's responses in the final session, there is a further more fundamental reason for concurrently exposing and testing multiple novel relations. In studies in which a single novel relation is exposed, false positive responses may be produced by responding on the basis of shared familiarity alone. Such responses afford criterion level performance in the absence of the acquisition of a specific relation between the target auditory and visual stimuli (this was discussed in Chapter 2, see Section 2.3). In order to control for responding on this basis, two or more novel word-referent relations must be exposed concurrently and tested in juxtaposition.

Characteristic patterns of responding were identified in participants' performances in the present study. The most prevalent pattern of responding was the development of stimulus preferences. Each of the participants exhibited a stimulus preference, albeit in some cases a weak preference, at some point in the study. Such preferences need to be identified prior to exposure of the target relations in order that they do not hinder participants' performances on comprehension test trials.

It is also of importance to note RJ's performance in Phase 2. Despite achieving criterion level on baseline trials, he failed to understand the nature of the responses required on test trials in which novel stimuli were presented in the same context. In order to overcome this, pre-testing trials are required in which novel words and objects are presented as sample and comparison stimuli.

Also notable are CV's responses in the final test session in which the second novel relation was exposed. Her responses on comprehension test trials indicated evidence of unreinforced conditional selection (URCS). This is a further possible source of false positive responding on matching-to-sample trials identified in Chapter 2 (see Section 2.2.3). Although her responses were not to criterion level, and were not in accordance with the exposed relations, there was a 1 in 3 chance that they could have been. It is thus important to identify URCS in subsequent studies.

In Phase 2.3, a token reward system was introduced in cases in which participants failed to produce accurate responses on exclusion exposure trials and related control trials. This was intended to increase participants' overall level of attention to, and correct responding on, test trials. Although this served to improve their responding a little, it appeared that this was introduced too late in the study in order to maximise its effectiveness. By Phase 2.3, the participants appeared to have already tired of the procedure and the rewards served little value at this point. If the token reward system had been introduced from the outset of the study, this may have more effectively improved their responding.

The above observations provide important considerations for future studies of this kind. False positive responding was identified in TW's responses on comprehension and naming test trials, and a potential source of false positive responding (i.e., URCS) was also identified in CV's responses on comprehension test trials. Further, the benefit of the exposure of multiple novel relations was highlighted in CV's performance in the final session of the study; this is further necessitated in order to control for false positive responding on the basis of shared familiarity. In addition, the importance of the early identification of URCSs and stimulus preferences was also highlighted. These measures were thus incorporated in subsequent studies.

CHAPTER 5

STUDY 2

STIMULUS EQUIVALENCE AND THE EXPOSURE LEARNING OF MULTIPLE NOVEL RELATIONS: AN INITIAL STUDY

Study 2 investigated the exposure learning of equivalence relations between multiple novel words and their referents. Although employing a stimulus equivalence paradigm, this study paralleled, and combined procedural elements of, both the cognitive/developmental and behaviour analytic research outlined in Chapter 1.

In contrast to Study 1, Study 2 involved the concurrent exposure and testing of *two* novel relations, the necessity of which was initially discussed in Chapter 2 (see Section 2.3) and was further highlighted by the participants' performances on comprehension test trials in Study 1.

Phase 1 verified the prerequisite skills for responding on matching-to-sample test trials. In addition, the free play session was extended in order that stimulus preferences were identified prior to exposure of the novel relations; two novel objects observed to be equally appealing to the participants were selected as the target visual stimuli. The importance of the early identification of stimulus preferences was highlighted by the participants' performances in Study 1.

Phase 2 paralleled the lexical training procedures employed in the cognitive/developmental research outlined in Chapter 1. Participants were introduced to two novel stimulus sets: Set A were novel objects and Set B were novel words. In each session they were given exposures to two novel object-word relations in three consecutive exposure contexts: non-ostensive impending word exposures, ostensive exposures, and exclusion exposures. As in Study 1, non-ostensive exposures were presented first in order that, following these trials, the derivation of symmetrical relations was assessed. (B-A trials conducted following A-B non-ostensive exposure trials thus comprised tests of symmetry.) In addition, ostensive and exclusion exposure trials have been proposed to be more beneficial to learning than non-ostensive trials (e.g., Baldwin & Markman, 1989). Acquisition of the novel word-referent relations was assessed with B-A (word-object) matching-to-sample test trials; these directly parallel cognitive/developmental comprehension test trials.

In Phase 3, in order to conduct a test for stimulus equivalence, a third stimulus set was introduced: Set C -- novel shapes. In each session, participants were given C-A (shape-object) non-ostensive exposure trials of two relations. The participants' formation of equivalence classes between the stimuli was assessed by B-C (word-shape) matching-to-sample test trials. Only non-ostensive C-A exposure trials were presented; this was in order that a stringent test of the derivation of equivalence relations was conducted (see Chapter 3, Section 3.4.2 for a rationale of this control).

The administration of B-C test trials provides a stringent assessment of equivalence for the following reason. Following criterion level performance on B-A trials, whether derived via symmetry following A-B non-ostensive exposure trials, or whether derived following exposures to the B-A relations in ostensive trials, the participants were given C-A non-ostensive exposure trials. If the acquired C-A relations were indeed equivalence relations, then A-C relations would emerge via symmetry. Combining the B-A relations and symmetrical A-C relations transitively gives rise to the emergence of B-C equivalence relations. Transitivity alone would also be demonstrated if the participants showed emergent labelling of each novel shape (C) with the name of its corresponding object (B). In order for these C-B naming relations to emerge, participants must combine the C-A (see shape-see object) and A-B (see object-hear word) exposed relations transitively to give C-B (see shape-hear object name) relations. This in turn would give rise to C-B naming via the child's generalised echoic repertoire (see shape C - hear object name B - say object name B).

However, in cases in which participants passed B-A tests following exclusion exposure trials, both B-C and C-B tests comprised tests of equivalence; the rationale for this is as follows. On ostensive exposure trials, participants are exposed to both the A-B and B-A relations by virtue of the bi-directional nature of the exposure trial type. In contrast, on unreinforced exclusion exposure trials, participants are exposed only to the B-A relations: they are required to select the A stimuli conditionally upon presentation of the corresponding B stimuli on traditional matching-to-sample trials. Thus, they do not receive differential A-B exposures. As a result, both B-C and C-B tests comprise equivalence tests. Criterion level responding on B-C tests requires participants to combine, transitively, the B-A exposed relations with the A-C relations derived via symmetry. Similarly, criterion level responding on C-B tests requires participants to combine, transitively, the C-A exposed relations with the A-B relations derived via symmetry.

To recap, criterion level responding on B-C tests following acquisition of the novel relations as a result of non-ostensive, ostensive, or exclusion exposure trials demonstrated the emergence of equivalence relations. Likewise, criterion level responding on C-B tests following acquisition of the novel relations as a result of B-A exclusion exposure trials also demonstrated the emergence of equivalence relations. In both cases, criterion level performance on these tests demonstrated that the word-referent relations acquired were indeed symbolic relations, and were thus linguistic. Therefore conclusions regarding real word learning could be drawn.

As in Study 1, experimenter cueing was eliminated by employing a blind testing procedure; this was achieved by the participation of two experimenters. The elimination of experimenter cueing ensured that the participants' criterion level responding on B-A and B-C test trials demonstrated evidence of acquisition of the novel relations as a result of the A-B and C-A exposure trials (this issue is again discussed in Chapter 3, see Section 3.4.2).

In summary, cognitive/developmental exposure learning procedures were combined with the behaviour analytic stimulus equivalence paradigm in order to conduct a controlled study of the exposure learning of symbolic relations -- equivalence relations -- between multiple novel words and their corresponding referents.

METHOD

Participants

Four preschool children were recruited from Tir na n-Og Day Nursery in Bangor, North Wales. Written informed consent for their participation was obtained from their parents/guardians prior to the commencement of the study (see Appendix A). Each participant's gender, and age at the start of the study, is presented in Table 5.1.

Table 5.1

Participants' gender and age at the start of the study.

Participant	Gender	Age at start Months:days
HD	F	34:07
GD	M	32:10
LS	F	29:20
RH	F	24:20

Note. M = Male; F = Female.

Prior to the administration of experimental sessions, the experimenters made several informal visits to the nursery during which they interacted with the participants both in the nursery playroom and the experimental room. These informal sessions ensured that the participants were familiar with both the research setting, and the experimenters, before any experimental sessions were conducted.

At the end of the study, each participant's parents/guardians were debriefed as to the aims and procedures employed, and their child's performance throughout the study: parents/guardians were sent personal letters regarding only their own child's performance.

Apparatus and Materials

Setting and Apparatus

All the experimental sessions were conducted in a research room provided in Tir na n-Og day nursery, and were videotaped to allow post-session analysis. To this end, the research room was equipped with a portable video camera (Panasonic M10); this was mounted upon a tripod and was positioned in the corner of the room so that an unobscured view of both the experimenter and the participant was provided.

An adjoining research room, connected to the experimental room by a two way mirror, was also utilised; from this a second experimenter observed the test sessions and recorded the participants' responses on test trials in order to provide inter-rater reliability.

A set of pre-prepared record sheets was required for each participant. For each experimental session a record sheet detailed the order and type of exposure trials, the order of presentation of auditory samples on test trials, and the counterbalanced order of presentation of visual comparisons on test trials. The participant's responses on test trials were noted on the record sheet, by the experimenter, throughout the duration of each session.

A variety of toys, suitable for the age group of the present participants, was also required. These were used to occupy the participants during inter-trial intervals, and at the beginning and end of each experimental session; they were also used to engage the participants' attention when they had become uncooperative or distracted.

In order to present the non-ostensive exposure trials, a cardboard box (40 cm x 34.5 cm x 38 cm) was required in which to hide the novel objects from the participants' view. A piece of material was attached to the top of the box; a slit in this material allowed the object to be dropped inside and remain obscured from the participants' view.

Familiar Stimuli

Familiar auditory and visual stimuli were required for use in baseline trials, exclusion exposure trials, and control trials. The familiar visual stimuli consisted of plastic farm animals (see Appendix E). These comprised a pig (10 cm x 5 cm), a sheep (9 cm x 5 cm), a cow (12.5 cm x 6.5 cm), and a horse (12.5 cm x 9.5 cm). The familiar auditory stimuli consisted of their corresponding conventional names. These auditory-visual relations were determined as being familiar to the participants from their responses in the free play session, conducted at the commencement of the study, and from informal interviews held with their parents/guardians, and the Tir na n'Og nursery nurses, prior to the start of the study.

Novel Stimuli

Three sets of novel stimuli were presented to the participants: Sets A, B, and C.

Set A stimuli. Set A comprised novel objects. The novel objects consisted of plastic model dinosaurs unfamiliar to the participants (see Appendix E). In Phases 2 and 3, two novel dinosaurs -- A1 and A2 -- were presented. These were selected from an array of six, namely: a Stegosaurus (15 cm x 8 cm), a Parasaurolophus (17.5 cm x 12 5 cm), an Allosaurus (20 cm x 11 cm), a Mosaurus (14.8 cm x 5.5 cm), a Euoplocephalus (13 cm x 4.5 cm), and a Tachycephalosaurus (17.5 cm x 9 cm). Two of the remaining objects were further selected as A3 and A4 for use in Phase 4.

Set B stimuli. Set B comprised novel words. The novel words consisted of nonsense words, each no longer than two syllables.[1] For each participant the nonsense words "Tak" [tõak] and "Os" [oz] were selected as B1 and B2 for use in Phases 2 and 3; each one of these was paired with one of the novel objects. The nonsense words "Bosch"

[1] The nonsense words "Tak", "Bosch", "Kiekie", and "Os" were selected from Lipkens, Hayes, & Hayes (1993).

[boS] and "Kiekie" ['kõi:ki] were selected as B3 and B4, for use in Phase 4 of the study, and were each paired with one of the novel objects. These nonsense words were selected in order that they were novel to the participants, were easily pronounceable, and were distinct from one another.

Set C stimuli. Set C comprised novel shapes. The novel shapes consisted of two 2-dimensional multi-sensory patterns which differed on three dimensions -- colour, shape, and texture. The first of these comprised a sandpaper cross (12 cm x 12 cm) with four sandpaper triangles surrounding it; the second comprised a large green felt circle (10.5 cm in diameter) with smaller circles of purple and red felt placed upon it (see Appendix E). In order to conduct the C-A exposure trials, each of these shapes was attached to the lid of one of two identical boxes (15 cm x 15 cm x 15 cm); one shape was attached to the lid of one box, and one shape to the lid of the other. The boxes were made of blue holographic cardboard designed to be appealing to the participants.

Procedure

General Procedure

The general procedure was divided into four major phases in which the participants were exposed to, and tested for the derivation of, relations between novel objects, words, and shapes (see Figure 5.1).

In Phase 1, pre-testing was conducted in order to select Set A stimuli for each participant, and to verify the prerequisites for auditory-visual matching-to-sample tasks.

In Phase 2, the participants received A-B (object-word) exposures, and were tested for the derivation of B-A (word-object) relations (see Figure 5.1). This phase was divided into three sub-phases: Phases 2.1, 2.2, and 2.3. Each of these sub-phases consisted of the same procedure, yet differed in the type of exposure trials employed. In Phase 2.1, the participants received A-B non-ostensive impending word exposure trials; in Phase 2.2, they received A-B ostensive exposure trials; and in Phase 2.3, they received B-A exclusion exposure trials (these trial types are described in detail below).

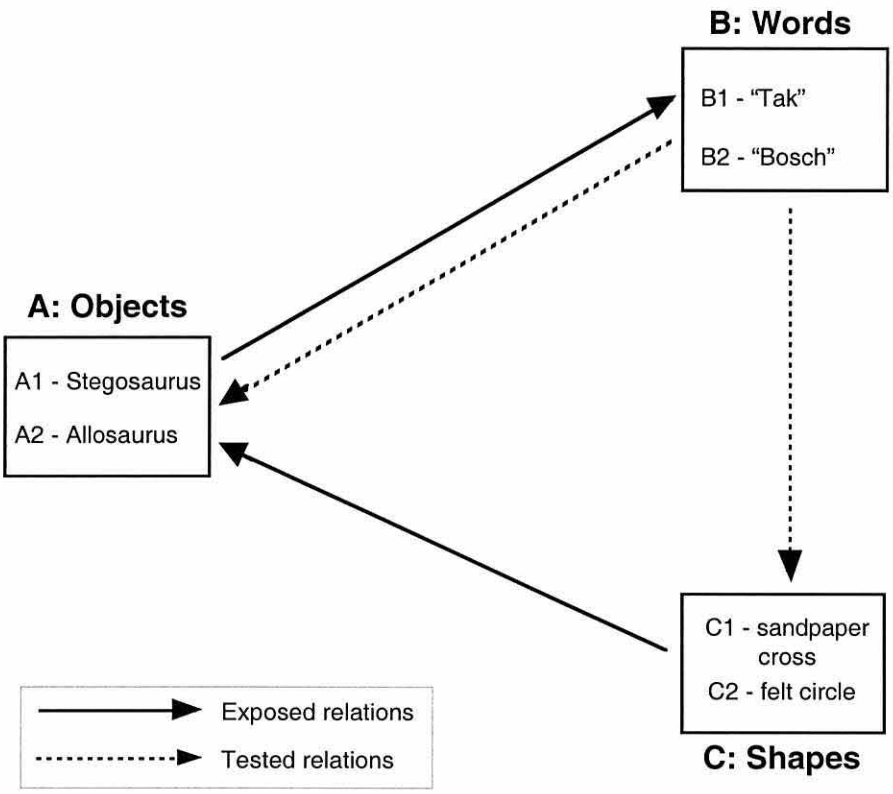

Figure 5.1. Schematic representation of the novel relations exposed and tested in Study 2. Arrows point from sample to comparison stimuli. Note that exclusion exposure trials were B-A trials (these are not represented in this figure).

In Phase 3, the participants received C-A (shape-object) exposure trials, and were tested for derivation of the B-C (word-shape) equivalence relations (see Figure 5.1). In this phase of the study, the participants received only non-ostensive exposure trials; this was in order that an equivalence test could be conducted.

In Phase 4, the participants were introduced to new stimulus sets. They received A-B non-ostensive exposures and B-A testing; thus this phase was procedurally identical to Phase 2.1.

Each individual participant's progression through the phases was dependent upon their performance on test trials in the previous phase (see Figure 5.2).

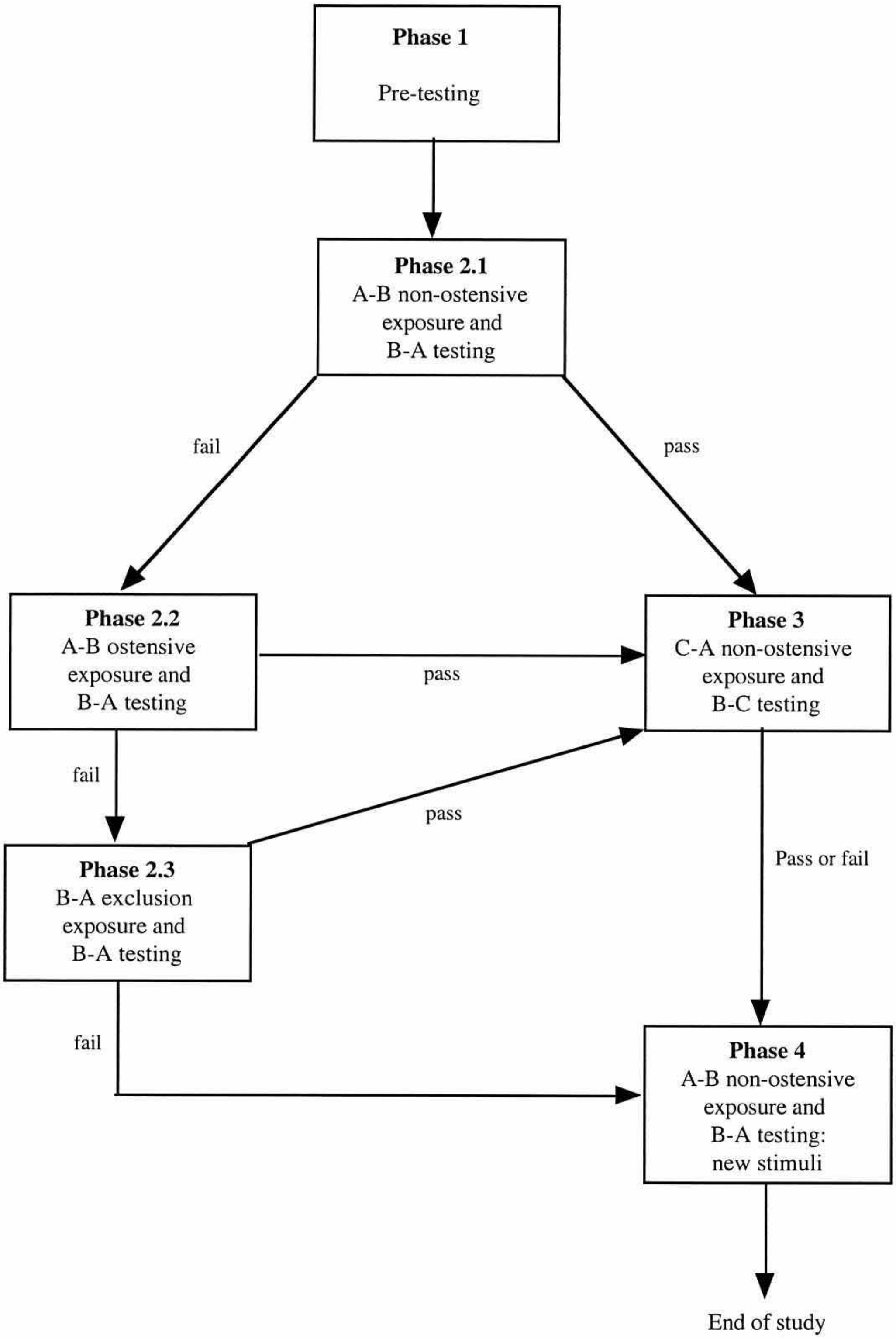

Figure 5.2. Participants' progression through the phases of Study 2.

All the experimental sessions were conducted in the research room. Each session lasted no longer than 20 minutes, and no more than two sessions were conducted per day with each participant (when two sessions were conducted in one day, the first was conducted in the morning and the second in the afternoon, thus affording a substantial break in testing).

A blind testing procedure was employed in order to eliminate experimenter cueing. This was achieved by the participation of two experimenters. In each session, only one experimenter was present for the administration of each trial type: Experimenter 1 (E1) was present for, and conducted, only the exposure trials; and Experimenter 2 (E2) was present for, and conducted, only the test trials. As E2 was not present throughout the exposure trials, she was unaware of the correct pairings between the novel stimuli, and was thus unaware of the accuracy of the participants' responses on test trials. As a result, no feedback or reinforcement for correct responding was provided on test trials.

Throughout the test trials, E2 recorded the participants' responses on the record sheet provided for that session. The record sheets were placed on the floor, to the side of E2, so that they were obscured from the participant's view. In addition, E1 observed the test trials from the adjoining research room, through the two way mirror, and recorded the participants' responses; this was in order to provide inter-rater reliability.

Phase 1. Pre-testing

The pre-testing phase consisted of two experimental sessions: a free play session and a baseline pre-testing session.

1.1. Free play session. In this initial session the participants were presented with the six novel objects and were encouraged to play freely with them. Both experimenters were present throughout this session. The participants' verbal and non-verbal behaviours, and their interactions with the objects, were observed in order to determine that the objects were unfamiliar to them, and that they did not consistently label any object. Stimulus preferences were noted, and four objects, which were observed to be equally appealing to the participants, were selected as Set A stimuli (two for use in Phases 2 and 3, and two for use in Phase 4).

1.2. Baseline pre-testing session. This session was conducted, by E2, in order to ensure that the participants possessed the prerequisite skills for responding on matching-to-sample test trials (i.e., to ensure that they were able to scan, and select from, an array of two visual comparisons in response to an auditory sample) in the absence of any feedback or reinforcement for correct responding.

In this session, the participants were presented with 12 baseline trials -- test trials of the familiar auditory-visual relations. These test trials employed the matching-to-sample format in which all the test trials in the present study were conducted (see Table 5.2). It is important to note that all baseline trials were unreinforced, as were all the other test trial types presented in the study. The matching-to-sample format is as follows.

Table 5.2

Matching-to-sample trial types employed in Phases 1, 2, and 3 of the study.

		Visual Comparisons	
Trial type	Auditory sample	S+	S-
Baseline	"Pig"	pig	horse
B-A	"Tak"	stegosaurus	allosaurus
B-C	"Tak"	cross	circle
Exclusion	"Tak"	stegosaurus	horse
Control	"Horse"	horse	stegosaurus

Note: In this example the novel relations comprise:
A1 - stegosaurus; B1 - "Tak"; C1 - cross.
A2 - allosaurus; B2 - "Bosch"; C2 - circle.

The participant and E2 were seated opposite each other at the table. On each trial, the participant was presented with two visual comparisons that were placed on the table before him or her. As the objects were placed down the auditory sample was presented, dictated by E2 (in the carrier phrase appropriate for the individual participant), and the participant was requested to select the correct corresponding comparison, for example, "Where is (the) X?" (where X was the auditory sample). Thus on each trial the participant was required to manually indicate a choice between the two comparisons by pointing to, picking up, or giving E2 one of the objects. If the participant failed to produce a clear and codeable response the trial was reconducted. Once a clear response was produced, the comparisons were removed and the next trial conducted.

The presentation of comparisons was counterbalanced over the 12 baseline trials: each of the familiar objects was designated as the correct comparison on three trials, and as the incorrect comparison on three trials; the objects also appeared in left and right hand positions with equal frequency. These measures served to discourage preferential responding.

Criterion for progression to Phase 2. In order to progress to Phase 2, the participants were required satisfy the baseline criterion level: this was 80 percent correct responding, or above, within one baseline pre-testing session. The baseline pre-testing session was repeated, where necessary, until this criterion level was satisfied.

Phase 2. A-B Exposures and B-A Testing

Throughout Phase 2, the participants received A-B (object-word) exposures and B-A (word-object) test trials. (Note that in Phase 2.3 exposure trials were B-A exclusion trials.) This phase was divided into three consecutive sub-phases. Each sub-phase employed the same general procedure, as follows, yet differed in the type of exposure trials presented (these are described in detail below). Each experimental session comprised exposure trials conducted by E1, and subsequent B-A test trials conducted by E2 (see Table 5.2). In the first session of each sub-phase, the participants received two exposure trials, one of each novel relation (e.g., one each of A1-B1 and A2-B2); in the remaining two sessions the participants received six exposure trials, three of each novel relation.

Each block of exposure trials was followed by 12 B-A test trials (i.e., six B1-A1 trials and six B2-A2 trials). In some sessions the number of test trials varied due to experimenter error or to the inattentiveness of the participant; these exceptions are noted in the relevant results sections. B-A test trials were presented randomly, and no more than three trials of each novel relation were presented consecutively.

Dependent upon the participants' performance on the B-A test trials, the sessions were repeated where necessary. If a participant performed well on B-A trials, yet did not satisfy criterion level, the session was repeated. If a participant failed to produce responses on all 12 test trials, due to a lack of cooperation or attention, the session was often repeated before moving on to the next. Thus whilst the typical number of sessions per sub-phase was three, each individual participant's progression through these phases differed.

Phase 2.1. A-B non-ostensive exposure trials and B-A testing. In Phase 2.1, the participants received A-B non-ostensive impending word exposure trials: they were initially presented with the novel object and, once this was obscured from view, they were presented with the corresponding novel word.

On each exposure trial the participant was seated at the table opposite E1. E1 placed one of the novel objects on the table in front of, and to the right of, the participant. The object was then moved along the length of the table, from right to left, in a predetermined characteristic movement (e.g., A1 was made to move in small double jumps across the table, and A2 was made to slide along the table in a zig-zag motion); the presentation of the object lasted approximately 25 seconds on average, although this differed dependent upon the participant's attention. At the end of this presentation, the object was dropped into the large box situated at the end of the table. E1 then made eye contact with the participant and presented the corresponding novel word in the carrier phrase "That was X" (where X was the target auditory stimulus). Thus the novel word was presented only 2-3 seconds, on average, after the object was removed from view. If the participant did not attend to the novel object, E1 stopped moving the object along the length of the table and regained the participant's attention before resuming presentation. Following each exposure trial, E1 surreptitiously removed the object from the box and the next trial was conducted.

Phase 2.2. A-B ostensive exposure trials and B-A testing. In Phase 2.2, the participants received A-B ostensive exposure trials: they were presented with the novel object and the corresponding novel word simultaneously.

The participant and E1 were seated opposite each other at the table. E1 placed one of the novel objects on the table before the participant and he or she was allowed to play freely with it. When both E1 and the participant were engaged in joint visual attention on the object, E1 presented the corresponding novel word in the carrier phrase "This is X" (where X was the target auditory stimulus). The object was then removed from the participant's view and the next exposure trial conducted. Each object was presented for approximately 10 seconds on average; this length of presentation was again dependent upon the participant's attention and willingness to cooperate.

Phase 2.3. B-A exclusion exposure trials and B-A testing. In Phase 2.3, the participants were introduced to the novel B-A relations through the use of exclusion exposure trials and control trials. Both trial types were presented in the same matching-to-sample format as the baseline test trials (see Table 5.2). On B-A exclusion exposure trials, the participants were presented with one of the novel objects (either A1 or A2) and one of the familiar objects; on these trials they were requested to select the novel object upon presentation of the corresponding novel word. On control trials, the participants were again presented with one of the novel objects and one of the familiar objects; on these trials they were requested to select the familiar object upon presentation of the corresponding familiar word. The participant's performance on the control trials indicated that his or her correct responses on exclusion exposure trials were controlled, in some part, by the auditory sample presented, and were not a result of selection of the correct object as a result of its novelty per se.

The participants were presented with four exclusion exposure trials per session (i.e., two B1-A1 trials and two B2-A2 trials); these were interspersed with the same number of control trials. (Participant HD received only two exclusion exposure trials -- one of each B-A relation -- and two control trials per session; this was a result of her increasing lack of cooperation on test trials.)

B-A test trials throughout Phase 2. Following the exposure trials in each session, E1 left the experimental room and E2 entered in order to conduct the test trials. In each session the participants were presented with unreinforced B-A test trials. These were conducted in the matching-to-sample format described earlier (see Table 5. 2).

Throughout Phases 2.1 and 2.2, 12 B-A test trials were presented in each experimental session (i.e., six B1-A1 trials and six B2-A2 trials). In these sessions the participant received a short break in testing, between Trials 6 and 7, in order to maximise his or her attention.

B-A testing in Phase 2.3 differed: the number of B-A test trials was reduced to eight per session; this was designed to alleviate the participants' boredom with the procedure (likely to occur because the B-A exposure trials now employed the same format as the B-A test trials). (The number of test trials presented to participant HD, in Phase 2.3, was further reduced as a result of her increasing inattentiveness during experimental sessions.)

Within each session the position of the comparisons was counterbalanced across all trials: the novel objects appeared as correct and incorrect comparisons, with equal frequency, in both left and right hand positions. This served to discourage the emergence of preferential responding.

A-B Naming test. Some participants were administered a naming test at the end of the sub-phases. This comprised six free recall trials, three trials of each novel relation. On each trial, E1 presented the participant with one of the novel objects and requested them to label it; this request was presented it in the carrier phrase: "Who's this?" These trials were unreinforced.

Criteria for progression to Phases 3 and 4. In order to progress to Phase 3, the participants must have satisfied the criterion level of at least 80 percent correct responding on B-A test trials of *both* novel relations (i.e., both B1-A1 and B2-A2) in one experimental session (i.e., one block of 12 B-A trials). Thus participants were able to progress to Phase 3 following either Phase 2.1, having received non-ostensive exposure trials alone, Phase 2.2, having received both non-ostensive and ostensive exposure trials, or Phase 2.3, having received all three exposure trial types. If the participants failed to achieve criterion level responding by the end of Phase 2.3, they proceeded straight to Phase 4 of the study.

Phase 3. C-A Exposures and B-C Testing

Once the participants had performed at criterion level on B-A test trials, they proceeded to Phase 3, in which they received C-A (shape-object) non-ostensive exposure trials and B-C (word-shape) equivalence testing. The general procedure remained the same as Phase 2. However, experimental sessions now comprised the presentation of three trial types: B-A test trials, C-A exposure trials, and B-C test trials. In each session, two B-A test trials (one of each novel relation) were initially presented. Following this, the participants received C-A exposure trials; in the first session they received two exposure trials (one of each relation), and in the remaining sessions they received six exposure trials (three of each relation). The participants were then presented with 12 B-C test trials. Cueing of correct responses was controlled for in the same manner as Phase 2.

C-A non-ostensive exposure trials. In Phase 3, the participants received C-A non-ostensive exposure trials: they were initially presented with a shape and, once this was obscured from view, they were presented with the corresponding novel object.

On each exposure trial, the participant was seated at the table opposite E1. E1 presented the participant with one holographic box which had one of the novel shapes attached to the lid; this contained the corresponding novel object. This was presented so that the shape was facing the participant. The participant was encouraged to look at and touch the shape, and note its defining features. E1 then asked "Who's in here?" or "Who's hiding in here?" and opened the lid of the box; in doing so, the shape was laid on the table and obscured from the participant's view. The corresponding object was revealed to the participant and he or she was encouraged to play freely with it. The participant or E1 then replaced the object in the box and the box was slipped off the table so that the shape remained out of the participant's view. The next exposure trial was then conducted.

B-C test trials. Following the exposure trials, E1 left the research room and E2 entered in order to conduct the test trials. In each session the participants were presented with 12 unreinforced B-C test trials (six each of B1-C1 and B2-C2). These were conducted in the same matching-to-sample format as described earlier (see Table 5.2).

The participant and E2 were seated opposite each other at the table. On each trial, E2 presented the participant with the two boxes so that the shapes were facing the participant; these were placed on the table before him or her. (Throughout the test trials the novel objects were not placed inside the boxes; this was to ensure that, in cases in which the participants attempted to open the boxes, the pairings between the shapes and objects were not revealed.) The participant was then requested to select one of the shapes upon presentation of the corresponding novel word in the carrier phrase "Where is X hiding?" or "Where does X hide?" (where X was the target auditory stimulus). Once the participant had produced a clear and codeable response, the boxes were removed and the next trial conducted. The participants received a short break in testing, between Trials 6 and 7, in order to alleviate boredom with the procedure.

Within each session the position of the comparisons was counterbalanced across all 12 test trials so that each of the shapes appeared as correct and incorrect comparisons, with equal frequency, in both the left and right hand locations; this served to discourage preferential responding.

Phase 4. Follow-up Testing, A-B Non-Ostensive Exposures and B-A Testing

The participants who completed Phase 3 of the study progressed to this final phase. In addition, the participants who failed to respond at criterion level on B-A test trials at the end of Phase 2.3, also progressed to this phase of the study. Thus the administration of Phase 4 was not contingent upon participants having previously performed at criterion level at any point.

In Phase 4, the participants were introduced to new stimulus sets (i.e., A3-B3 and A4-B4). They received A-B non-ostensive exposures and B-A testing. The procedure employed in this phase was identical to Phase 2.1, described earlier.

Response Requirements and Scoring Criteria

On each test trial the participants were required to manually indicate an unambiguous and clear choice between the two comparison stimuli: on baseline trials and B-A test trials this was by pointing to, picking up, or giving E2 one of the objects; on B-C test trials this was by pointing to one of the boxes to which the novel shapes were attached. If the participants distinctly selected one of the comparison stimuli followed by the remaining stimulus, their first response was recorded. If the participants selected both of the comparison stimuli simultaneously, the comparisons were removed and the test trial was reconducted until a clear and codeable response was provided.

In participants GD's case, he could not be encouraged to reliably produce clear responses on B-A test trials in response to "Where is X?" questions (where X was the target auditory stimulus). As a result, the box employed in non-ostensive A-B exposure trials was introduced into the testing procedure. This was placed next to the table, and on each test trial he was requested to "Put X in the box". Therefore the recorded response was which novel object was placed in the box.

Frequently, in testing sessions, the participants failed to produce responses due to a lack of interest in the test trials. In these instances a game was introduced into the procedure. Here they were requested to point to their body parts and various items in the research room, and were rewarded, with verbal praise, for doing so correctly. Once the participants had established a pattern of doing this correctly a test trial was conducted. This served to encourage the participants to point to comparisons on test trials. Further, where the participants tired of the testing procedure, a play break was introduced between Trials 6 and 7 in which they were provided with the familiar objects, and other toys present in the experimental room, and were encouraged to play freely with them. Once their attention was regained, these toys were removed and testing was resumed.

Participant's Vocalisations

The participant's vocalisations of the novel words throughout the experimental sessions were recorded. The context in which the vocalisation occurred, the visual stimuli present at the time, and the surrounding discourse were also noted in order that each vocalisation could be classified within one of three categories: spontaneous labelling, prompted labelling, or echoing. These categories are described in detail in Chapter 4 (see Method section).

RESULTS

The participants' performances in Phase 1 are initially presented. Each participant's performance in Phases 2, 3, and 4 is then presented individually in order to determine whether he or she derived the novel B-A and B-C relations. (Participants' performances on all test trial types in individual experimental sessions are presented in Appendix F.)

Phase 1. Pre-testing

1.1. Free Play Session

This session confirmed that the objects were novel to the participants (i.e., the participants did not consistently name them), and no stimulus preferences were identified. The stimuli selected for use in Phase 2 were: Parasaurolophus (A1) and Tachycephalosaurus (A2); "Tak" (B1) and "Os" (B2). For Phase 4 of the study the stimuli were: Allosaurus (A3) and Stegosaurus (A4); "Kiekie" (B3) and "Bosch" (B4).

1.2. Baseline Pre-Testing Session

Participants' performances in the baseline pre-testing sessions are presented in Table 5.3. All the participants progressed to Phase 2 of the study having satisfied the baseline criterion level. Each participant therefore demonstrated the prerequisite skills for responding on auditory-visual matching-to-sample trials. In addition, it is important to note that the participants achieved the baseline criterion level in the absence of feedback or rewards for correct responding on test trials; this was necessary as all subsequent matching-to-sample trials were unreinforced.

Table 5.3

Participants' performances on baseline pre-testing sessions. (Bold text denotes sessions in which criterion level was achieved.)

	Baseline pre-testing sessions (percentage of correct responding)		
Participant	1	2	3
RH	66.6*	**83.3**	-
HD	75	**100**	-
GD	**100**	-	-
LS	58.3	**83.3**	**100**

* Only three baseline trials were conducted in this session.

As a result of a lack of interest in the procedure, RH received three baseline trials in Session 1 before testing was abandoned. In Session 2 however, 12 test trials were conducted on which RH satisfied the baseline criterion level.

LS, although satisfying the baseline criterion level in Session 2, was administered one further session; this was because her responses in Sessions 1 and 2 were occasionally ambiguous, necessitating the repetition of some test trials, and her attention was frequently distracted. In the final session, her responses on the first repetition of all 12 trials were unambiguous, and her attention was focused throughout.

Participants' Performances in Phases 2 - 4

Participants' performances on test trials throughout Phases 2 - 4 are summarised individually (see Appendix F for session-by-session analyses). The criterion level for passing tests of the novel relations in these phases (B-A and B-C) was at least 80 percent correct responding on each relation tested (i.e., B1-A1 and B2-A2, or B1-C1 and B2-C2) within one experimental session (i.e., one block of 12 test trials).

Participant RH

RH did not progress beyond Phase 2.1. Despite attending to exposure trials, she was uncooperative throughout B-A tests and could not be encouraged to produce responses on test trials. Thus she took no further part in the study.

Participant HD

HD did not pass the B-A tests as a result of either 16 non-ostensive or 8 ostensive exposure trials. On B-A test trials she exhibited a stimulus preference that increased in intensity from Phase 2.1 to Phase 2.2.

In Phase 2.3, HD failed to achieve criterion level on exclusion trials and related control trials. Not surprisingly, she also failed to pass subsequent B-A tests; her stimulus preference was no longer evident in this phase. Throughout this phase HD used only the novel word "Tak" to label both target objects.

Phase 4 -- the exposure and testing of new stimulus sets -- was abandoned as a result of HD's increasing inattentiveness throughout experimental sessions.

Participant GD

GD did not demonstrate acquisition of the novel relations on B-A tests following 16 non-ostensive and 14 ostensive exposure trials. He exhibited a stimulus preference that increased in intensity from Phase 2.1 to Phase 2.2.

In Phase 2.3, despite achieving criterion level on exclusion exposure trials and related control trials, he again failed subsequent B-A tests; his exclusive stimulus preference remained evident.

In Phase 2.1, GD occasionally echoed the novel word presented on B-A test trials and labelled the novel objects; in each labelling instance he used the novel word "Tak". In Phase 2.2, although he continued to label both novel objects "Tak" in the first session, in Session 2 his informal vocalisations became more accurate. However, in Phase 2.3 his vocalisations were seldom and were typically inaccurate, thus confirming that he had not acquired the novel relations.

In Phase 4, although GD responded conditionally on B-A trials of Stimulus Sets 3 and 4, he appeared to have formed the incorrect relations between the novel stimuli; this pattern of responding may be accounted for by URCS.

Participant LS

Initially, LS did not pass the B-A tests in Phase 2.1. In these sessions she did not label the novel objects and was reluctant to participate in experimental sessions. However, following a break in testing, LS achieved criterion level on B-A test trials following a total of 10 A-B non-ostensive exposure trials; she was aged 31 months and 10 days. Although she did not pass the A-B naming test conducted at the end of this phase, further evidence of her acquisition of the target relations was provided in her accurate informal vocalisations of the target words in sessions in which she responded at criterion level on B-A tests.

In Phase 3, LS demonstrated immediate derivation of the B-C equivalence relations, aged 31 months and 18 days; her criterion level performance was maintained over two subsequent sessions.

In Phase 4, LS did not pass the B-A tests with Stimulus Sets 3 and 4; she exhibited an exclusive stimulus preference on test trials. There was no contradictory evidence of her acquisition of the target relations in her informal vocalisations throughout these sessions.

Summary of Results

Phase 2. A-B Exposures and B-A Testing

All four participants progressed to Phase 2 of the study in which they received A-B exposure trials and B-A test trials (see Table 5.4).

Table 5.4

Participants' performance on B-A tests in Phase 2.

	Sub-phases of Phase 2		
Participant	2.1	2.2	2.3
RH	fail	-	-
HD	fail	fail	fail
GD	fail	fail	fail
LS	pass	-	-

Note. In Phase 2.1, A-B non-ostensive exposure trials were presented; in Phase 2.2, A-B ostensive exposure trials were presented; and in Phase 2.3, B-A exclusion exposure trials and control trials were presented.

One of the four participants -- LS -- passed the B-A symmetry tests in phase 2; this was following 10 non-ostensive A-B exposure trials. Her informal vocalisations corresponded with her B-A test performance; these vocalisations were accurate only in sessions in which she achieved criterion level on B-A trials.

Two of the participants -- HD and GD -- failed to achieve criterion level on B-A tests following all three exposure trial types. Both of these participants exhibited stimulus preferences throughout B-A test sessions. Further, there was no contradictory evidence that they had acquired the novel relations from their informal vocalisations.

The remaining participant -- RH -- received only non-ostensive exposure trials; following these she failed to produce codeable responses in B-A tests, and thus she took no further part in the study.

Phase 3. C-A Exposures and B-C Testing

Only one participant -- LS -- proceeded to Phase 3 of the study. Following only one non-ostensive exposure trial of each C-A relation, she demonstrated derivation of the B-C equivalence relations; LS performed without error on three consecutive B-C tests.

Phase 4. Follow-up Testing, A-B Non-Ostensive Exposures and B-A Testing

Three of the participants -- HD, GD, and LS -- proceeded to Phase 4 of the study. LS received three sessions, in which she did not achieve criterion level on the B-A tests; she exhibited a stimulus preference. GD received one session, in which his responses on the B-A test trials indicated that he had formed the incorrect B-A relations (i.e., had associated A3 with B4, and similarly, A4 with B3). Finally, HD had one session; this was abandoned due to her increasing lack of interest in test sessions.

DISCUSSION

The results of Study 2 are briefly discussed with respect to the participants' responses on B-A and B-C test trials; these determine whether the participants acquired symbolic relations between the target stimuli. In addition, where participants failed to achieve criterion level on these tests, their responses on test trials are also are briefly discussed; this is with respect to the identification of characteristic patterns of responding which provide implications for the modification of the present procedure.

In Phase 1, all the participants satisfied the baseline testing criterion, thus verifying the prerequisite skills for responding on auditory-visual matching-to-sample test trials.

Despite achieving criterion level on baseline trials, RH failed to consistently produce codeable responses on B-A test trials. As a result of this, and her increasing inattentiveness in experimental sessions, she took no further part in the study.

Two of the participants -- GD and HD -- failed to achieve criterion level on B-A tests following non-ostensive, ostensive, and exclusion exposure trials. GD's informal vocalisations suggested that he may have acquired the target relations, but, although these became more accurate throughout Phase 2.2, they did not reach criterion level.

In contrast, LS passed the B-A symmetry tests following 10 non-ostensive impending word exposure trials aged 31:30. Although she did not pass a naming test conducted in Phase 2, her informal vocalisations also suggested that she had acquired the target word-referent relations. In Phase 3, LS went on to immediately pass the B-C equivalence test following only one non-ostensive exposure trial of each C-A relation; she was aged 31 months and 18 days when she passed this test.

LS passed both the B-A and B-C tests following only limited non-ostensive exposures under conditions in which experimenter cueing was eliminated. It is also unlikely that a pattern of unreinforced conditional selection (URCS) can account for her criterion level performance on test trials: LS failed to achieve criterion level on B-A tests in Sessions 1 and 2 before going on to pass these tests in Sessions 3 and 4. If her correct comparison selections were indeed URCSs, then it is questionable why she did not respond accurately in the initial sessions; URCSs would have established criterion level responding from the outset of testing.

Because of the implementation of these controls, it is tempting, at this point, to claim that this is the first study to have shown that children are able to acquire multiple novel word-referent relations following non-ostensive exposures in a stringently controlled context, and that the relations acquired were equivalence relations. However, such a claim is questionable: it is acknowledged that methodological flaws in the present study, although unintentional, lead one to question whether the relations acquired by LS were indeed equivalence relations. This is for two reasons.

First, it was intended to present non-ostensive A-B (object-word) exposure trials, in which the stimulus presentations were uni-directional; this was to be achieved by placing the novel object in a box, out of view of the participant, before the corresponding novel word was presented. Indeed, this is how the A-B non-ostensive exposures were conducted. However, following the presentation of the novel word, on some exposure trials E1 permitted the participants to remove the object from the box before the next exposure trial was conducted; thus they may have been exposed, non-ostensively, to the symmetrical B-A (word-object) relations. If this is the case, LS's criterion level performance on B-A tests demonstrates acquisition of the target relations following either impending word or impending object non-ostensive exposures, or a combination of both; it does not, however, unequivocally demonstrate evidence of symmetry because the symmetrical B-A relations may have been exposed.

It might be argued that the unintentional exposure of the symmetrical B-A relations did not affect LS's performance on B-A tests: the temporal delay between the presentation of the word and the corresponding object exceeded 10 seconds in each instance. Cognitive/developmental authors claim that such a temporal delay is not conducive to the exposure learning of novel word-referent relations (e.g., Tomasello & Barton, 1994), and research has shown that non-ostensive exposure trials in which such a delay between non-ostensive stimulus presentations has been implemented have not been effective in producing acquisition of the target relation (Whitehurst, Kedesdy, & White, 1982). However, this remains a matter of contention; it is still possible that the inadvertent B-A exposures affected LS's performance on the subsequent test trials. If this is the case, this has implications for the B-C equivalence test; this is now discussed with respect to the second issue.

Second, it was also intended to the present the C-A exposure trials non-ostensively. This was to be achieved by placing the object in a box, to the lid of which the corresponding novel shape was attached; thus when the box was opened, the shape was removed from view and the corresponding object was then revealed. This is indeed how the exposures were conducted. However, on a number of the C-A exposure trials, LS was permitted to replace the object in the box, and E1 closed the lid of the box so that the shape was again visible; thus LS was exposed, non-ostensively, to the symmetrical A-C relations. In each instance of A-C pairings, unlike B-A pairings, the temporal delay between the stimulus presentations was only a few seconds, and thus it is likely that this affected her performance on subsequent test trials. As B-A and A-C relations were unintentionally exposed, the B-C test was, strictly, not a test of equivalence; rather the B-C test could have been passed by combining the exposed B-A and A-C relations transitively. The same criticisms were levelled at Lipkens et al.'s (1993) study (see Chapter 3, Section 3.4.2).

As a consequence, although LS's performance demonstrates acquisition of the target relations following either impending word or impending object non-ostensive exposure trials, and demonstrates the acquisition of visual-visual relations following similar exposure trials, it does not unequivocally demonstrate the derivation of equivalence relations between the target stimuli. In order to demonstrate such, in subsequent studies it is essential that the direction of stimulus presentations in A-B and C-A non-ostensive exposures are controlled -- they must be uni-directional.

On inspection the findings of Study 2 in general, similar patterns of responding were evident in individual participants' performances; a number of these were also identified in Study 1.

First, with respect to the effect of exposure context, these findings are consistent with those of Study 1: in cases in which participants failed to pass B-A tests following non-ostensive exposure trials, ostensive and exclusion exposures served no added benefit for acquisition of the relations. This is inconsistent with predictions posited by Baldwin & Markman (1989) for instance.

Second, of the two participants receiving unreinforced exclusion trials and related control trials, only one of these demonstrated reliable responding on both trial types: GD achieved and maintained criterion level responding on both exclusion exposure trials and control trials in each experimental session. These data are surprising: cognitive/developmental authors claim that children aged 14 months and above will reliably select the novel comparison on fast mapping/exclusion trials (e.g., Hutchinson, 1986; Markman & Wachtel, 1988; Golinkoff, Hirsh-Pasek, Bailey, Wenger, 1992).

Third, GD and HD both failed to achieve criterion level on B-A tests, and, in doing so, exhibited similar patterns of responding. Both exhibited a preference for the A2 stimulus which increased in intensity over consecutive sub-phases. The stimulus preferences exhibited were not evident in pre-testing; rather, they developed with greater contact with the novel objects, particularly in sessions in which they were utilised in a test trial context. It is likely that the development of these preferences hindered GD's and HD's performance on B-A test trials. The identification of stimulus preferences is thus an important methodological consideration for subsequent studies; relevant measures should include greater contact with the novel objects in general, and contact with the novel objects within a test trial context, prior to exposure of the novel relations.

Fourth, also evident was HD's confusion in early B-A test sessions. Despite achieving criterion level on baseline trials, when initially confronted with the novel stimuli on B-A trials, it appeared that she did not understand the response requirements on these trials. This was also evidenced in RJ's responses in Study 1 (see Chapter 4).

This again highlights the need for greater contact with the novel objects, preferably in a test trial context, prior to the exposure of the target relations.

It is possible that stimulus preferences in the present study were more prevalent, and of a greater intensity, than those of Study 1 because of the use of toy dinosaurs as Set A stimuli. Perhaps participants are more likely to form preferences for animate than non-animate objects. Indeed, two of the participants appeared to find some of the objects "scary" and were apprehensive about selecting these; some participants also commented that they did not like some of the dinosaurs. The participants appeared to tire quickly of these objects both within experimental sessions and across the course of the study. Further, in contrast to Study 1, participants tired of the testing procedure rapidly. In the present study, signs of boredom and fussiness were observed in the participants' responses in early Phase 2 sessions. Also relevant to this issue is participants' performances in Phase 4 of the study: the exposure and testing of new stimulus sets. By this point in the study all the participants had tired of the procedure and only a few sessions were able to be conducted. As a result, in subsequent studies, the use of objects more appealing to, and more likely to sustain the attention of, participants of this age would be advantageous. In addition, modifications to the present procedure are required in order to sustain participants' interest in experimental sessions.

There is one important observation from Phase 4. Following two non-ostensive A-B exposure trials, GD responded conditionally on the subsequent B-A test; these responses, however, were not consistent with the stimulus pairings presented in the exposure trials: on B3-A3 trials GD selected A4, and on B4-A4 trials he selected A3. This may be accounted for by URCS: prior associations between these words and objects were not tested. However, an alternative explanation may be posited. Although A-B exposure trials in Phase 4 were controlled with respect to the direction of stimulus presentations, another possible confound was identified. Following presentation of the novel word in the first exposure trial, E1 then presented the A stimulus (the novel object) of the next exposure trial following only a short inter-trial interval. The target relations were exposed on alternating trials, thus: following presentation of B3, A4 was consistently revealed for the next trial; similarly, following presentation of B4, A3 was consistently revealed for the next exposure trial. Although the temporal delay between these presentations was greater than 10 seconds (see above for the relevance of this temporal delay), it is possible that these non-ostensive pairings may have led GD to form the incorrect relations. Thus, in subsequent studies, such a confound must be controlled for; this may be achieved by the random presentation of exposure trials of each target relation, and the implementation of greater inter-trial intervals.

In summary, two of the participants failed to demonstrate acquisition of the novel word-referent relations; both these participants exhibited a similar pattern of responding across test trials. In contrast, LS demonstrated acquisition of the word-referent relations and passed subsequent B-C tests suggesting that she had formed equivalence classes between the stimuli. However, this is questionable. As the symmetrical B-A and A-C relations may have been exposed, LS's criterion level performance on the B-C tests only provides evidence of transitivity. In order to unequivocally demonstrate derivation of equivalence relations following exposure trials, it is essential that, in subsequent studies, the direction of stimulus presentations on non-ostensive exposures are tightly controlled.

CHAPTER 6

STUDY 3

STIMULUS EQUIVALENCE AND THE EXPOSURE LEARNING OF MULTIPLE NOVEL RELATIONS: A CONTROLLED REPLICATION

Study 3 largely replicated the general procedure of Study 2 with the implementation of additional controls, the necessity of which was identified by participants' performances in Study 2 (see Chapter 5). Again, this study employed procedures and paradigms from the cognitive/developmental and behaviour analytic research outlined in Chapter 1 in order to investigate the exposure learning of symbolic relations between multiple novel words and their referents.

The procedure comprised three major phases.

In Phase 1, the prerequisite skills for responding on auditory-visual matching-to-sample test trials were verified. Further, in Study 2, it was observed that stimulus preferences developed with greater contact with the novel objects, particularly in a test trial context. Also related to this issue is the performance of some participants in Studies 1 and 2; RJ and HD, respectively, were initially confused as to the responses required on target relation test trials. In order to control for both these patterns of responding, a B-A pre-testing session was incorporated in the present study. This gave participants experience of the novel objects in a test trial context, and enabled the identification of stimulus preferences, prior to exposure of the novel relations. In addition, this pre-testing provided an assessment of unreinforced conditional selection (URCS). Through pre-testing it could be ensured that two objects equally appealing to the participants were selected as Set A stimuli, and that participants did not have any prior associations between these and the novel target words.

In Phase 2, as in Study 2, participants were given A-B exposures and B-A tests. Again, A-B non-ostensive impending word exposures were presented first, in order that symmetry was assessed; A-B ostensive and B-A exclusion exposures were presented subsequently. Following a consideration of the methodology of Study 2, a number of procedural modifications were made in this phase. In order to control the direction of stimulus presentations on non-ostensive A-B exposure trials, it was ensured that there was at least a 20 second inter-trial interval between exposure trials, that exposure trials of the target relations were presented randomly, and that participants were unable to see the novel object following presentation of the corresponding novel word. Also, for some participants, A-B non-ostensive exposure trials were interspersed with non-ostensive exposure trials of the familiar auditory-visual relations. These were conducted in order to increase variation in, and hence interest in, exposure trial blocks, and to set the context for learning; such a procedure has been previously adopted by cognitive/developmental researchers (Schafer & Plunkett, 1998; Whitehurst, Kedesdy, & White, 1982).

In Phase 3, as in Study 2, participants were exposed to C-A relations and were given B-C equivalence tests. In the present study it was ensured that, following the presentation of the object on C-A exposure trials, participants were not able to again see the corresponding novel shape; thus the direction of stimulus presentations was tightly controlled. As was noted with reference to Study 2, in cases in which participants achieved criterion level responding on B-A trials following A-B non-ostensive exposures or ostensive exposures, B-C matching-to-sample test trials comprised tests of equivalence and C-B naming test trials comprised tests of transitivity. In cases in which participants achieved criterion level responding on B-A trials following B-A exclusion exposures, B-C *and* C-B test trials comprised tests of the emergence of equivalence relations (see Chapter 5, introduction to Study 3).

A third phase was incorporated in the present study. In Study 2, after achieving criterion level on B-A tests in Session 3, LS immediately passed the B-C tests. It is possible that a history of correct conditional responding within the experimental context facilitated her performance on matching-to-sample trials of relations exposed and tested subsequently. Therefore, in the present study, some of the participants who failed B-A tests at the end of Phase 2 were trained the B-A relations (word-object relations) with feedback and rewards for correct responding. This was in order to provide exemplar training prior to Phase 3 of the study. Following criterion level on B-A training trials, participants proceeded to Phase 3.

In Phase 3, participants who learned B-A matching via direct reinforcement were given C-A exposures followed by tests of B-C matching and C-B naming. As in the previous studies, the B-C matching tests were tests of equivalence because B-C could only emerge if the C-A exposures gave rise to A-C relations via symmetry, and these A-C relations combined transitively with the directly trained B-A relations to give B-C. One might also assume that the emergence of C-B naming demonstrates equivalence -- the B-A relations giving rise to A-B via symmetry, and these A-B relations combining transitively with the exposed C-A relations to give C-B. However, this assumption is incorrect because the contingency for directly training B-A matching may also directly train the A-B naming relations. Consider what happens on an B-A matching trial once the participants have learned the B-A relations. Upon hearing, for example, the B1 sample name, the participant will select the A1 comparison object, and a reward will follow. But comparison selection is not the only response the participants can make to the B1 sample name; they are also likely to echo the B1 word overtly or covertly. They would thus also be rewarded for saying B1 conditional upon selecting A1. Given that the A-B naming relation is directly trained, then the emergence of C-B naming following C-A exposures would only demonstrate transitivity (C-A and A-B giving rise to C-B; no symmetry required).

To summarise the above, in cases in which criterion level responding is achieved on B-A trials following non-ostensive exposures, ostensive exposures, or direct training, equivalence is assessed by B-C matching tests; C-B naming tests constitute tests of transitivity. In contrast, in cases in which criterion level responding is established on B-A trials as a result of B-A exclusion exposure trials, B-C *and* C-B tests constitute tests of the emergence of equivalence relations.

A number of more general controls were also implemented.

First, Set A stimuli were changed in the present study. These stimuli now comprised the inanimate multi-sensory objects that were utilised in Study 1. These were employed in order to sustain participants' interest within and across experimental sessions.

Second, in order to sustain interest in, and promote correct responding on, target test trials, a token reward system was employed. Participants were given token rewarded baseline trials which were interspersed among the (unreinforced) target test trials. These were employed from the outset of the study in order that participants were familiar with the contingencies for receiving rewards prior to exposure of the novel relations; the necessity of this was identified in Study 1 (see Chapter 4).

Third, experimenter cueing was eliminated for a number of participants (for whom two experimenters were available to conduct the study).

In summary, Study 3 employed the same general procedure as Study 2 in order to investigate the exposure learning of equivalence relations between multiple novel words and their referents. Importantly, this was conducted in a more stringently controlled context; this was achieved by incorporating necessary control measures that were identified from participants' responses in Studies 1 and 2.

METHOD

Participants

Ten preschool children, aged between 23 and 32 months, participated in the study. Four of the participants (SR, CE, RP, and DN) were recruited from Tir na n'Og Day Nursery in Bangor, North Wales; the remaining six participants (SB, TW, TS, CL, SJ, and KN) were recruited from Clebran Private Day Nursery in Llandudno, North Wales (see table 6.1). Written informed consent for each child's participation was obtained from their parents/guardians prior to the commencement of the study (see Appendix D).

Table 6.1

Participants' gender and age at the start of the study.

		Age at start	MCDI scores	
Participant	Gender	Months:days	expressive	receptive
SB	M	23:05	65	226
TW	M	24:02	236	243
TS	M	24:03	168	242
SR	M	25:04	-	-
CE	M	25:20	-	-
RP	M	25:27	-	-
CL	M	27:25	198	287
SJ	M	28:28	295	323
KN	F	30:09	380	381
DN	M	31:15	-	-

Note: M = Male; F = Female.

The parents of six participants, those attending Clebran Day Nursery, were requested to complete the MacArthur Communicative Development Inventory: Words and Gestures (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick, & Reilly, 1993) prior to the start of the study (see table 6.1). This provided an assessment of participants' receptive and expressive vocabularies. From the responses on the MCDI it was ensured that each of the participants were post-vocabulary spurt. The criterion for classifying participants as having undergone the vocabulary spurt was the acquisition of at least 50 words in production; this criterion is typically employed by a number of cognitive/developmental researchers (e.g., Mervis & Bertrand, 1994; Woodward, Markman, & Fitzsimmons, 1994). The parents of the participants in Tir na n'Og nursery did not complete the MCDI. However, as these children were aged 18 months and above they participated in the study; this criterion has also been adopted by cognitive/developmental researchers for classifying children as having undergone the vocabulary spurt (e.g., Woodward et al., 1994).

Prior to the administration of the experimental sessions, the experimenters made several informal visits to the nursery; during these sessions they interacted with the participants both in the nursery playroom and in the research room. These informal sessions ensured that the participants were familiar with both the research setting and the experimenters before any experimental sessions were conducted.

At the end of the study, each participant's parents/guardians were debriefed as to the aims and procedures employed, and their child's performance throughout the study; this was by personal letters detailing only their own child's performance.

Apparatus and Materials

Setting and Apparatus

All the experimental sessions were conducted in a research room provided in each of the nurseries. Both of the research rooms were equipped with identical furniture for use in the experimental sessions; all the other furniture and toys were removed from the research room, where possible, in order to minimise distractions.

All the experimental sessions were videotaped to allow post-session analysis. To this end the research rooms were equipped with a portable video camera (Panasonic

M10); this was mounted upon a tripod and positioned in the corner of the room so that an unobscured view of both the experimenter and the participant was provided.

A set of pre-prepared record sheets was required for each participant. For each experimental session a record sheet detailed the order and type of exposure trials, the order of presentation of auditory samples on matching-to-sample trials, and the counterbalanced order of presentation of visual comparisons on matching-to-sample trials. The participant's responses on test trials were noted on the record sheet, by the experimenter, throughout the duration of each session.

A collection of toys, applicable for the age group of the present participants, was also required (e.g., jigsaw puzzles, form boards, stickle-bricks). These were used to entertain the participants during inter-trial intervals, and at the beginning and end of each experimental session; they were also used to engage the participants' attention when they became uncooperative or distracted.

In order to present the non-ostensive exposure trials, a cardboard box (40 cm x 34.5 cm x 38 cm) was required in which to hide the novel object from the participants' view. A piece of material was attached to the top of the box; a slit in this material allowed the object to be dropped inside and remain obscured from the participants' view.

A token reward system was utilised for baseline trials. This comprised an MB Games "Connect 4" game which consisted of a 36 piece plastic matrix and 36 plastic tokens coloured red or yellow (see Appendix B). Tokens were dropped into the top of the matrix columns and were removed by a trap door at the bottom. At the end of each session participants exchanged red tokens for stickers or small presents.

Familiar Stimuli

Familiar auditory and visual stimuli were required for use in baseline matching-to-sample trials, exclusion exposure trials and control trials, and non-ostensive and ostensive exposure trials. The familiar visual stimuli consisted of plastic toy farm animals (see Appendix G). These comprised a pig (10 cm x 5 cm), a rabbit (6 cm x 5 cm), a cow (12.5 cm x 6.5 cm), and a horse (12.5 cm x 9.5 cm). The familiar auditory stimuli consisted of their corresponding conventional names.

These auditory-visual relations were determined as being familiar to the participants from their responses in the free play session conducted at the commencement of the study, and from informal interviews held with the participants' parents/guardians, and the nursery nurses, prior to the start of the study. In addition, for some participants the familiarity of these relations was confirmed by parents/ guardians' responses on the MCDI.

Novel Stimuli

Three sets of novel stimuli were used: Set A, Set B, and Set C.

Set A stimuli. Set A comprised novel objects. These consisted of a variety of three-dimensional multi-sensory objects and toys (also used in Study 1) and were as follows (see Appendix G): a multi-coloured plastic "slinky spring" (7.5 cm x 6.5 cm); a triangular "Galt Pocket Alarm" (4 cm x 4.5 cm), that produced lights and sounds when its button was depressed; a pink and white concertina snail (4.5 cm x 19.5 cm), that produced a squeak when depressed; a multi-coloured "Koosh Ball" (10 cm in diameter) made of thick blue, yellow, or red elastic strands; a white "Koosh Ball" (10 cm in diameter) made of fine silken elastic stands; a pair of round yellow plastic castanets (6 cm in diameter); and a red plastic lobster (9 cm x 6.5 cm), that produced a "Sshhh" sound when squeezed. These visual stimuli were selected in order that they were novel and appealing to the participants, were visually distinct from one another, and were manipulable by participants of this age range. For each individual participant, two of these objects were selected as Set A stimuli for use in Phases 2 and 3 of the study.

Set B stimuli. Set B comprised novel words. These consisted of the monosyllabic nonsense words "Tak" [tõak], "Bosch" [boS] (selected from those used by Lipkens, Hayes, and Hayes, 1993), "Koob" [kub], and "Dax" [dœks][1]. These nonsense words were selected in order that they were novel to the participants, were easily pronounceable, and were distinct from one another.

Set C stimuli. Set C comprised novel shapes. These consisted of two 2-dimensional multi-sensory patterns which differed on three dimensions -- colour, shape, and texture. The first of these comprised a large sandpaper cross (12 cm x 12 cm) with four small sandpaper triangles surrounding it, and the second comprised a large green felt circle (10.5 cm in diameter) with smaller circles of purple or red felt placed upon it (see Appendix G).

In order to conduct the C-A exposure trials, each of these shapes was attached to the side of one of two identical boxes (15 cm x 15 cm x 15 cm); one shape was attached to the side of one box and one shape to the side of the other (see Appendix G). The boxes were made of blue holographic cardboard designed to be appealing to the participants.

Procedure

General Procedure

The procedure was divided into three major phases, similar to those of the previous study, in which the participants were exposed to, and tested for the derivation of, relations between novel objects, words, and shapes (see Figure 6.1).

[1] The novel words "Koob" and "Dax" (taken from Dollaghan (1985) and Golinkoff et al. (1992) respectively) were selected for use with Participant DN; this was because the words "Tak" and "Bosch" were used in pre-testing with DN in a previous study.

In Phase 1, pre-testing, Set A stimuli were selected for each participant, and it was ensured that they were able to demonstrate the basic prerequisite skills required in order to respond correctly on auditory-visual matching-to-sample trials.

In Phase 2, the participants were exposed to novel A-B, object-word, relations and were tested for the derivation of the symmetrical B-A, word-object, relations (see Figure 6.1). This phase was further divided into three sub-phases. Each of these sub-phases employed the same general exposure and testing procedure, but differed in the type of exposure trials employed: in Phase 2.1 A-B impending word non-ostensive exposure trials were employed, in Phase 2.2 A-B ostensive exposure trials were employed, and in Phase 2.3 B-A exclusion exposure trials were employed. (The general procedure and each of the trial types are described in detail below.)

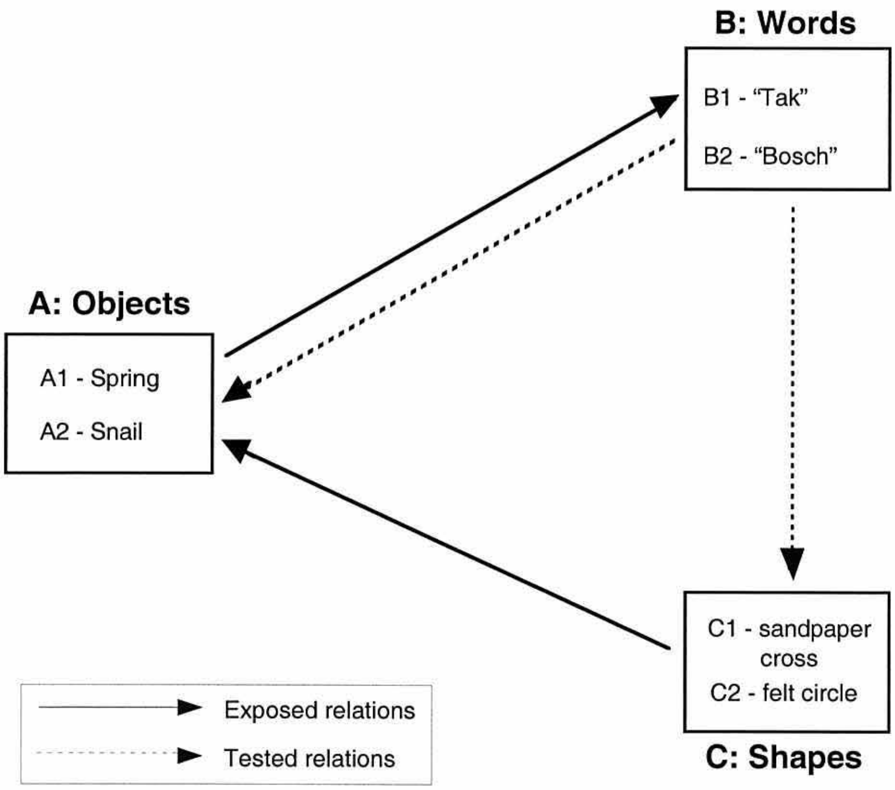

Figure 6.1: Schematic representation of the novel relations exposed and tested in Study 3. Arrows point from sample to comparison stimuli. Note that in Phase 2.3 exposure trials comprised B-A exclusion trials (these are not represented in this figure).

Two of the participants were then given a training phase, between Phases 2 and 3, in which they were rewarded for correct responses on B-A matching-to-sample trials.

Finally, in Phase 3, the participants were exposed to C-A, shape-object, relations and were tested for the emergence of B-C, word-shape, equivalence relations (see Figure 6.1). In this phase of the study only non-ostensive exposure trials were employed.

Each participant's progression through these phases was dependent upon his or her performance in the previous phase (see Figure 6.2). This is described in detail later.

The experimental sessions lasted no longer than 20 minutes, and no more than two sessions were conducted per day with each participant (when two sessions were conducted in one day, the first was conducted in the morning and the second in the afternoon, thus affording a substantial break in testing).

For four of the participants (SR, CE, RP, and DN) a blind testing procedure was employed in order to eliminate cueing of correct responses. This was achieved by the participation of two experimenters. In each session, one of the experimenters was present for each trial type: Experimenter 1 (E1) conduced only the exposure trials, and Experimenter 2 (E2) conducted only the test trials. As E2 was not present throughout the exposure trials, she was unaware of the correct pairings between the novel stimuli and was thus unaware of the accuracy of the participants' responses on test trials. As a result, no feedback or reinforcement for correct responding was provided.

For the remaining six participants (SB, TW, TS, CL, SJ, and KN), only one experimenter was available for participation in the study; she conducted both the exposure and the test trials. Thus for these participants, although test trials were also unreinforced and feedback was not provided, there was no control implemented to eliminate unintentional cueing of correct responding.

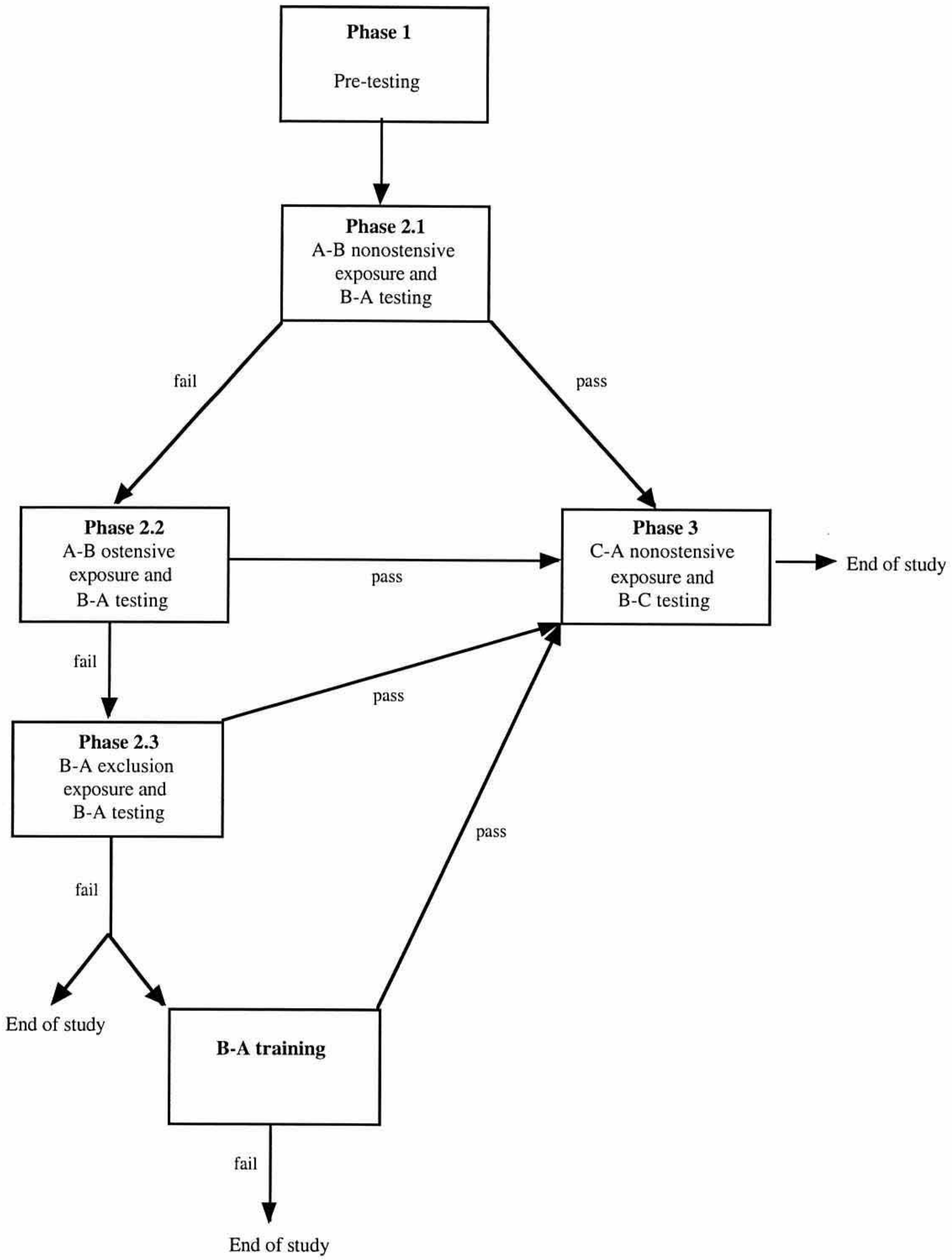

Figure 6.2. Participants' progression through the phases of Study 3.

Phase 1. Pre-testing

The pre-testing phase consisted of three types of experimental session, each of which was conducted at least once, and was repeated where necessary with individual participants. These comprised a free play session, a baseline pre-testing session, and a B-A pre-testing session.

Free play session. In this initial session participants were presented with the seven novel objects and were encouraged to play freely with them. (Both of the experimenters were present throughout this session for participants SR, CE, RP, and DN.) The participants' verbal and non-verbal behaviours, and their interactions with the objects, were observed in order to determine that the objects were unfamiliar to them, and that they did not consistently label them. Further, any stimulus preferences were identified and objects that were observed to be equally appealing to each of the participants were selected for use in the B-A pre-testing session.

Baseline pre-testing session. This session was conducted in order to verify the prerequisites for matching-to-sample trials. In this session, the participants were presented with 12 baseline trials -- matching-to-sample test trials of familiar auditory-visual relations. That is, participants were presented with a familiar auditory sample and were requested to select the corresponding stimulus from an array of two familiar visual comparisons. Baseline trials employed the same matching-to-sample format as all other auditory-visual test trial types presented in the study (see Table 6.2).

The format for the matching-to-sample trials was as follows. The participant and E were seated opposite each other at the table; the connect 4 matrix was placed on the side of the table to the right of the participant. On each trial the participant was presented with two visual comparisons that were placed on the table before him or her. As the objects were placed down, the auditory sample was presented, dictated by E, in the carrier phrase appropriate for the individual participant (e.g., "Where is the X?" or "Give me the X", where X was the auditory sample). These requests were presented when the participant was holding either both or no objects in order to avoid biasing comparison selections.

Table 6.2

Matching-to-sample trial types employed in Phases 1, 2, and 3 of the study.

		Visual Comparisons	
Trial type	Auditory sample	S+	S-
Baseline	"Pig"	pig	horse
B-A	"Tak"	spring	alarm
	"Bosch"	alarm	spring
B-C	"Tak"	cross	circle
	"Bosch"	circle	cross
Exclusion	"Tak"	spring	horse
Control	"Horse"	horse	spring

Note: In this example the novel relations comprise:
A1 - spring, B1 - "Tak", C1 - cross. A2 - alarm, B2 - "Bosch", C2 - circle.

On each trial the participant was required to manually indicate a choice between the two comparison stimuli by pointing to, picking up, or giving E one of the comparisons. If the participant produced a clear and codeable response, the objects were removed and the next trial commenced. If the participant produced an ambiguous response, or did not make a response, the trial was reconducted up to three times before that particular trial was abandoned.

Throughout this session a token reward system was utilised. After each correct response on a baseline trial, the participants were rewarded with verbal praise and were given a token which they placed in one of the columns of the connect 4 matrix. For the initial five correct responses in a session, the participants were given a yellow token; for the sixth correct response they were given a red token which was placed at the top of the column. This was repeated for every six correct responses. At the end of the session the tokens were dropped out of the matrix and the red tokens were exchanged for stickers or stars.

Initially, the participants received tokens for every correct response within a baseline pre-testing session. In the final baseline pre-testing session this was reduced, and tokens were given on no more than eight baseline trials; this was because the participants would receive rewards for correct responses on baseline trials alone in testing sessions in Phases 2 and 3, and thus would not receive rewards for correct responses on every trial in a session (i.e., appropriate responding on B-A and B-C test trials was not rewarded).

In order to progress to Phase 2, the participants were required to perform at, or above, the baseline criterion level: this was at least 80 percent correct responding within one baseline pre-testing session.

B-A pre-testing session. This final pre-testing session was conducted to ensure that subsequent criterion level responding on B-A trials was not a result of unreinforced conditional selection (URCS). By monitoring the participants' selections of the novel objects in response to the novel words, it was ensured that the participants did not have any associations between the objects and words prior to their exposure in Phase 2. In addition, it was determined that stimulus preferences did not develop with contact with the novel objects in the test trial context.

This session employed the same format as the subsequent B-A test sessions (i.e., the presentation of B-A test trials interspersed with baseline trials in order to sustain the participants' interest in the session). For each participant, two of the novel objects selected from the free play session were designated A1 and A2, and the novel words were designated B1 and B2. Twelve unreinforced B-A pre-testing trials were conducted in which the participants were shown both of the novel objects as comparisons, and were requested to select one upon presentation of one of the novel words (six trials in which B1 was the auditory sample, and six trials in which B2 was the auditory sample). These trials were conducted in the same matching-to-sample format as the baseline trials described earlier (see Table 6.2).

In order to progress to Phase 2, the participants had to satisfy two criteria in this session.

First, they had to select both of the objects with equal frequency; that is, they had not to select one of the novel objects on more than eight B-A pre-testing trials. This demonstrated that the objects were equally salient.

Second, the participants had to perform below criterion level (80 percent correct responding) on the B-A pre-testing trials (i.e., on trials in which B1 was the sample they must not select A1 on 5/6 trials or more, and on trials in which B2 was the sample they must not select A2 on 5/6 trials or more). Thus this assessed URCS.

In sessions in which these criteria were not met, the objects were changed (i.e., the preferred object was substituted, or in cases where the participants demonstrated a pattern of URCS, two further novel objects were substituted) and the session was reconducted. Once the participants satisfied these criteria they progressed to Phase 2 of the study.

Phase 2. A-B Exposures and B-A Testing

In Phase 2, the participants had object-word exposures and B-A (word-object) tests. This phase was divided into three consecutive sub-phases: Phases 2.1, 2.2, and 2.3, each of which employed different exposure trial types (described below). Each sub-phase employed the same general procedure, as follows. Each experimental session consisted of exposure trials and subsequent B-A test trials. (For participants SR, CE, RP, and DN, E1 conducted the exposure trials and E2 conducted the test trials; for the remaining participants E2 conducted both the exposure and test trials.) In the first session, the participants had two A-B exposure trials (e.g., one each of A1-B1 and A2-B2), and in the remaining two sessions they had six exposure trials (e.g., three each of A1-B1 and A2-B2).

For some participants, the A-B non-ostensive exposure trials were interspersed with familiar trials of the same type: trials in which familiar auditory-visual relations were exposed. This was in order to set the context for learning, and to sustain the participants' attention in the exposure procedure. (The participants who had these trials are noted in the results section.)

Each block of exposure trials was followed by 12 B-A test trials (six each of B1-A1 and B2-A2, see Table 6.2). These trials were randomly presented and were unreinforced. (In some sessions the number of test trials varied due to the willingness of the participant to cooperate throughout the session.) The B-A test trials were interspersed with a varying number of baseline trials on which correct responding was rewarded; these were conducted in order to sustain the participants' attention in the experimental session. The presentation of test trial blocks always began and ended with a baseline trial. At the end of each session the red tokens gained were exchanged for stars or stickers.

At the end of each sub-phase the participants received an A-B naming test session (described in detail below).

Although the general procedure comprised the presentation of three experimental sessions in each sub-phase, the number of sessions actually presented varied for each participant; this was because experimental sessions were occasionally repeated. For example, if a participant performed well on B-A trials in one session, yet did not achieve criterion level, this session was repeated; or, if a participant did not produce responses on all 12 B-A trials, the session was often repeated.

Each of the sub-phases employed this general procedure, yet differed in the type of exposure trials employed, as follows.

Phase 2.1a. A-B non-ostensive exposure trials and B-A testing. In Phase 2.1a, the participants were given A-B non-ostensive exposure trials. That is, they were initially presented with a novel object and, once this was obscured from their view, the corresponding novel word was presented. On each exposure trial the participant was seated at the table opposite E. E placed one of the novel objects on the table before the participant and he or she was encouraged to play freely with it for an average of 20 seconds. The object was then dropped into the box at the side of the table where it was obscured from the participant's view. E then made eye contact with the participant and presented the novel word in the carrier phrase "That was a X" (where X was the auditory sample). Thus the novel word was presented only two to three seconds, on average, after the object was removed from view. If the participant did not attend to E for the presentation of the novel word, after approximately five seconds, the object was removed from the box and the trial was reconducted.

Phase 2.1b. A-B non-ostensive exposure trials and B-A testing. Phase 2.1b was identical in nature to Phase 2.1a. However, the A-B exposure trials were interspersed with non-ostensive exposure trials of the familiar auditory-visual relations. These were conducted utilising a procedure identical to the A-B ostensive exposure trials. Participants who received this sub-phase are noted in the results section.

Phase 2.2. A-B ostensive exposure trials and B-A testing. In Phase 2.2, the participants were given A-B ostensive exposure trials; that is, they were presented with the novel object and corresponding word simultaneously. E and the participant were seated opposite one another at the table. One of the novel objects was placed on the table between them, and the participant was encouraged to play freely with it for approximately 20 seconds. When both E and the participant were looking at the object, E presented the corresponding novel word in the carrier phrase "This is a X" (where X was the auditory sample). The object was then removed from the table and the next exposure trial conducted.

Phase 2.3. B-A exclusion exposure trials and B-A testing. In Phase 2.3, the participants were exposed to the novel B-A relations through the use of exclusion exposure trials. These were presented in the same matching-to-sample format as other test trial types (see Table 6.2). On each trial the participant was presented with one familiar object and one of the novel objects, and was requested to select the novel object upon presentation of the corresponding novel word, dictated by E.

This sub-phase was further divided into Phases 2.3.1, 2.3.2, and 2.3.3 which were presented consecutively.

Phase 2.3.1. In Phase 2.3.1, the participants received only exclusion exposure trials in each experimental session. However, it was noted that although the participants may have responded correctly on these trials, it was possible that they did so without attending to the auditory sample presented; this was by selecting the correct visual comparison on the basis of its novelty alone (see Chapter 2).

Phase 2.3.2. In Phase 2.3.2, these trials were interspersed with baseline trials. Correct performance on the baseline trials indicated that they were attending, in some part, to the auditory samples presented. However, again it was noted that correct performance on exclusion trials may still be achieved by selecting the correct comparison on the basis of its novelty alone (see Chapter 2).

Phase 2.3.3. In order to control for this, in Phase 2.3.3, the exclusion exposure trials were interspersed with control trials (see Table 6.2). On these trials the participants were presented with a familiar object and one of the novel objects and were requested to select the familiar visual stimulus. As it was not possible for the participants to respond correctly on these trials if they were responding on the basis of novelty alone, correct responding on control trials indicated that the participants' correct responses on exclusion trials were controlled by, and that the participants were attending in some part at least to, the auditory sample presented. (Some participants received only this sub-phase in Phase 2.3, as is noted in the results section.)

B-A test trials throughout Phase 2. Following the exposure trials, the participants were presented with 12 B-A test trials (see Table 6.2). These trials were always unreinforced and were interspersed among token rewarded baseline trials. Within each session the position of comparisons was counterbalanced across all 12 trials: the novel objects appeared as correct and incorrect comparisons, with equal frequency, in both left and right hand locations. This served to discourage the emergence of preferential responding.

A-B naming test session. At the end of each sub-phase the participants were given an A-B naming test session. This comprised three consecutive trial types: free recall trials, prompted recall trials, and recognition trials. Participants were given six trials of each type (three trials each of A1-B1 and A2-B2).

On free recall trials, the participants were shown one of the novel objects and were asked "What's this?" by E.

On prompted recognition trials, the participants were again shown one of the novel objects and were asked "Is this a X1, or a X2?" (where X1 and X2 were the novel words). On half of the trials the correct corresponding novel word was presented first, and on the other half it was presented second. Thus it was not possible for the participants to produce criterion level responding by simply repeating the last novel word presented.

On recognition trials, the participants were presented with one of the novel objects and were asked "Is this a X?" (where X was one of the novel words). On half of the trials the correct corresponding novel word was presented, and on the other half the incorrect novel word was presented. Thus it was not possible for the participants to produce criterion level responding by simply replying yes (or no) on all the recognition trials.

All of these trials were unreinforced and were interspersed with familiar trials of the same type (that is, familiar free recall, familiar prompted recall, and familiar recognition trials); correct responses on familiar trials were rewarded with tokens.

Criteria for progression to Phase 3. The participants' progression through the phases of the study is presented in Figure 6.2. If the participants failed to achieve criterion level responding on B-A trials in Phase 2.1, they progressed to Phase 2.2; similarly, if participants failed to achieve criterion level on B-A trials in Phase 2.2, they progressed to Phase 2.3. If participants failed to achieve criterion level responding on B-A test trials at the end of Phase 2.3 two options were available, dependent on the participants attention and cooperation with the procedure -- for participants who showed an increasing lack of interest in experimental sessions, the study was ended at this point; participants who showed sustained interest in the procedure progressed to a training phase.

Participants who responded at criterion level at any point in Phase 2, or the training phase, progressed to Phase 3 of the study.

Training Phase

Two of the participants (CL and KN), who did not respond at criterion level on B-A test trials at the end of Phase 2.3, were given a training phase. In each experimental session they were presented with non-ostensive A-B exposure trials and B-A training trials. B-A trials were identical in nature to Phase 2 (see Table 6.2), but correct responses were rewarded with verbal praise and the presentation of tokens. B-A trials continued to be interspersed with token rewarded baseline trials.

The experimental sessions were repeated until the participant performed at criterion level on the B-A trials. At this point, a further session was conducted in which the rewards for correct responses on B-A trials were removed. This session was repeated until the participants performed at criterion level in the absence of rewards. The participants then progressed to Phase 3.

Phase 3. B-A Test Trials, C-A Non-Ostensive Exposure Trials, and B-C Testing

Once participants had achieved criterion level on B-A trials they progressed to Phase 3 (see Figure 6.2). In this phase they were given non-ostensive C-A, shape-object, exposure trials and B-C, word-shape, equivalence tests (ostensive and exclusion exposure trials were not employed in this phase).

The general procedure remained the same as Phase 2. However, each experimental session now comprised the presentation of three trial types: B-A test trials, C-A exposure trials, and B-C test trials. In each session participants were given between two and six B-A test trials. Following this they were given C-A exposure trials (described below); two in the first session (one each of C1-A1 and C2-A2) and six in the remaining sessions (three each of C1-A1 and C2-A2). Finally, the participants were presented with 12 B-C test trials (described below). Some participants were also given a C-B, a C-A, or an A-C test session (also described below) at the end of Phase 3.

C-A non-ostensive exposure trials. The participant and E were seated opposite each other at the table. E presented the participant with one blue holographic box which had one of the novel shapes attached to the side; this contained the corresponding novel object. This was presented such that the shape was facing the participant. He or she was encouraged to look at and touch the shape, and note its defining features, for an average of 10 seconds. E then asked "What's hiding in here?", turned the box over so that the shape was laid on the table and obscured from the participant's view, and opened the lid of the box to reveal the corresponding object. After a period of free play with the object E, or the participant, placed the object back in the box, and the box was slipped off the table so that the shape remained obscured from the participant's view. The next exposure trial was then conducted.

B-C test trials. Following the exposure trials the participants were presented with 12 unreinforced B-C test trials (six each of B1-C1 and B2-C2).

These were conducted in the matching-to-sample format used for all other test trials (see Table 6.2). The participants and E were seated opposite each other at the table. On each trial E placed the two blue boxes on the table so that the shapes were facing the participant. (Throughout the test trials the novel objects were not placed inside the boxes; this was to ensure that, in cases in which the participants opened the boxes, the correct pairings between the novel shapes and objects were not revealed.) The participants were then requested to select one of the shapes upon presentation of the corresponding novel word in the carrier phrase "Where is the X hiding?" (where X was the auditory sample). Once the participant had produced an unambiguous response, the boxes were removed and the next trial was conducted. In these sessions baseline trials were conducted only at the beginning and end of the B-C test trials; this was because the two test trial types differed slightly in procedural specifics, and the interspersion of these trials may have confused participants as to the required responses.

Within each session the position of comparisons was counterbalanced such that each of the shapes appeared as correct and incorrect comparisons, with equal frequency, in both the left and right hand locations; this served to discourage preferential responding.

C-B test trials. Some participants were given a C-B test session which comprised 12 unreinforced C-B, shape-word, test trials (i.e., test trials in which the novel shapes were presented as samples and the participants were required to produce the corresponding novel word; these comprised six trials each of C1-B1 and C2-B2). On each trial the participant was presented with one of the blue boxes with one of the novel shapes on and was asked: "What hides in here?" Once the participant had produced one of the novel words, the box was removed and the next trial conducted. Baseline trials were not presented in this session. In cases in which participants achieved criterion level on B-A trials following A-B non-ostensive or ostensive exposures or B-A training, C-B tests assessed the emergence of transitive relations. (Combining transitively the C-A and A-B exposed relations). In contrast, in cases in which participants achieved criterion level on B-A tests following exclusion exposure trials, C-B trials comprise tests of the emergence of equivalence relations (combining transitively the C-A exposed relations, and the A-B relations derived via symmetry, see introduction to this chapter).

C-A test trials. Some of the participants were given a session comprising 12 unreinforced C-A, shape-object, test trials (i.e., trials in which the novel shapes were presented as samples and the novel objects as comparisons; these comprised six trials each of C1-A1 and C2-A2). On each trial the participant was presented with both of the novel objects which were placed on the table before him or her. E then placed one of the boxes in the centre of the table so that the shape was facing the participant. They were then asked, "Which one hides in here? Can you put it in for me?" Once the participants had placed one of the novel objects in the box, the box and the remaining object were removed and the next trial was conducted. The position of the novel objects was counterbalanced across all 12 test trials such that each of the objects appeared as correct and incorrect comparisons, with equal frequency, in both the left and right hand positions. Baseline trials were not presented in this session.

A-C test trials. Participants, in some cases, were given a session comprising 12 unreinforced A-C, object-shape, test trials (i.e., trials in which the novel objects were presented as samples and the novel shapes as comparisons; these comprised six trials each of A1-C1 and A2-C2). On each trial the participant was presented with both of the boxes so that the shapes were facing him or her. E then placed one of the novel objects on the table, in the middle of the boxes, and asked, "Where does this hide?" Once the participant had placed the novel object in one of the boxes, the boxes were removed and the next trial conducted. The position of the novel shapes was counterbalanced across all 12 test trials so that each of the shapes appeared as correct and incorrect comparisons, with equal frequency, in both the left and right hand positions. Baseline trials were not presented in this session.

Response Requirements and Scoring Criteria

Baseline, B-A, and B-C test trials. On these trials the participants were required to manually indicate a choice between two comparison stimuli. If the participants distinctly selected one of the comparisons followed by the remaining comparison, their first response was recorded. If the participants selected both of the comparisons simultaneously, the comparisons were removed and the trial was reconducted up to three times until a clear and codeable response was recorded. If the participants failed to produce an unambiguous response on the third repetition of the trial, it was abandoned and the next trial conducted.

Participant TS did not reliably produce clear responses on test trials in which "Where is X?" questions were asked. Thus the box used for the non-ostensive A-B exposure trials was utilised. This was placed at the side of the table and on each trial TS was requested: "Put the X in the box." On these trials he consistently produced unambiguous responses.

In sessions where participants brought a toy into the room, and they could not be encouraged to give it to E, the toy was utilised on test trials. For example, if a teddy was brought into the room, the participants were asked: "Give teddy the X" or "Show teddy where the X is" on test trials.

A-B and C-B naming test trials. On naming test trials the participants were required to produce a vocal response. If they produced a familiar word on a target test trial, the trial was repeated until they produced one of the novel words. On recognition trials, the participants were required to say either "Yes" or "No". On these trials only these responses were recorded. That is, if a participant produced one of the novel words, the trial was repeated until they produced either "Yes" or "No". If the participants responded to familiar relation recognition trials by nodding or shaking their head, then these responses were also recorded on target recognition trials.

Participants' Vocalisations

The participants' informal productions of the novel words were recorded throughout the study. The context in which the vocalisation occurred, the visual stimuli present at the time, and the surrounding discourse was also noted in order that each vocalisation could be classified into one of three categories: spontaneous labelling, prompted labelling, or echoing. These categories are described in detail in Study 1 (see Chapter 4, method section).

RESULTS

The participants' performances in Phase 1, pre-testing, are initially presented. Each participant's performance on test trials, throughout Phases 2 and 3, is then presented individually in order to determine whether they derived the target novel B-A and B-C relations. (Individual participants' responses on all test trial types throughout experimental sessions, and their informal vocalisations of the target novel words, are presented in Appendix H.)

Phase 1. Pre-testing

Free Play Session

The participants' verbal and non-verbal behaviours observed during their interactions with the novel objects confirmed that the objects were unfamiliar to the them: the participants did not consistently label any of the objects. Objects that the participants were observed to have a preference for were removed from the array, and objects that were equally appealing were selected for use in the B-A pre-testing session.

Baseline Pre-testing Session

In order to verify the prerequisites for auditory-visual matching-to-sample trials, and to progress to Phase 2 of the study, the participants were required to satisfy the baseline testing criterion: at least 80 percent correct responding within one baseline pre-testing session that included no more than eight baseline trials on which correct responses were rewarded.

The participants' performances in baseline pre-testing sessions are presented in Table 6.3. All the participants satisfied the baseline testing criterion. TW, SB, and TS were given repeated baseline pre-testing sessions, even in cases where they produced criterion level responding in a previous session; this was because their responses in the initial sessions were often ambiguous, necessitating the repetition of test trials, and their attention was frequently distracted. In the final baseline pre-testing session conducted with each participant, it was ensured that he or she performed at baseline criterion level, that their responses on all test trials were unambiguous, and that their attention was focused throughout.

Table 6.3

Participants' performances in baseline pre-testing sessions. (Bold text denotes sessions in which criterion level was achieved.)

	Baseline pre-testing sessions (percentage of correct responding)									
Participant	1	2	3	4	5	6	7	8	9	10
TW	**91.6**	66.6	**100**	**100**	**100**	-	-	-	-	-
DN	**83.3**	-	-	-	-	-	-	-	-	-
RP	**100**	-	-	-	-	-	-	-	-	-
CE	71.4	70	58.3	**91.6***	-	-	-	-	-	-
SR	**100**	-	-	-	-	-	-	-	-	-
SB	75	25	66.6	58.3	**100**	66.6	66.6	66.6	**83.3**	**83.3**
TS	**83.3**	58.3	**91.6**	58.3	**100**	**83.3**	66.6	77.7	**91.6**	**91.6**
SJ	**100***	-	-	-	-	-	-	-	-	-
KN	**100***	-	-	-	-	-	-	-	-	-
CL	66.6	**91.6***	-	-	-	-	-	-	-	-

* denotes sessions in which criterion level was achieved but rewards were not reduced

For TS, a new context was employed in which to present matching-to-sample trials. Although his responding in early sessions was at criterion level, he rarely produced clear responses on the first repetition of each baseline trial in which the auditory sample was presented in the carrier phrase "Where is X?" (where X was the auditory sample). Thus, in Session 9, the box utilised for the A-B non-ostensive exposure trials was placed by the side of the table, and on each trial he was requested to: "Put the X in the box." There was a marked improvement in his responding, and thus this procedure was employed for all subsequent matching-to-sample trials.

It is noted, in Table 6.3, that for CE, SJ, KN, and CL the rewards for correct responding were not reduced, and in the final session they received tokens for every correct response. Despite this, their performance in Phase 2 and 3 test sessions, where rewards were not given for every correct response in a session, was not affected; their attention in these sessions was sustained, and they continued to produce responses on all 12 unreinforced B-A trials and additional baseline trials.

B-A Pre-testing Session

Each of the participants received between one and five B-A pre-testing sessions. Nine of the participants (all those except TW) satisfied the B-A pre-testing criteria. Thus two objects were selected for which the participants did not demonstrate a preference. Further, each participant performed below criterion level on the B-A pre-testing trials, with the stimuli selected, and thus did not demonstrate any prior associations between these novel words and objects. The novel objects selected from the B-A pre-testing sessions, and the participants' responses on the B-A pre-testing trials with these stimuli, are shown in Table 6.4.

The remaining participant, TW, did not progress beyond Phase 1. He had five B-A pre-testing sessions, in which four combinations of novel objects were presented. In each session he demonstrated a preference for one object, which he selected on more than eight trials. As two equally appealing objects could not be selected for TW, he took no further part in the study.

Table 6.4

Stimuli selected for use in Phases 2 and 3, and participants' performances on B-A pre-testing trials with these stimuli.

	Set A stimuli		Set B stimuli		B-A pre-testing trials	
Participant	A1	A2	B1	B2	B1-A1	B2-A2
DN	spring	snail	Koob	Dax	3/6	4/6
RP	white koosh	coloured koosh	Tak	Bosch	3/6	4/6
CE	alarm	snail	Tak	Bosch	2/6	3/6
SR	alarm	spring	Tak	Bosch	3/6	4/6
SB	spring	alarm	Tak	Bosch	3/6	1/6
TS	lobster	castanets	Tak	Bosch	4/6	1/6
SJ	spring	snail	Tak	Bosch	1/6	4/6
KN	spring	alarm	Tak	Bosch	2/6	4/6
CL	spring	alarm	Tak	Bosch	3/6	4/6

Note. For participant DN, the novel words "Koob" and "Dax" were selected for use in Phase 2. This was because DN participated in pre-testing in a previous study in which the novel words "Tak" and "Bosch" were presented.

Participants' Performances in Phases 2 and 3

Participants' performances on test trials throughout Phases 2 and 3, and in some cases the training phase, are summarised individually (see Appendix H for session-by-session analyses).

The criterion level for passing tests of the target novel relations (B-A and B-C) was at least 80 percent correct responding on each relation tested (i.e., both B1-A1 *and* B2-A2 or both B1-C1 *and* B2-C2) within one experimental session (i.e., one block of 12 test trials).

Participant DN

DN did not pass the B-A tests following 14 non-ostensive and 14 ostensive exposure trials; he exhibited a stimulus preference in Phase 2.1 which, although declined in intensity, remained evident in Phase 2.2. He did not produce the target auditory stimuli throughout these phases. DN took no further part in the study.

Participant RP

RP failed to achieve criterion level on B-A tests following 14 non-ostensive exposure trials and 10 ostensive exposure trials; on B-A tests he exhibited a stimulus preference which increased in intensity from Phase 2.1 to Phase 2.2. His responses on A-B naming tests conducted at the end of each phase were below criterion level, and his informal vocalisations further confirmed that he had not acquired the target relations.

Participant CE

CE did not pass the B-A tests following 14 non-ostensive and 14 ostensive exposure trials; he exhibited a stimulus preference on B-A test trials which increased in intensity from Phase 2.1 to Phase 2.2. Despite failing to achieve criterion level on B-A trials, it was noted that CE may have acquired the A2-B2 relation, and, in addition, may have related the A1 stimulus with the label "Telephone". On free recall naming test trials in Phases 2.1 and 2.2, CE correctly produced the novel word "Bosch" on 5/6 A2-B2 trials; in contrast, on A1-B1 trials he produced the word "Telephone" (2/6 trials) or did not make a response (3/6 trials); note that he did not use the (B2) target word "Bosch" to label the A1 stimulus at any point. This pattern of responses was also evident in his informal vocalisations.

As a result, CE proceeded to Phase 3. He did not demonstrate derivation of the B-C equivalence relations following 14 C-A non-ostensive exposure trials; again he exhibited a stimulus preference. He also failed a subsequent C-A test conducted at the end of Phase 3 and his labelling of the novel shapes (C-B matching) did not approach criterion level.

Participant SR

SR demonstrated immediate derivation of the B-A symmetrical relations (aged 25 months and 18 days) following only one A-B non-ostensive exposure trial of each novel relation. In the following Phase 3 experimental session, SR did not pass the B-C equivalence test.

As a result, he was given a further B-A symmetry test on which he again achieved criterion level, despite not receiving additional A-B exposures. Consequently, Phase 3 sessions were resumed. SR now passed the B-C equivalence tests, aged 26 months, following a total of four C-A non-ostensive exposure trials; he achieved criterion level in two consecutive B-C test sessions. He also responded at criterion level on a succeeding A-B naming test. Although SR did not pass C-A and A-C tests conducted at the end of Phase 3, his responses in both of these sessions were 80 percent correct over the first eight trials; his overall failure was the likely result of a switch to a pattern of preferential responding.

Participant SB

SB did not pass the B-A symmetry tests following 14 A-B non-ostensive exposure trials. However, in Phase 2.2, he passed the B-A tests, aged 30 months and 1 day, following a total of 36 ostensive exposure trials. SB's prompted labelling of the novel objects was at criterion level and further confirmed that he had acquired the novel relations.

SB went on to demonstrate immediate derivation of the B-C equivalence relations (i.e., following one C-A non-ostensive exposure trial of each novel relation) aged 30 months and 4 days. Criterion level responding was not maintained in a subsequent B-C test session, in which he demonstrated a stimulus preference.

Participant TS

TS did not pass B-A tests following 32 non-ostensive and 50 ostensive exposure trials. His failure to achieve criterion level on A-B naming tests, and his informal vocalisations in Phases 2.1 and 2.2, further confirmed that he had not acquired the target relations.

In Phase 2.3, however, TS responded with 100 percent accuracy on both exclusion exposure trials and control trials, and passed the subsequent B-A tests; he was aged 32 months and 2 days when he passed this test. TS also passed an A-B naming test conducted at the end of this phase.

Participant SJ

SJ did not pass B-A tests following 16 non-ostensive and 14 ostensive exposure trials; he exhibited both stimulus and location preferences on B-A test trials. In addition, in both Phases 2.1 and 2.2, SJ failed A-B naming tests further confirming that he had not acquired the target relations.

In Phase 2.3.1, SJ responded with 100 percent accuracy on B-A exclusion trials; however, he did not pass the subsequent B-A or A-B tests. Similarly, in Phase 2.3.2, SJ responded with 100 percent accuracy on both exclusion trials and baseline trials, but again he failed the subsequent B-A tests. Although his response accuracy on an A-B naming test improved he did not achieve criterion level.

In contrast, in Phase 2.3.3, SJ responded with 100 percent accuracy on both exclusion trials and control trials, and passed the subsequent B-A and A-B tests; he was aged 30 months and 6 days when he passed the B-A test. In addition, SJ also began to produce the novel words informally with a greater frequency and accuracy in this sub-phase.

SJ went on to demonstrate immediate derivation of the B-C equivalence relations aged 30 months and 23 days. In addition, he passed a C-B equivalence test and continued to accurately label the novel objects both spontaneously and in response to prompts.

Participant KN

KN did not pass the B-A tests following 20 non-ostensive and 14 ostensive exposure trials; in Phase 2.2, KN exhibited a strong stimulus preference on B-A test trials. In both sub-phases she failed to achieve criterion level on A-B naming tests, and only rarely echoed the novel words, thus further confirming that she had not acquired the target relations.

KN also failed to achieve criterion level on B-A tests in Phase 2.3 despite responding above criterion level on exclusion trials alone in Phase 2.3.1, exclusion trials and baseline trials in Phase 2.3.2, and exclusion trials and related control trials in Phase 2.3.3. Throughout these sub-phases, KN exhibited stimulus preferences on B-A trials, failed to achieve criterion level on A-B naming tests, and rarely produced the novel words.

In Phase 2.1b, the inclusion of familiar relation non-ostensive exposure trials interspersed with A-B non-ostensive exposure trials did not serve to improve KN's responding on B-A and A-B tests -- she again failed to achieve criterion level. Although she began to produce the novel words informally with a greater frequency during this sub-phase, she did not do so with a greater accuracy.

In the subsequent training phase KN achieved criterion level on B-A trials in Session 18, and continued to respond at criterion level when feedback and rewards were phased out. Her informal vocalisations further confirmed that she had acquired the novel relations: these vocalisations were at criterion level only in sessions in which she also achieved criterion level on B-A trials.

KN went on to demonstrate immediate derivation of the B-C equivalence relations aged 34 months and 14 days; this performance was maintained over two subsequent B-C test sessions. KN also passed a C-B test of transitivity conducted at the end of Phase 3.

Participant CL

CL did not pass the B-A tests following 16 non-ostensive exposure trials in Phase 2.1a, 16 non-ostensive exposure trials interspersed with familiar relation exposure trials in Phase 2.1b, and 14 ostensive exposure trials in Phase 2.2. In each phase he demonstrated stimulus and/or location preferences on B-A test trials, and also failed to achieve criterion level on A-B naming tests. His informal vocalisations were sparse and predominantly comprised echoing of the novel words. In cases in which he used the novel words to label the target objects, these further confirmed that he had not acquired the target relations.

In phase 2.3.3, CL responded above criterion level on both exclusion trials and related control trials, but continued to fail B-A tests. Again, patterns of preferential responding were evident on B-A trials, and he failed to achieve criterion level on an A-B naming test.

In the training phase, CL achieved criterion level on B-A trials in the third training session; this performance was maintained over two further sessions. Note that rewards for correct responding were not removed before Phase 3 was conducted.

CL did not demonstrate derivation of the B-C equivalence relations in Phase 3 following 12 C-A non-ostensive exposure trials; he exhibited both stimulus and location preferences in B-C test sessions. However, his informal vocalisations suggested that he had acquired the C-B transitive relations: when prompted to label the novel shapes he did so with 85.7 percent accuracy.

Summary of Results

Phase 2. A-B Exposures and B-A Testing

Nine participants received A-B exposure trials and B-A tests (see Table 6.5).

Table 6.5

Participants' performance on B-A tests in Phase 2

Participant	Sub-phases of Phase 2					
	2.1a	2.1b	2.2	2.3.1	2.3.2	2.3.3
DN	fail	-	fail	-	-	-
RP	fail	-	fail	-	-	-
CE	fail	-	fail	-	-	-
SR	pass	-	-	-	-	-
SB	-	fail	pass	-	-	-
TS	-	fail	fail	-	-	pass
SJ	fail	-	fail	fail	fail	pass
KN	fail	fail	fail	fail	fail	fail
CL	fail	fail	fail	-	-	fail

Note: Phase 2.1a -- A-B non-ostensive exposure trials. Phase 2.1b -- A-B non-ostensive exposure trials interspersed with familiar exposure trials. Phase 2.2 -- ostensive exposure trials. Phase 2.3.1 -- B-A exclusion exposure trials. Phase 2.3.2 -- B-A exclusion exposure trials interspersed with baseline trials. Phase 2.3.3 -- B-A exclusion exposure trials interspersed with control trials.

Four of the nine participants -- SR, SB, TS, and SJ -- passed B-A tests following exposure trials in Phase 2. Of these four participants, only one -- SR -- passed the B-A symmetry tests following non-ostensive exposure trials in Phase 2.1. Similarly, only one participant -- SB -- passed the B-A tests following ostensive exposure trials in Phase 2.2. Thus two participants demonstrated acquisition of the novel relations following non-ostensive or ostensive exposure trials.

In Phase 2.3, four participants received B-A exclusion exposure trials. Each of these participants responded above criterion level on exclusion exposure trials, additional baseline trials conducted in Phase 2.3.2, and additional control trials conducted in Phase 2.3.3. Of these participants, two -- TS and SJ -- passed subsequent B-A tests, thus demonstrating acquisition of the novel relations. Note that both of these participants passed B-A tests following exposure trials in Phase 2.3.3, in which exclusion exposure trials were interspersed with control trials.

All but one of the participants did not demonstrate any contradictory evidence of having acquired the novel relations either in naming tests or in their informal vocalisations: participants who failed the B-A tests also failed naming tests and used the novel words inaccurately throughout the experimental sessions. Conversely, participants who passed the B-A tests also achieved criterion level in naming tests in the same sub-phase, and also demonstrated emergent labelling of the novel objects in their informal vocalisations. (Note that CE failed both B-A tests and the related A-B naming tests; however, he did demonstrate acquisition of one of the novel relations in his informal vocalisations and response patterns on naming tests.)

Training Phase

Two participants -- KN and CL -- who did not pass B-A tests at the end of Phase 2, were given B-A training sessions; both of these participants achieved criterion level on B-A trials. KN continued to respond at criterion level on B-A trials when rewards for correct responding were phased out. (These rewards were not phased out for CL.)

Phase 3. C-A Exposures and B-C Testing

Six participants proceeded to Phase 3 of the study (see Table 6.6).

Of these participants, five had passed B-A tests in either Phase 2 or the training phase. The remaining participant -- CE -- failed to achieve criterion level on B-A tests; however, it was apparent from his performance on A-B naming tests, and his informal vocalisations, that he had acquired at least one of the novel relations. Thus he proceeded to Phase 3 of the study, in which he failed to achieve criterion level on B-C tests.

Table 6.6

Participants' performance on B-C equivalence tests in Phase 3

Participant	B-C test performance	No. of exposures (in total / to criterion)
CE	fail	14
SR	pass	4
SB	pass	2
SJ	pass	2
KN	pass	2
CL	fail	12

As is shown in Table 6.6, four of the six participants -- SR, SB, SJ, and KN -- passed the B-C equivalence tests following C-A non-ostensive exposure trials. Note the relative ease with which these participants demonstrated derivation of the equivalence relations: three participants achieved criterion level in Session 1, and the remaining participant achieved criterion level in Session 2. The remaining participant -- CL -- although failing to achieve criterion level on B-C tests did demonstrate evidence of derivation of the C-B transitive relations in his informal vocalisations.

DISCUSSION

The participants' performances on B-A and B-C test trials are briefly discussed with respect to the acquisition of the target relations and the derivation of equivalence relations between the novel stimuli. In addition, characteristic patterns of responding are identified as possible sources of participants' failure to achieve criterion level on test trials.

In Phase 1, all the participants achieved criterion level in baseline pre-testing sessions, thus verifying the prerequisites for responding on auditory-visual matching-to-sample trials. Further, all but one of the participants satisfied the B-A pre-testing criterion: they did not demonstrate either stimulus preferences or patterns of unreinforced conditional selection (URCS) with the stimuli selected for use in Phases 2 and 3 of the study. The remaining participant consistently exhibited patterns of preferential responding and thus took no further part in the study.

In Phase 2, five participants failed to achieve criterion level on B-A tests. DN and RP failed B-A tests following non-ostensive and ostensive exposure trials; both of these participants exhibited stimulus preferences and, in cases in which they produced vocalisations of the novel words, these confirmed that they had not acquired the novel word-referent relations. These participants took no further part in the study.

CE also failed to pass B-A tests following non-ostensive and ostensive exposure trials. However, in contrast to DN and RP, his informal vocalisations and responses on naming tests strongly suggested that he had acquired one of the novel relations and had idiosyncratically linked the remaining novel object with another word. As a result, he proceeded to Phase 3; in this, he failed B-C equivalence tests, exhibiting, instead, a stimulus preference.

Participants CL and KN failed B-A tests following each exposure trial type; both participants exhibited stimulus or location preferences and failed to achieve criterion level on A-B naming tests. They then proceeded to the training phase. CL achieved criterion level on B-A training trials by the third experimental session. In the following Phase 3 sessions, however, he did not pass the B-C equivalence tests; instead he exhibited patterns of preferential responding. He did, however, demonstrate some evidence of emergent C-B transitive relations in his informal vocalisations. In contrast, KN did not achieve criterion level on B-A training trials until Session 18 of the training phase. In sessions in which she achieved criterion level, her emergent labelling of the visual stimuli was accurate and satisfied criterion level, thus providing confirmatory evidence of acquisition of the target relations. Also in contrast to CL, KN passed the B-C and C-B tests in Phase 3, thus demonstrating immediate derivation of the equivalence and transitive relations respectively.

In contrast to the above, four participants passed the B-A tests in Phase 2. SB passed B-A tests following ostensive exposure trials and also went on to demonstrate immediate derivation of the B-C equivalence relations in Phase 3. Two participants passed the B-A tests following exclusion exposure trials interspersed with control trials: TS took no further part in the study; SJ went on to demonstrate immediate derivation of the B-C and C-B equivalence relations in Phase 3. Finally, SR demonstrated immediate derivation of the symmetrical B-A relations in Phase 2 following only one non-ostensive exposure trial of each novel relation; further, he went on to pass the B-C equivalence tests in Phase 3 following only two non-ostensive exposure trials of each novel relation.

Because of the methodological limitations of Study 2, a number of controls were implemented in the present study; these enable two conclusions to be drawn.

First, the A-B exposure trials in the present study were controlled in order that the relations were exposed uni-directionally. As a result, criterion level responding on B-A tests following non-ostensive exposure trials provides evidence of symmetry; thus, in the present study, one participant (SR) demonstrated derivation of the symmetrical B-A relations following non-ostensive A-B exposure trials.

Second, the stimulus presentations on C-A exposure trials were also controlled in order that they were exposed uni-directionally. As a result, B-C tests provide a stringent assessment of stimulus equivalence. Following criterion level performance on

B-A trials, whether derived via symmetry from the A-B non-ostensive exposures or established directly through B-A training, the participants were given C-A non-ostensive exposure trials. If the acquired C-A relations were indeed equivalence relations, then the A-C relations would emerge via symmetry. Combining the B-A and symmetrical A-C relations transitively gives rise to the emergence of the B-C equivalence relations. Hence, the B-C test combines a test for both symmetry and transitivity, and is thus a test for equivalence. In the present study, three participants -- KN, SR, and SB -- demonstrated derivation of equivalence relations between the target stimuli; one of these also passed C-B tests of transitivity. In addition, SJ passed B-C and C-B equivalence tests; these were both tests of equivalence because SJ achieved criterion level on B-A trials following exclusion exposure trials.

As possible sources of false positive responding were controlled for or eliminated, the present study has demonstrated that young normally developing children are able to acquire novel word-referent relations following unreinforced exposures in a tightly controlled context; acquisition of the relations was demonstrated following non-ostensive, ostensive, and exclusion exposure trial types. Further, in the majority of these cases, the relations acquired were demonstrated to be symbolic -- equivalence -- relations. The youngest participant in the present study to pass the equivalence tests was aged 26 months. Although previous studies claim to have demonstrated the derivation of equivalence relations in younger participants aged 23 to 25 months (Devany, Hayes, & Nelson, 1986; Lipkens, Hayes, & Hayes, 1993), these studies have been variously criticised for their lack of methodological control (see Chapters 2 and 3; also see McIlvane & Dube, 1996; Saunders & Green, 1996). This is the youngest participant thus far to have passed equivalence tests in such stringently controlled conditions.

It might be questioned whether participants' criterion level performances on B-A trials following exposure trials alone demonstrate the acquisition of symbolic word-referent relations; that is, whether these B-A relations possess any properties of equivalence. It is noted that success on B-C tests demonstrates the derivation of equivalence relations between the novel objects, words, and shapes. Further, it demonstrates, unequivocally, that the C-A relations acquired are symbolic; this is because criterion level responding on B-C trials requires reversal of the non-ostensively exposed C-A relations. As stated earlier, in order to pass B-C tests participants are required to combine, transitively, the B-A relations with the symmetrical A-C relations.

However, the same may not be said of the B-A relations: whilst correct responding on B-C tests demonstrates that these relations are transitive (by their combination with A-C relations), it does not demonstrate that they are symmetrical: transitivity does not require reversal of the B-A relations. Is there any evidence that participants' criterion level performances on B-A trials involve symmetry?

Only one of four participants -- SR -- passed B-A tests following A-B non-ostensive exposure trials; in this case, evidence of the derivation of symmetrical relations is demonstrated because of the uni-directional exposure of the corresponding stimuli on A-B trials. The remaining three participants, however, passed B-A tests following either ostensive (i.e., SB) or exclusion exposure trials (i.e., SJ and TS). In these cases, the B-A tests were not strictly tests of symmetry. Thus there is nothing in their criterion responding on B-A trials alone, and in their accurate responses on B-C test trials, to suggest that the B-A, word-referent, relations acquired were symmetrical. One must look for further confirmatory evidence.

With reference to criterion level B-A responding following exclusion exposure trials, such evidence is provided by SJ's and TS's emergent labelling of the novel objects. This is exemplified as follows (see Figure 6.18). SJ and TS achieved criterion level responding on both exclusion exposure trials and control trials in Phase 2.3.3, thereby verifying control by the novel auditory samples on exclusion trials. Correct responding on matching-to-sample exclusion trials requires the participants' selections of the novel objects conditionally upon hearing the corresponding novel words; thus these trials establish B-A relations (see Figure 6.18). In addition, it is also noted that children of this age are capable of echoing the novel words. Indeed SJ and TS did so frequently from the outset of Phase 2; this was evidenced in their informal vocalisations on A-B exposure trials and B-A test trials. For the purposes of the present example, these relations are termed B-X relations, in which B is hearing the novel word and X is saying the novel word (see Figure 6.18). Thus participants have B-A and B-X relations.

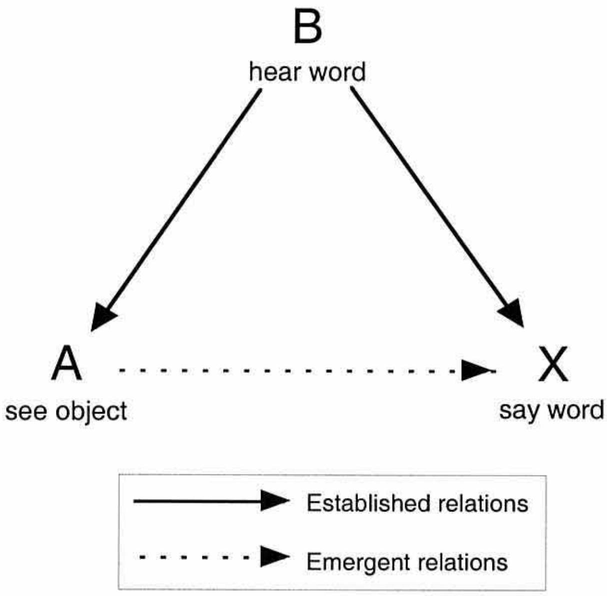

Figure 6.18. Schematic representation of the role of emergent labelling in demonstrating the acquisition of symmetrical B-A relations following B-A exclusion exposure trials. Arrows point from sample to comparison stimuli.

It is also noted that both these participants demonstrated emergent labelling of the novel objects to criterion level; this was evidenced in A-B naming tests and in their informal vocalisations. In the present example, labelling of the novel objects is represented as A-X relations, in which A is seeing the object and X is saying the corresponding word (see Figure 6.18). In order for such object-related naming to emerge, the participants must combine A-B and B-X relations transitively; this performance thus requires reversal of the B-A relations established on exclusion exposure trials. As a result, the participants' emergent labelling of the novel objects demonstrates evidence of the symmetrical nature of B-A relations acquired following exclusion exposure trials.

The same, however, cannot be said for criterion level performance following A-B ostensive exposure trials. Although criterion level emergent labelling was evidenced in SB's informal vocalisations, the same argument may not be levelled at this performance by virtue of the bi-directional nature of the A-B exposures; this is because the A-B relations in this instance have been exposed.

In summary thus far, four participants acquired the word-referent relations as a result of unreinforced exposure trials. For three participants these were shown to be symbolic relations: the derivation of symmetrical A-B relations was demonstrated in the performances of participants passing B-A tests following non-ostensive and exclusion exposure trials. Further, four participants passed tests of equivalence thereby demonstrating derivation of the symmetrical A-C relations and transitivity of B-A and A-C relations; as stated above, for two of these participants the B-A relations were demonstrated to be symmetrical.

Further questions may be levelled at the participants' performances on test trials in the present study. Although the exposure trials were controlled with respect to direction of stimulus presentations, it might be argued that participants' criterion level responding on test trials was a result of a pattern of false positive responding. However, this is unlikely. The participants' criterion level responding on B-A trials in the present study cannot be attributed to patterns of unreinforced conditional selection (URCS); their responses in B-A pre-testing sessions confirmed that they did not have any associations between the novel words and referents prior to the exposures. Although URCSs on B-C test trials were not directly assessed, it is unlikely that such a pattern of responding affected their performances: participants who failed to pass the B-C tests did not demonstrate conditional responding; in addition, SR initially failed the B-C tests before going on to pass them in Session 2 -- URCS would have produced criterion level responding, or responding approaching 0 percent correct, from the outset (this was also evidenced in LS's performance in Study 2). Note also that throughout B-A pre-testing sessions, none of the participants exhibited patterns of URCS with any combination of novel stimuli presented.

It might be argued that participants' criterion responding on B-A and B-C test trials, in some cases, may have been established through experimenter cueing -- a cueing control was implemented for only four participants. Indeed, three participants for whom such a control was not implemented passed B-A tests, and similarly, three passed B-C tests. However, three of the four participants for whom such a control was implemented failed B-A tests, and one of two failed B-C tests. Conversely, the participant who demonstrated the most rapid learning did so under conditions in which experimenter cueing was eliminated. If experimenter cues were provided it is difficult to explain why they only affected the performance of some participants. Two further strands of evidence lend strength to this argument: some participants only passed B-A tests in later Phase 2 sessions -- it is questionable why experimenter cues did not establish criterion level responding from the outset of testing -- and it was very difficult to train KN the B-A relations throughout the training phase.

The identification of trends in the present data, and the observation of characteristic patterns of responding, have implications for modifications of the present procedure.

First, as in Studies 1 and 2, there was little or no additional benefit of ostensive or exclusion exposure trials over non-ostensive exposures. Only one participant passed B-A tests following non-ostensive exposure trials. Of the remaining eight participants, one passed B-A tests following ostensive exposure trials, and two passed following exclusion exposure trials; the remaining five participants failed to pass B-A tests following any exposure trial type. The fact that three participants passed B-A tests following either ostensive or exclusion exposures may not be a result of the facilitative effects of these exposure contexts. In each of these cases, the participants had received numerous exposure trials before passing the B-A tests: SB received 50 trials in total (25 of each relation), SJ received 60 (30 of each relation), and TS received 90 (45 of each relation). Thus it is possible that, where participants failed to acquire the target relations following non-ostensive exposure trials, the increased number of exposure trials presented overall may account for their acquisition of the target relation, rather than the trial type per se.

Second, there was no added benefit of the interspersion of familiar relation exposure trials among A-B non-ostensive exposure trials. Where participants failed to acquire the target relation following non-ostensive A-B exposure trials alone, each of these also failed to learn from these trials in cases in which familiar exposure trials were interspersed among them.

Third, participants in the present study were given exclusion exposure trials in three contexts: exclusion trials alone, exclusion trials interspersed with baseline trials, and exclusion trials interspersed with control trials. None of the participants acquired the target relations following the first two exposure contexts, despite responding at criterion level on each trial type. However, two participants (SJ and TS) passed B-A tests following exclusion trials interspersed with control trials. This suggests that, despite criterion level responding on exclusion trials in Phases 2.3.1 and 2.3.2, participants may not have attended to the auditory samples presented: they may have selected the target objects on the basis of novelty alone. Only when control trials are interspersed among exclusion trials are participants required to attend to the novel auditory sample on test trials in order to produce accurate responses across both trial types (see Chapter 2, Section 2.1.1); thus acquisition of the novel relations is likely to occur only following exclusion exposure and control trials.

Fourth, the difficulty of training young children to respond accurately on auditory-visual matching-to-sample trials highlighted by Lipkens et al. (1993) was also evidenced in the present study. Although CL achieved criterion level in only three training sessions, it was difficult to teach KN the B-A relations. She required a total of 215 training trials before achieving criterion level. This was despite maintaining criterion level on baseline trials. In subsequent studies, differing training procedures might be implemented in order to bring participants' responses under control of the auditory samples.

In relation to this issue, it is noted that despite the difficulty of training KN on the B-A relations, she went on to immediately pass subsequent B-C tests. Also, in relation to this issue, it is noted that participants who passed B-A tests, albeit irrespective of exposure trial type, went on to immediately pass B-C tests in Phase 3; this pattern of responding was also evidenced in LS's performance in Study 2. It thus appears that a history of conditional responding with novel stimuli in the experimental context facilitates participants' performances on subsequent matching-to-sample trials with new stimulus sets.

In contrast, CL did not pass the B-C tests following criterion responding on B-A training trials. It may be argued that the exemplar training did not facilitate his performance on test trials in Phase 3. However, another explanation may be posited. At the end of the training phase, the rewards for correct responding were not phased out before progressing to Phase 3 of the study. Thus, when confronted with blocks of B-C test trials, the absence of rewards may have affected CL's performance. This is especially likely as token rewarded baseline trials were not interspersed among B-C test trials in Phase 3 (unlike Phase 2 and the training phase); rather, a small number were presented at the beginning and end of B-C test trial blocks. The sudden change in context may have confused CL as to the contingencies for rewards and hindered his performance on test trials. This highlights the necessity of phasing out rewards for appropriate responding in training sessions before subsequent exposure and testing sessions are presented.

Fifth, the inclusion of the B-A pre-testing session had little predictive value. Although it confirmed that the participants did not have any prior associations between the novel words and objects, it was argued earlier that it is unlikely, given the participants' responses on test trials in this and previous studies, that URCSs effected their performances. With respect to the identification of preferential responding prior to testing, B-A pre-testing again had little value. Stimulus preferences identified in this session were eradicated by substitution of the preferred stimulus and re-testing to ensure that the novel objects were selected with equal frequency on test trials. Despite this, stimulus and location preferences continued to develop in B-A test sessions: all but one of the participants exhibited preferential patterns of responding on these trials.

Sixth, the multi-sensory novel objects employed were more appealing to, and sustained the attention of, the participants in the present study: they attended for longer durations both within and across experimental sessions than participants in Study 2. The inclusion of token rewarded baseline trials, however, did not appear to have a facilitative effect on participants' responses on test trials. Although the token reward system sustained interest in experimental sessions in general, it did little to encourage correct responding on target test trials. Whilst participants responded above criterion level on rewarded baseline trials, they often appeared to tire of the target test trials and refused to respond on these requesting instead to play with the connect 4 apparatus. Further, token rewarded baseline trials were not employed in Phase 3 because of the discrepancy between the required responses on these and B-C trials; despite this, the majority of participants in this phase passed the B-C tests and were fully attentive throughout the B-C test trials. Thus it appeared that something intrinsic in the test situation or test trials themselves sustained the participants' interest. As the token reward system served little value in the present study, in subsequent studies a further measure is required to both sustain participants' attention to, and to facilitate correct responding on, test trials.

In summary, four participants in the present study demonstrated acquisition of multiple novel relations following non-ostensive, ostensive, or exclusion exposure trials conducted in a stringently controlled context. In cases in which participants failed these tests and were subsequently trained the B-A relations this served to facilitate responding on B-C tests for one of two participants. In addition, four participants passed B-C equivalence tests thus demonstrating that the word-referent relations acquired were indeed symbolic relations. Trends in the data again showed ostensive and exclusion exposure trials to have little added benefit over non-ostensive exposures alone. Patterns of preferential responding were again prevalent despite the inclusion of the B-A pre-testing session, and participants' responses in the training phase highlighted the need for the phasing out of rewards for correct responding on test trials before proceeding to Phase 3 of the study. These provide important considerations for subsequent studies.

CHAPTER 7

STUDY 4

STIMULUS EQUIVALENCE AND NON-OSTENSIVE EXPOSURE LEARNING OF MULTIPLE NOVEL RELATIONS: A NEW CONTEXT

Study 4 was a replication of the general procedure employed in Study 3, and thus utilised procedures from both the cognitive/developmental exposure learning paradigms and the behaviour analytic stimulus equivalence paradigm outlined in Chapters 1 to 3. A number of modifications additional to those introduced in Study 3 were implemented in Study 4 in attempt to facilitate participants' performances on test trials.

The general procedure comprised three major phases. Each of these is briefly outlined below with reference to the procedural modifications and controls.

As in previous studies, Phase 1 was conducted in order to verify the prerequisites for responding on auditory-visual matching-to-sample trials. This also included a free play session to identify stimulus preferences prior to Phase 2. The B-A pre-testing session conducted in Study 3 was not employed in the present study; this was because it had little predictive value: stimulus preferences developed throughout subsequent Phase 2 experimental sessions, and patterns of unreinforced conditional selection were not evident in any participant's responses in the B-A pre-tests of Study 3.

In Phase 2, participants were given A-B non-ostensive exposures, and their acquisition of the novel relations was assessed by B-A symmetry tests. Only non-ostensive exposure trials were conducted in the present study; this was because there had thus far been no satisfactory evidence that ostensive and exclusion exposures were any more effective than non-ostensive exposure trials in producing learning outcomes. As in Study 3, the A-B exposure trials were controlled in order that the corresponding auditory and visual stimuli were presented uni-directionally.

Participants who failed to achieve criterion level on B-A tests in Phase 2 proceeded to a training phase in which they were given exemplar training with the novel target stimuli. In this, they were taught the B-A relations via rewards and feedback for correct responses. In previous studies it seemed that an experimental history of correct conditional responding on matching-to-sample test trials in Phase 2, or the training phase, facilitated performance on subsequent tests: in cases in which participants achieved criterion level on B-A training or test trials, they typically went on to demonstrate immediate or rapid derivation of the B-C equivalence relations. The difficulty of training auditory-visual relations was identified by Lipkens et al. (1993) and was further highlighted by KN's performance on B-A training trials in Study 3. Thus a number of training procedures were implemented in the present study in order to bring participants' responses under control of the novel auditory stimuli. Importantly, it was ensured that rewards and feedback were phased out before Phase 3 commenced (see Study 3 discussion for the necessity of this measure).

In Phase 3, participants were given C-A non-ostensive exposure trials and derivation of equivalence relations between the novel stimuli was assessed by B-C equivalence tests; in all cases in this study, C-B tests constituted tests of transitivity by virtue of the non-ostensive exposure of the A-B relations, or training of the B-A relations. Again, as in Study 3, the C-A exposure trials were tightly controlled in order that the corresponding stimuli were exposed uni-directionally; the necessity of this was highlighted in Study 2 (see Chapter 5 discussion).

Finally, the general procedure was repeated with new stimulus sets. Would conditional responding in the experimental context with Stimulus Sets 1 and 2 facilitate participants' performances in a second repetition of the procedure with Sets 3 and 4?

Other important elements of the general procedure in the present study were as follows.

First, experimenter cueing was eliminated for some participants by employing the blind testing procedure as described in previous studies.

Second, a new context within which to conduct the exposure and test trials was employed. Participants were administered the procedure within a new context: a magic show. In this, the exposure and test trials were conducted within the scenario of a magic show in which the participants assisted a puppet -- Sooty -- in making the novel objects disappear. On test trials the participants' attention was focused on the activity surrounding the test trials rather than on the comparison selections per se. Such procedures have been utilised by cognitive/developmental researchers who have employed methods in which participants are encouraged to perform an activity with the object selected, and thus the focus is removed from the act of selection itself (e.g., Dollaghan, 1985; Woodward, Markman, & Fitzsimmons, 1994).

The use of this new experimental context necessitated the modification of the carrier phrase in which the target auditory stimulus was presented on exposure trials. In the present study the target word was presented in the carrier phrase: "Look, the X has gone, where's the X gone?" Thus each presentation of the novel object was paired with two tokens of the target word.

It was also noted that the change in carrier phrase may, in itself, be effective in facilitating learning from non-ostensive exposure trials. In Studies 1 to 3, the target novel word was presented in the carrier phrase "That was a X" (where X was the novel word). There is nothing in such a phrase that alerts the participants to the fact that the new word is a noun and refers directly to the novel object; it may equally be interpreted as an adjective describing the action of placing the novel objects in the box. In Study 3, it was attempted to control for this by the inclusion of familiar relation exposure trials -- these were interspersed among non-ostensive A-B exposure trials. It was hoped that these would set the context for learning and encourage the participants to treat the novel word as a label for the novel object; such procedures have been previously adopted by cognitive/developmental researchers (Schafer & Plunkett, 1998; Whitehurst, Kedesdy, & White, 1982). However, these did nothing to facilitate learning: participants for whom familiar exposure trials were interspersed among A-B exposures did not pass B-A tests, and for the only participant to pass B-A tests following A-B non-ostensive exposure trials, target relation exposure trials were not interspersed with familiar relation exposures. Thus, in order to determine whether the modified carrier phrase alone was facilitative of learning, a number of participants were administered the present procedure in the basic table-top context that was employed in Studies 1 to 3.

In summary, Study 4 investigated the acquisition of symbolic relations between multiple novel words and their referents following unreinforced non-ostensive exposure trials conducted in a tightly controlled context.

METHOD

Participants

Ten pre-school children, aged between 22 and 26 months, were recruited from Clebran Private Day Nursery in Llandudno, North Wales (see Table 7.1). Written informed consent for their participation was gained from their parents/guardians prior to the commencement of the study (see Appendix A). Their parents/guardians also completed the MacArthur Communicative Development Inventory: Words and Gestures (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick, & Reilly, 1993) prior to the start of the study. This provided an assessment of the participants' expressive and receptive vocabularies (see Table 7.1).

Table 7.1

Participants' gender, age, and MCDI scores at the start of the study.

		Age at start	MCDI scores	
Participant	Gender	Months:days	receptive	expressive
BS	M	22:05	345	164
FR	F	23:13	335	267
SM	F	23:22	297	141
TJ	M	23:23	289	69
SS	F	23:24	-	-
LB	F	23:30	248	87
DE	M	24:27	191	70
KJ	F	25:00	326	301
ST	F	25:08	176	153
IB	M	25:10	358	333

Note. SS' parents did not return the MCDI checklist.

From the responses on the MCDI it was ensured that each of the participants were post-vocabulary spurt. The criterion for classifying participants as having undergone the vocabulary spurt was the acquisition of at least 50 words in production; this criterion is typically employed by a number of cognitive/developmental researchers (e.g., Mervis & Bertrand, 1994; Woodward, Markman, & Fitzsimmons, 1994).

Before beginning the study, the experimenters spent several informal sessions interacting with the participants within the nursery playroom and the research room; this was in order to familiarise the participants with the experimenters, and the experimental setting, prior to the commencement of the study.

At the end of the study, each participant's parents/guardians were debriefed as to the aims of the study, the procedures employed, and their child's performance throughout the study; this was by sent personal letters regarding only their own child's performance.

Apparatus and Materials

Experimental Setting

All the experimental sessions were conducted in a research room provided in Clebran Day Nursery. This was equipped with a childsize table and two childsize chairs. All other toys and furniture were removed from the room, as far as possible, in order to minimise distractions. In order to allow post-session analysis, all experimental sessions were videotaped. To this end the experimental room was equipped with a portable video camera (Panasonic M10); this was mounted upon a tripod and was positioned in the corner of the room so that an unobscured view of both the experimenter and participant was provided. Although two different procedural contexts were employed, the experimental setting was identical for both.

Apparatus and Materials

For each individual participant, the study was conducted in one of two procedural contexts -- either the *magic context* or the *table-top context.* The apparatus and materials required for use in each of these contexts is as follows.

Table-top context. The table-top context was identical to the exposure and testing procedure employed in Study 3 (see Chapter 6), and thus required the same apparatus. In order to conduct the non-ostensive A-B exposure trials, a black cardboard box (50 cm x 22 cm x 35 cm) was required in which to conceal the novel objects. A piece of black cloth was attached to the top of the box; a slit in this cloth allowed the object to be dropped inside and remain obscured from the participants' view. In addition, a flap was cut at the bottom of the box from which the experimenter could surreptitiously remove the object once it was dropped inside; this ensured that, in cases where the participants could not be prevented from looking, or reaching, inside the box, they did not see or touch the novel object following the presentation of the corresponding novel word.

Magic context. In this context, the A-B non-ostensive exposure trials and B-A test/training trials were conducted within the scenario of a magic show in which the participants assisted a teddy bear -- *"Sooty"* -- in performing magic with the novel objects. In order to conduct the magic show, and create the illusion that objects had disappeared, a magic-box was required; this was a wooden rectangular box (28 cm x 24.5 cm x 36.5 cm), with both interior and exterior painted black (See Appendix J). In addition, the exterior was decorated with silver holographic stars, designed to be appealing to the participants. At each end of the box was a door. At the front end of the box, the door (24.5 cm x 15.5 cm) was fitted with a handle and a magnetic clasp. The participants used this door to place the objects inside the box; the clasp ensured that the door remained closed once the object had been placed inside. At the rear of the box, the door comprised the whole side of the box and was not obvious to the participant;

from this door the experimenter (E) was able to inconspicuously remove the objects (see Figure 7.1).

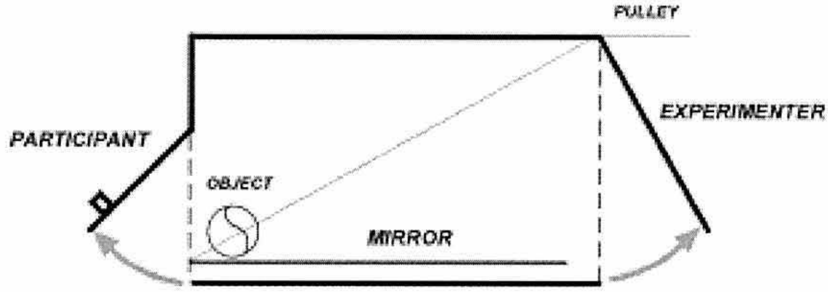

Figure 7.1a : Position of mirror as objects are placed in the box

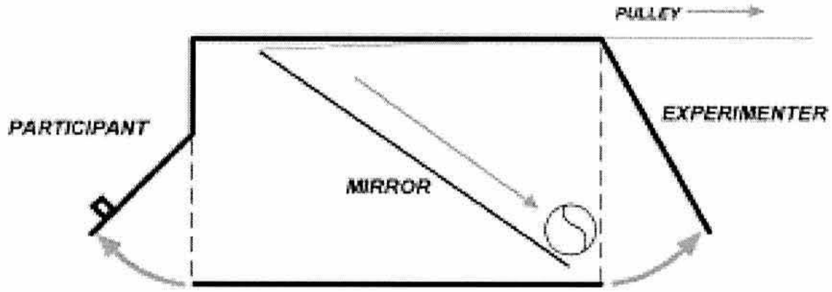

Figure 7.1b : Position of mirror creating the illusion that the object has disappeared

Figure 7.1. Mechanics of the magic box used to create the illusion that objects had disappeared on exposure and test trials.

In order to create the required illusion, a mirror (27 cm x 33 cm -- the same size as the interior of the box) was attached inside the box. The reflective side of the mirror faced the bottom of the box, and the back of the mirror, which was painted black, faced the top of the box; when the mirror was positioned on the floor of the box it appeared that the box was empty. The mirror was attached to a pulley system which was operated, by E, from outside the box. Before the participant placed an object in the box, the mirror was lowered so that it rested on the floor of the box, and thus the object was placed on top of it. When E extended the pulley, the mirror was raised, at a 45 degree angle, to touch the top of the box; the object, which was obscured behind it, slipped to the door at the rear of the box. When the participant then opened the box they simply saw a mirrored reflection of the black interior of the box, and thus it appeared that the box was empty (see Figure 7.1 for an illustration of the mechanics of the magic box). E was then able to inconspicuously remove the object from the box by the door at the rear.

In addition, a Sooty glove puppet and a magic wand were required; the magic wand was made of wooden doweling (0.5 cm diameter, 33.5 cm in length) and was painted black in the middle and white at both ends (see Appendix J).

Apparatus utilised in both contexts. A plastic bucket was required in which to hide the objects from the participants' view during experimental sessions. This was of particular importance in the magic context because the experimenter had to inconspicuously remove the objects from the magic box and subsequently hide them from the participants' view.

A token reward system was utilised in the training phase. This comprised an MB Games "Connect 4" game which consisted of a 36 piece blue plastic matrix, and a set of 36 plastic tokens coloured red or yellow (see Appendix B). The tokens were dropped into the columns at the top of the matrix and were released from a trap door at the bottom.

For some individual participants, a children's sticker-story book was required for use in the training phase. Each book consisted of an illustrated story and a set of approximately 60 accompanying stickers; the stickers comprised elements of the story and were visual punctuations to the narrative (e.g., Cunliffe, J. (1997). *Postman Pat Story Stickers.* World International Ltd).

A collection of toys, appropriate for the age range of the present participants, was also required (e.g., jigsaw puzzles, form boards, books, stickle bricks). These were used to occupy the participants' attention during inter-trial intervals, and at the beginning and end of each session.

A set of pre-prepared record sheets was required for each participant. For each experimental session a record sheet detailed the order of presentation of exposure trials, the order of presentation of auditory samples, and the counterbalanced order of presentation of visual comparisons on matching-to-sample trials. The participants' responses were recorded on the record sheets throughout the sessions.

At the end of each experimental session the participants were given small stickers or stars, the presentation of which were not contingent upon the participants' performance on test trials; these stickers were given as a reward for their general cooperation and attention throughout the session.

Familiar Stimuli

Familiar visual stimuli consisted of a set of toy farm animals (see Appendix J). These comprised a rabbit (6 cm x 5 cm), a pig (10 cm x 5 cm), a cow (12.5 cm x 6.5 cm), and a horse (12.5 cm x 9.5 cm). The familiar auditory stimuli consisted of their corresponding conventional names. It was ensured that these auditory-visual relations were familiar to the participants from their parents/guardians' responses on the MCDI checklists, and from their responses in the free play sessions conducted at the commencement of the study.

Novel Stimuli

Three sets of novel stimuli were required: Set A, Set B, and Set C.

Set A stimuli. Set A comprised novel objects (see Appendix J). These consisted of three-dimensional multi-sensory objects and toys that were unfamiliar to the participants, namely: a multi-coloured plastic "slinky spring" (7.5 cm x 6.5 cm); a triangular "Galt Pocket Alarm" (4 cm x 4.5 cm), which produced lights and sounds when its button was pressed; a pink and white plastic concertina snail (4.5 cm x 19.5 cm), which produced a squeak when depressed; a multi-coloured "Koosh Ball" (10 cm in diameter), made of blue, yellow, or red elastic strands; a pair of round yellow plastic castanets (6 cm in diameter); and a cylindrical giggle stick (17.5 cm x 2 5 cm), which simulated a laughing sound when moved up and down. These objects were selected in order that they were novel and attractive to the participants, were visually distinct from one another, and were manipulable for participants of this age range. Two of these objects were selected as Set A stimuli (A1 and A2) for use in Phases 1 to 3 of the study. Where the procedure was repeated with new sets of stimuli, two of the remaining objects were selected as A3 and A4.

Set B stimuli. Set B comprised novel words. These consisted of the nonsense words "Tak" [tõak], "Bosch" [boS], "Os" [oz], and "Kiekie" ['kõi:ki][1]. These nonsense words were selected in order that they were novel to the participants, were easily pronounceable, and were distinct from one another. For each participant, "Tak" and "Bosch" were selected as B1 and B2, and the novel words "Kiekie" and "Os" were selected as B3 and B4. Each of these was paired with one of the novel objects.

Set C stimuli. Set C comprised novel shapes. The novel shapes consisted of two-dimensional multi-sensory patterns which differed on three dimensions -- colour, shape, and texture (see Appendix J). These were a large sandpaper cross, with four smaller sandpaper triangles surrounding it (12 cm x 12 cm); a large green felt circle, with smaller circles of purple or red felt placed upon it (10.5 cm in diameter); a white fur square (11 cm x 11 cm); a large navy blue flannel circle (12 cm in diameter), with smaller green flannel circles placed upon it; a yellow and orange stripy zig-zag pattern (11 cm x 11 cm), made of pieces of crushed tissue paper; and a circle (12.2 cm in diameter) in which each quarter was coloured blue, yellow, green, or black, and was covered with bubble wrap.

In order to conduct the exposure trials, each of the shapes was attached to the front of a box (15 cm x 15 cm x 15 cm). Although all the boxes were identical in size,

[1] These nonsense words were selected from those used by Lipkens, Hayes, and Hayes (1993); the novel word pairings in the present study differ from Lipkens et al. (where "Tak" and "Os" were B1 and B2, and "Kiekie" and "Bosch" were B3 and B4). The novel word pairings for the present study were based on participants' performances in Studies 1 and 2.

and all were made of holographic cardboard, two of the boxes were coloured blue and the remaining four were coloured red. For each participant the shapes were paired together (i.e., C1 paired with C2, and C3 paired with C4) so that each was mounted upon boxes of the same colour. (Note also that two of the novel shapes -- the felt circle and flannel circle -- were never paired together due to their close physical similarity.)

Procedure

General Procedure

The procedure was divided into four major phases (corresponding to the phases in Study 3, see Chapter 6) in which the participants were exposed to, and tested for the derivation of, relations between novel objects, words, and shapes (see Figure 7.2).

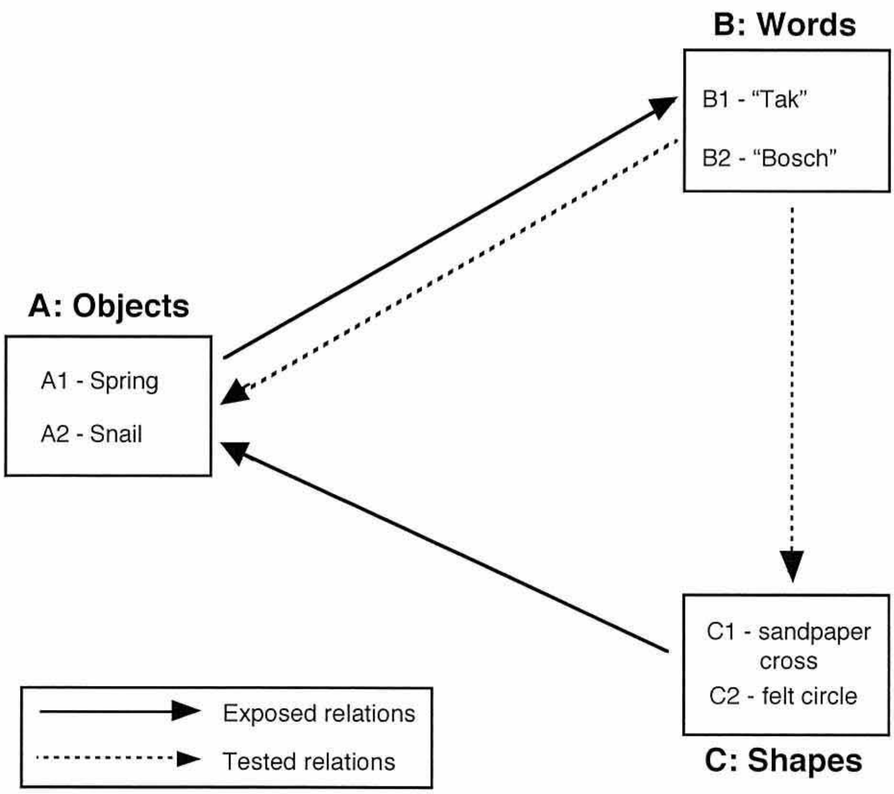

Figure 7.2. Schematic representation of the major relations exposed and tested in Study 4. Arrows point from sample to comparison stimuli.

Phase 1, pre-testing, was conducted in order to select Set A stimuli for each participant, and to ensure that they possessed the basic prerequisite skills required in order to respond on auditory-visual matching-to-sample trials. In Phase 2, the participants were given non-ostensive A-B (object-word) exposure trials and B-A (word-object) symmetry testing. If the participants failed to achieve criterion level on B-A tests, they proceeded to the training phase, in which they received non-ostensive A-B exposure trials and B-A training trials. Finally, once participants had achieved criterion level responding on either B-A test trials or B-A training trials, they proceeded to Phase 3; in this phase they were given non-ostensive C-A (shape-object) exposure trials and B-C (word-shape) equivalence tests. If the participants performed at criterion level on B-C test trials the procedure was then repeated with new sets of stimuli. Thus each individual participant's progression through the study was dependent upon his or her performance in the previous phase; this is illustrated in Figure 7.3, and is described in detail later[2].

For each individual participant, the study was conducted in one of two procedural contexts (see Table 7.2). The basic table-top context was identical in nature to the procedure employed in Studies 2 and 3 (see Chapters 5 and 6). In contrast, the magic context was designed to be more engaging for the participants, and was thus more elaborate. The procedural specifics of each context are outlined later.

For some of the participants a blind testing procedure was implemented in order to eliminate cueing of correct responses (the participants for whom this control was implemented is shown in Table 7.2); this was achieved by the participation of two experimenters: Experimenter 1 (E1) conducted only the exposure trials, and Experimenter 2 (E2) conducted only the test trials. As E2 was not present throughout the exposure trials, she was unaware of the pairings between the novel stimuli, and was thus unaware of the accuracy of the participants' responses on test trials; consequently, no feedback or reinforcement was provided on test trials. For four of the participants,

[2] Some of the participants' progression through the phases differed from this general procedure; these individual modifications are noted in the results section.

only one E was available for participation in the study, and thus she conducted both the exposure and test trials (see Table 7.2). Although feedback and reinforcement was not provided on test trials, for these participants, a control for cueing was not implemented.

Table 7.2

The procedural context in which the study was conducted for each participant, and participants for whom a control for cueing of correct responses was implemented.

Participant	Procedural context	Control for cueing
TJ	Magic	x
ST	Magic	✓
KJ	Magic	x
IB	Magic	x
LB	Magic	✓
SS	Magic	x
DE	Magic	✓
SM	Table-top	✓
FR	Table-top	✓
BS	Table-top	✓

Each experimental session lasted no longer than 20 minutes, and, typically, only one session was conducted per day. If two sessions were conducted in one day, the first was conducted in the morning and the second was conducted in the afternoon, thus affording a substantial break in testing.

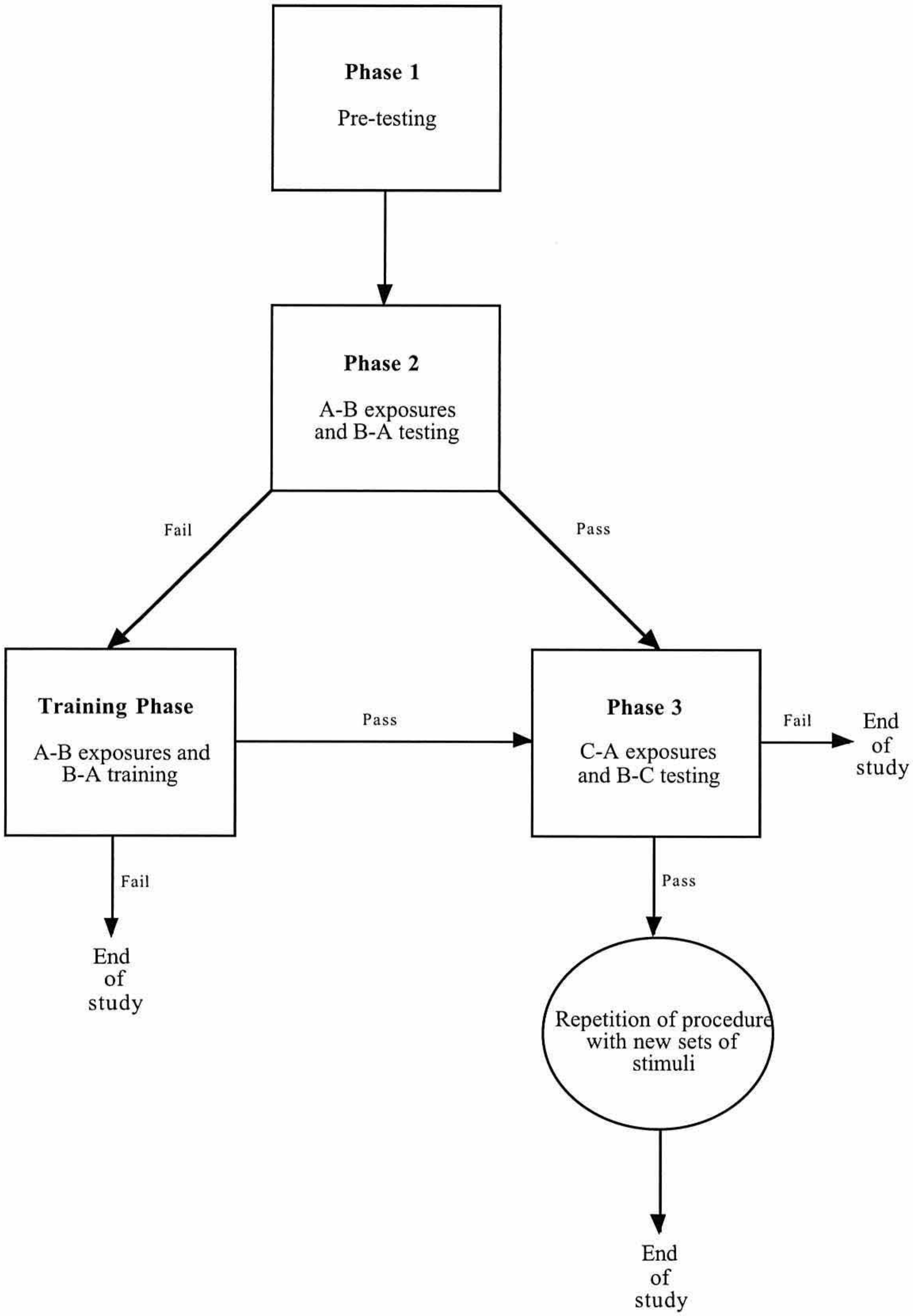

Figure 7.3. Participants' progression through the phases of Study 4.

Phase 1. Pre-testing

Phase 1 was conducted in order to select Set A stimuli for each participant, and to verify the prerequisites for responding matching-to-sample trials. This phase comprised a free play session and a baseline-pre-testing session; an additional session was included in the magic context in which the participants were familiarised with the magic-box procedure.

1.1. Free play session. The participants were presented with the novel objects and were encouraged to play freely with them. (Both Es were present throughout this session.) The participants' verbal and non-verbal behaviours were observed in order to ensure that the objects were indeed unfamiliar to them. In addition, from the participants' interactions with the novel objects, stimulus preferences were identified, and two objects, observed to be equally appealing to the participants, were selected as Set A stimuli (i.e., A1 and A2). In this session, participants in the magic context were also familiarised with the Sooty puppet; E introduced the puppet to the participants and they were encouraged to interact with it, and assist it, in simple games with the objects and toys.

1.2. Familiarisation with magic context. Participants in the magic context received this additional session in order to familiarise them with the magic-box and the context within which it was used. The participants were given four non-ostensive baseline exposure trials -- trials in which familiar auditory-visual relations were exposed. These non-ostensive exposure trials were conducted in the same format as subsequent exposure trials of the novel target relations. The format for the exposure trials in the magic context was as follows.

The participant and E1 were seated at the table opposite one another, and the magic-box was placed on the table between them. E1 introduced the puppet and the magic wand to the participant: "Sooty would like to do some magic, can you help him?" The puppet was then manipulated such that it pushed one object along the top of the box towards the participant; as this was done E1 said, "Sooty would like to do magic with this. Can you put this in the box for Sooty?" The participant was encouraged to play with the object for an average of 10 seconds before placing it in the box. Once the object was placed in the box, and the door closed, it was made to disappear. E1 tapped the box with the magic wand and said the "magic" words, "Izzy wizzy, let's get busy." The participant was also encouraged to help by tapping the magic wand and saying the magic words him or her self. As this was done, E1 extended the pulley so that the mirror was raised and the object, now obscured behind it, was tipped towards the back of the box. (The magic words, and the tapping of the wand, were employed in order to disguise any noise created by the magic-box.) The participant then opened the door of the box and looked inside; the box now appeared to be empty. At this point E1 made eye contact with the participant and presented the corresponding word in the carrier phrase, "Look, the X has gone! Where's the X gone?" (where X is the corresponding word). Thus the word was presented approximately six seconds after the object was obscured from view. As the participant looked inside the box, E1 inconspicuously removed the object from the back of the box and placed it in the plastic bucket, located on the floor to the side of E1. The next trial was then conducted.

1.3. Baseline pre-testing session. This session was conducted, by E2, in order to ensure that the participants possessed the prerequisite skills for responding correctly on matching-to-sample trials (i.e., the ability to respond conditionally upon presentation of an auditory sample, and to scan and select from two visual comparisons). In this session, the participants were given 12 baseline trials -- matching-to-sample test trials of the familiar auditory-visual relations (see Table 7.3). That is, on each trial the participants were presented with two visual comparisons, and were requested to select one upon presentation of the corresponding auditory sample dictated by E2.

Table 7.3

Matching-to-sample trial types employed in Study 4.

Trial type	Auditory sample	Visual Comparisons S+	Visual Comparisons S-
Baseline	"Pig"	pig	horse
B-A	"Tak"	spring	alarm
	"Bosch"	alarm	spring
B-C	"Tak"	cross	circle
	"Bosch"	circle	cross
Exclusion	"Tak"	spring	horse
Control	"Horse"	horse	spring

Note: In this example the novel relations comprise:
A1 - spring; B1 - "Tak"; C1 - cross.
A2 - alarm; B2 - "Bosch"; C2 - circle.

The format for the matching-to-sample trials in each context was as follows.

Table-top context. The participant and E2 were seated at the table opposite each other. On each trial the participant was presented with two visual comparisons, which were placed on the table before him or her. As these were being placed down, E2 requested the participant to select one of the comparisons upon presentation of the corresponding auditory sample; this was dictated in the carrier phrase appropriate for the individual participant (e.g., "Where is the X?", or "Give me the X", where X was the auditory sample). These requests were presented when the participant was holding either both novel objects, or was holding neither object; this was in order to avoid biasing the participant's immediate or subsequent comparison selections. The participant was therefore required to manually indicate a selection between comparison stimuli by pointing to, picking up, or giving E2 one of the objects. Once a clear and codeable response was produced, the objects were removed and the next trial conducted.

Magic context. The matching-to-sample trials in this context were designed to be as similar as possible to the exposure trials. To this end, the participant and E2 were seated opposite one another at the table, and the magic-box was placed on the table between them. E2 introduced the puppet and the magic wand to the participant: "Sooty would like to do some magic, can you help him?" On each trial the puppet was manipulated such that it slid two visual comparisons along the top of the magic-box towards the participant. As the comparisons were slipped closer, E2 presented the auditory sample in one of two carrier phrases appropriate for the participant, each of which required a different comparison response.

1. E2 asked of the participant, "Sooty would like to do magic with the X. Put the X in the box for Sooty," (where X was the auditory sample). Once the participant had placed one of the objects in the box, the remaining object was then removed.

2. E2 asked of the participant, "Sooty would like to do magic with the X. Which one is the X?" (where X was the auditory sample). Once the participant had selected one of the objects, by pointing to it, or picking it up, the remaining object was removed from the top of the box, and the participant was requested to, "Put it [their chosen comparison] in the box for Sooty."

As with the exposure trials, once the participant had placed an object in the box, and closed the door, the object was made to disappear. The participant then opened the door of the box and looked inside; the box now appeared to be empty. E2 said, "Look, it's gone! Where's it gone?" As the participant looked inside the box, E2 inconspicuously removed the object from the rear of the box and placed it in the plastic bucket out of view of the participant. It is important to note that the object selected was made to disappear regardless of whether it was the correct comparison -- the magic routine was not contingent upon the participant's correct responding on test trials.

Elements common to both contexts. On each trial the participant was required to make a clear and unambiguous choice between the two visual comparisons; this was by picking up, by pointing to one of the objects, or by putting one of the objects in the magic-box. If the participant produced a clear and codeable response, the objects were removed and the next trial was conducted. If an ambiguous response was produced, or the participant did not respond, the same trial was reconducted up to three times. If the participant did not produce a clear response following three repetitions, the trial was abandoned and a new trial began.

All baseline trials were unreinforced and no feedback was provided. The order of presentation of visual comparisons was counterbalanced across all 12 trials so that the objects appeared as correct and incorrect comparisons, with equal frequency, in both left and right hand positions; this served to discourage the emergence of preferential responding.

Criteria for progression to Phase 2. In order to progress to Phase 2, the participants were required to perform at, or above, the baseline testing criterion level: at least 80 percent correct responding within one baseline pre-testing session. Further, they were required to satisfy this criterion in the absence of rewards for correct responding.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing

Phase 2 experimental sessions comprised the presentation of non-ostensive A-B (object-word) exposure trials and B-A (word-object) symmetry test trials. In the first session, the participants had two exposure trials (one each of A1-B1 and A2-B2); in the remaining two sessions, they had six exposure trials (three each of A1-B1 and A2-B2). Each block of exposure trials was followed by 12 B-A test trials (six each of B1-A1 and B2-A2). Although the typical number of sessions was three, sessions were occasionally repeated dependent upon the participants' performance in the previous session. Some participants also received an A-B naming test session; this is described in detail later.

At the end of each experimental session, the participants were presented with stars or stickers as a reward for their general attention and cooperation; these were not contingent upon their performance on test trials.

A-B exposure trials. The procedure for the A-B non-ostensive exposure trials in each context is as follows.

Table-top context. The non-ostensive A-B exposure trials conducted in this context were procedurally identical to those in Study 3 (see Chapter 6). To reiterate, E1 placed one of the novel objects on the table, and the participant was encouraged to play with it for an average of 20 seconds. The object was then dropped into the cardboard box, at the side of the table, where it was obscured from the participant's view. E1 then made eye contact with the participant and presented the corresponding novel word in the carrier phrase "The X has gone! Where has the X gone?" (where X was the novel word). Thus the novel word was presented only two to three seconds, on average, after the object was obscured from view. E1 then inconspicuously removed the object from the box and the next exposure trial was conducted.

Magic context. The procedure for the non-ostensive A-B exposure trials conducted in the magic context was described earlier in Phase 1 (see Section 1.2).

B-A test trials. The specific procedure for the matching-to-sample test trials, in each context, was described earlier in Phase 1 (see Section 1.3). In Phase 2, the participants were presented with 12 B-A test trials (six each of B1-A1 and B2-A2) in each experimental session. That is, the novel objects were presented as comparisons and the novel words as samples. These trials were randomly presented and were unreinforced. Within each session the position of comparisons was counterbalanced across all 12 trials; that is, the novel objects appeared as correct and incorrect comparisons, with equal frequency, in both left and right hand locations. This served to discourage the emergence of preferential responding.

A-B naming test. Some participants received an A-B (object-word) test session in Phase 2. This comprised three consecutive trial types: free recall trials, prompted recall trials, and recognition trials. Participants were given six trials of each type (three each of A1-B1 and A2-B2), and all trials were unreinforced.

On free recall trials, the participants were shown one novel object and were asked, "What's this?" by E. On prompted recognition trials, the participants were shown one novel object and were asked, "Is this a X1, or a X2?" (where X1 and X2 were the novel words). On half of the trials the correct corresponding novel word was presented first, and on the remaining half the corresponding novel word was presented second; thus criterion level responding could not be achieved by a pattern of simply repeating either the first (or equally the last) novel word presented. On recognition trials, the participant was again shown one novel object and was asked "Is this a X?" (where X was a novel word). On half of the trials the correct corresponding novel word was presented, and on the remaining half the incorrect novel word was presented; thus criterion level responding could not be achieved by a pattern of simply replying "Yes" (or equally "No") in response to every request. These trials were interspersed with baseline trials of the same type (i.e., free recall, prompted recall, and recognition trials of familiar auditory-visual relations) designed to familiarise the participants with the responses required of them on each trial type; these were also unreinforced.

Criteria for progression to subsequent phases. The progression through the phases is illustrated in Figure 7.3. The criterion for passing tests of the novel B-A relations was at least 80 percent correct responding on trials of both novel relations (i.e., B1-A1 *and* B2-A2) within one experimental session (i.e., one block of 12 test trials). If participants failed to respond at criterion level on B-A tests, at the end of Phase 2, they proceeded to the training phase. If participants passed the B-A tests, at any point in Phase 2, they proceeded to Phase 3 of the study.

Training Phase

In this phase participants received A-B non-ostensive exposure trials (identical to Phase 2) and B-A matching-to-sample training trials. B-A training trials were identical in nature to B-A test trials (see Table 7.3), but feedback was provided and correct responses were rewarded with verbal praise and applause by E2.

This phase comprised a maximum of eight types of training procedure (each of which is described in detail below). The training procedures employed for each individual participant were based upon their performances on B-A test trials (the specific training procedures employed for each participant, and the order in which they were conducted, is noted in their individual results sections). In the following sub-sections, the general method for each training procedure is outlined.

Generic training (T1). This initial training phase provided the basis for B-A training in all the subsequent training procedures. In each experimental session, the participants received two A-B non-ostensive exposure trials (one each of A1-B1 and A2-B2) and 12 B-A training trials (six each of B1-A1 and B2-A2). Following each training trial, the participant was told whether his or her response was correct or incorrect, and rewards for correct responses took the form of verbal praise and applause from E2 (in addition, in the magic context, E2 emphasised the role of Sooty: for incorrect responses the participants were told, "Sooty's sad now," and for correct responses they were told, "Sooty's happy,"). As stated earlier, the magic routine was not contingent upon the accuracy of the participants' responses, and thus the comparison stimulus selected on every trial was made to disappear following the presentation of feedback and/or a reward.

Some participants also received *correction trials*. If a participant produced an incorrect response on a training trial, E2 said, "Let's try again," and the trial was reconducted until the participant produced a correct response. Once a correct response was produced, it was rewarded and the next trial was conducted. Correction trials were of particular importance in cases in which the participants exhibited a pattern of preferential responding; by repeating a trial the participants were eventually required to produce a correct response before progressing through the session, and therefore were required to select their least preferred objects, or objects in less preferred locations.

Training by proximity (T2). If generic training did not eliminate stimulus or location preferences, then the participants were given B-A training by proximity. Each session was identical in nature to the generic training described above. However, on each B-A training trial the correct comparison was placed closer to the participant, thus increasing its salience; the incorrect comparison was placed further away, almost out of reach. As a result, it was hoped that the participants would select the proximate object, and would therefore begin to select their less preferred stimulus, or objects in the less preferred location. Once the participants responded at criterion level on these trials, the relative proximity between the objects was reduced progressively over consecutive sessions. By the final session in this phase, the comparisons were presented with equal proximity, and thus B-A training trials were identical to those in generic training.

Training by exclusion (T3). In this training procedure, training trials now consisted of varying numbers of three trial types, namely: exclusion trials, control trials, and B-A training trials (see Figure 7.3). B-A training trials were identical to those described above in generic training. On exclusion trials, the participants were presented with one novel object and one familiar object, and were requested to select the novel object upon presentation of the corresponding novel word. In order to ensure that the participants were attending, in some part, to the auditory stimulus presented on exclusion trials, and were not selecting the correct comparison on the basis of its novelty alone, they were also given an equal number of control trials. On control trials, the participants were again presented with one novel object and one familiar object, but were requested to select the familiar object upon presentation of the corresponding familiar word. In contrast to exclusion trials and control trials employed in the exposure phases of the previous studies, correct responses on these trials in the present study were rewarded in order that criterion level responding was trained.

Each session comprised 12 training trials which were composed of varying numbers of exclusion trials, control trials, and B-A training trials. The initial session in this phase comprised six exclusion trials and six control trials. Once criterion level responding was established on these trials, B-A training trials were gradually introduced in each consecutive session, thus subsequent sessions comprised the following: four exclusion trials, four control trials, and four B-A training trials; two exclusion trials, two control trials, and eight B-A training trials; and finally, 12 B-A training trials. The participants progressed to each session following criterion level responding on B-A training trials in the previous session.

A-B training (T4). In this phase the participants were trained the A-B (object-word) relations; that is, the novel objects were presented as samples and the participants were requested to produce the corresponding novel words. Each experimental session comprised 12 A-B training trials (six each of A1-B1 and A2-B2). On each trial, the participant was presented with one novel object and was asked, "What's this?" If the participant failed to produce a clear response, or did not respond at all, the trial was reconducted up to three times before it was abandoned. Feedback and rewards for correct responses were provided in the same manner as for B-A training trials. Once criterion level was achieved on A-B training trials, the participants were then given generic B-A training.

Training by descriptive samples (T5). It was noted that, throughout the experimental sessions, the participants frequently described the novel objects, or labelled some physical property of the objects themselves, during their interactions with them. As a result, these descriptive labels were employed as additional auditory samples on B-A training trials. For each participant undergoing this procedure, the novel objects were each assigned an adjective -- the pocket alarm was always associated with "noisy" or "a phone", and the spring with "bouncy" or "heavy". Experimental sessions were composed of three trial types: descriptive sample trials, in which the participants were asked "Which one is D?" (where D was the descriptive label); descriptive and novel sample trials, in which the participants were asked "The N is D. Where is the N?"

(where N was the novel label and D was the descriptive label); and finally, B-A training trials, in which only the novel words were presented as auditory samples. These were presented in varying numbers so that the salience of the descriptive samples was gradually reduced. Once criterion level responding was established on descriptive sample trials alone, the salience of the descriptive labels was progressively reduced in subsequent consecutive sessions, thus the sessions comprised either: (1) 12 descriptive sample trials; (2) 12 descriptive and novel sample trials; (3) eight descriptive and novel sample trials, and four B-A training trials; (4) four descriptive and novel sample trials, and eight B-A training trials; (5) finally, 12 B-A training trials. Each individual participants' progression through these sessions differed, and was based upon their response accuracies in the previous session.

Training by increased rewards (T6). In this phase the participants were given generic B-A training trials in which the rewards for correct responses were increased. By providing what was hoped to be more reinforcing consequences to their correct responses criterion level responding might be established. Thus each individual participant was given his or her own sticker-story book. Throughout the session, the participants were given one sticker for each correct response on a B-A training trial; the stickers were collected by the participant in a small pot at the side of the table. At the end of the session the stickers were placed in their book and the story was read to them.

Training by token rewards (T7). This training procedure directly followed T6. If the presentation of increased rewards failed to bring the participants' responding under control of the auditory samples, then a token reward system was introduced. In T6, as participants were still able to gain numerous stickers (i.e., six) by responding randomly, or with a pattern of preferential responding, there was little motivation to learn the relations between the novels words and objects. As a result, a system of token rewards was introduced. The connect 4 matrix was placed at the side of the table and participants were given a token for each correct response on B-A training trials. For the first two correct responses they were given a yellow token, and for the third correct response they were given a red token; this pattern was repeated for the 12 training trials. At the end of the session the red tokens were exchanged for story book stickers, which were then stuck in their book as the story read to them. Thus the participants were now required to respond correctly on three B-A training trials in order to gain one sticker.

Training by token rewards -- ostensive exposure trials (T8). This final training procedure directly followed T7. Each session was identical in nature to T7 sessions, with the exception that the exposure trials were now presented ostensively. That is, on each trial the participant was presented with the novel object and corresponding novel word simultaneously. The specific procedure for these trials is as follows. The participant and E1 were seated opposite one another at the table. E1 presented the participant with one of the novel objects and encouraged him or her to play freely with it for approximately 20 seconds. When both E1 and the participant were looking at the object, E1 presented the corresponding novel word in the carrier phrase "This is a X" (where X was the novel word). The object was then removed and the next exposure trial conducted.

Elements common to all training phases. At the end of each experimental session the participants were presented with small stickers or stars; these were not contingent upon their performance on training trials, but were a reward for their general cooperation throughout the session. If the participants achieved criterion level at the end of any training procedure (this was always a block of 12 B-A training trials), feedback and rewards were gradually phased out, until the participants responded at criterion level on a block of 12 B-A testing trials. They then progressed to Phase 3 of the study.

Switching contexts. By this point in the study, after repeated training sessions, the participants in the magic context tired of the procedure; they appeared to lose interest in the magic-box itself. Experimental sessions in this context became increasingly longer in duration, and participants began to refuse to cooperate following only a small number of trials. It was found that whilst the magic context was suitable for a small number of test sessions, repeated exposure to it became tiresome for the participants. As a result, when the participants tired of the procedure they switched to the table-top context. For these participants the Sooty glove puppet continued to be used in experimental sessions in order to encourage them to respond. The switch between contexts was always made with one generic B-A training session conducted in the new (table-top) context; this was in order to familiarise the participants with the new procedure and the new mode of responding required of them. The study was then was resumed, in the table-top context, from where it was interrupted.

Phase 3. B-A Test Trials, C-A Non-Ostensive Exposures, and B-C Testing

Once participants had responded at criterion level on B-A test or training trials, they proceeded to Phase 3 (see Figure 7.3). In Phase 3, the participants were given non-ostensive C-A (shape-object) exposure trials, and B-C (word-shape) equivalence test trials. The general procedure remained the same as Phase 2: the first experimental session comprised two C-A exposure trials (one each of C1-A1 and C2-A2), and the remaining sessions comprised six C-A exposure trials (three each of C1-A1 and C2-A2); each block of exposure trials was followed by 12 B-C test trials (six each of B1-C1 and B2-C2). In each session the participants were also initially given four B-A test trials prior to the exposure trials.

Some participants were also given a C-A test, an A-C test, and a C-B test. As stated above, all of the participants received Phase 3 sessions in the table-top context[3].

B-A test trials. Each experimental session began with four B-A test trials (two of each novel relation). The table-top procedure for these trials is described in Phase 1 (see Section 1.3).

C-A non-ostensive exposure trials. The participant and E1 were seated at the table opposite one another. E1 presented the participant with one of the holographic boxes which had one of the novel shapes attached to it; this contained the corresponding novel object. The box was presented so that the shape was facing the participant. He or she was encouraged to look at it, touch it, and note its defining features for an average of 10 seconds. E1 then asked, "What's hiding in here?" E1 then turned the box over so that the shape was on the bottom, obscured from the participant's view, and opened to the lid to reveal the corresponding novel object. Thus the object was presented once the shape was removed from the participant's view. After a period of free play with the object, E1, or the participant, replaced the object in the box, and the box was slipped off the table so that the shape remained out of view of the participant. The next exposure trial was then conducted.

[3] As it was initially intended to continue to present Phase 3 within the magic context, one participant -- DE -- received two sessions within this format. On C-A exposure trials DE was given both novel objects, which were placed in the magic box together and made to disappear. DE was told that Sooty had hidden them in other boxes. He was then given each of the boxes (with the novel shapes on), and the C-A relations were exposed as in the table-top context. The B-C test trials were also conducted in the table-top context. There were two problems with this procedure. First, DE was now requested to place both objects in the magic box; this he found confusing. Second, B-C test trials now required simple pointing responses, rather than placing objects in a box; DE did not produce codeable responses on these trials. Thus DE switched to the table-top context at this point in the procedure.

B-C test trials. B-C test trials were conducted in the same matching-to-sample format as other test trials (see Table 7.3), and were identical in nature to previous studies (see Chapters 5 and 6). The participant and E2 were seated opposite one another at the table. On each trial, E2 placed the two boxes on the table so that the shapes were facing the participant. The participant was not permitted to open the boxes throughout the test session. (Throughout the test trials the novel objects were not placed inside the boxes; this was to ensure that, in cases where the participants could not be prevented from opening the boxes, the correct pairings between the novel objects and words were not revealed.) The participant was then requested to select one of the novel shapes upon presentation of the corresponding novel word; this was dictated by E2 in the carrier phrase, "Where is the X hiding?" (where X was the auditory sample). Once the participant had produced a clear and codeable response, the boxes were removed and the next trial conducted. As with the B-A test trials, if an ambiguous response was produced the trial was reconducted up to three times before it was abandoned.

Within each session the trials were unreinforced and were presented randomly. The position of comparisons was counterbalanced across all 12 trials so that each of the shapes appeared as correct and incorrect comparisons, with equal frequency, in both left and right hand locations; this served to discourage preferential responding.

C-A test trials. On C-A test trials, the novel shapes were presented as samples and the novel objects as comparisons. Each session comprised 12 C-A trials (six each of C1-A1 and C2-A2). On each trial the participant was presented with both of the novel objects, which were placed on the table before him or her. E2 then placed one of the boxes in the centre of the table so that the shape was facing the participant. The participant was then asked, "Which one hides in here? Can you put it in for me?" Once the participant had placed one of the novel objects in the box, the box and the remaining object were removed, and the next trial conducted. The position of the novel objects was counterbalanced across all 12 trials such that they appeared as correct and incorrect comparisons, with equal frequency, in both the left and right hand positions.

A-C test trials. On A-C test trials the novel objects were presented as samples, and the novel shapes as comparisons. Each session comprised 12 A-C trials (six each of A1-C1 and A2-C2). On each trial the participant was presented with both of the boxes so that the shapes were facing him or her. E2 then placed one of the novel objects on the table between the boxes and asked, "Where does this hide?" Once the participant had placed the object in one of the boxes, both of the boxes were removed and the next trial was conducted. As with other test trial types, the position of the shapes was counterbalanced across all 12 trials to that they appeared, with equal frequency, in both left and right hand locations.

Repetition of the Procedure With New Sets of Stimuli

If the participants produced criterion level responding on B-C test trials in Phase 3, the procedure was repeated with new sets of stimuli (see Figure 7.3). One free play session was initially conducted in order to select the Set A stimuli -- A3 and A4. The procedure was then conducted from Phase 2 onwards; this repetition of the procedure was always conducted in the table-top context.

Participants' Vocalisations

The participants' informal productions of the novel words were recorded throughout the study. The context in which the vocalisation occurred, the visual stimuli present at the time, and the surrounding discourse was also noted in order that each vocalisation could be classified into one of three categories: spontaneous labelling, prompted labelling, or echoing. These categories are described in detail in Study 1 (see Chapter 4, method section).

RESULTS

First, the participants' responses in Phase 1, pre-testing, are presented. Second, in order to determine whether the participants derived the novel B-A and B-C relations, their responses on test trials throughout Phase 2, their responses on B-A trials throughout the training phase, and their performance on test trials throughout Phase 3 are summarised and presented individually. The participants' performances on test trials throughout the second repetition of the procedure -- with new sets of stimuli -- are also summarised. (Participants' performances on each test trial type throughout individual experimental sessions are detailed in Appendix K).

Phase 1. Pre-testing

1.1. Free Play Session

The participants' verbal and non-verbal behaviours were observed during their interactions with the novel objects; these confirmed that the objects were unfamiliar to them. Further, stimulus preferences were identified and preferred objects were removed from the array. Two novel objects, observed to be equally appealing, were selected as Set A stimuli (A1 and A2) -- for each participant the multi-coloured slinky spring was selected as A1, and the pocket alarm as A2. Two of the remaining objects were later selected, in a second free play session, as Set A stimuli for use in the second repetition of the procedure (A3 and A4) -- for Participants FR and DE, the multi-coloured koosh ball was selected as A3, and the giggle stick as A4; for participant BS, the concertina snail was selected as A3 and the giggle stick as A4.

1.2. Familiarisation With the Magic Context

This session was conducted in order to familiarise the participants with the magic-box and the context within which it was used. Of the seven participants in this context, six -- ST, KJ[4], IB, LB, SS, and DE -- required only one familiarisation session. In this session they cooperated throughout the exposure trials, and by the second trial they reliably placed the objects in the magic-box when requested to, and searched in the box for the object once it had disappeared.

The remaining participant, TJ, was given seven of these sessions. In each session he failed to attend to the exposure trials, and showed little or no interest in the magic-box itself; he preferred to play with other toys present in the room and repeatedly left the table to explore. With each consecutive session, TJ's attention became more easily distracted, and in the final three sessions he refused to cooperate on any exposure trial. By this point TJ had also tired of both the novel and familiar toys, and thus he took no further part in the study.

1.3. Baseline Pre-testing Session

Before proceeding to Phase 2, the participants were required to perform at, or above, criterion level on baseline pre-testing trials; this criterion was at least 80 percent correct responding within one baseline pre-testing session (i.e., one block of 12 baseline trials). As is shown in Table 7.4, nine of the participants satisfied the baseline pre-testing criterion (as stated earlier, participant TJ did not proceed beyond Session 1.2). Each of these nine participants demonstrated the prerequisite skills required for correct responding on matching-to-sample test trials, and thus progressed to Phase 2 of the study. Further, their criterion level performance demonstrated that they were able to sustain correct responding over 12 test trials in the absence of feedback or rewards for correct responses. Five of the participants in the magic context -- ST, KJ, IB, LB, and SS -- were given repeated baseline pre-testing sessions. This was because their responses in the early sessions, although at criterion level, were often ambiguous

[4] Participant KJ required two of these sessions. Although she responded reliably on the first session, this was interrupted by a fire alarm in the nursery; this caused KJ some distress and she was reluctant to return to the experimental room. As a result, the session was repeated the following day in order to re-familiarise her with the experimental room.

and necessitated the repetition of test trials. However, with repeated exposure to the magic-box in the matching-to-sample context, the participants performed at baseline criterion level producing clear responses on all 12 trials.

Table 7.4

Participants' performance in baseline pre-testing sessions. (Bold text denotes sessions in which criterion level was achieved.)

Context	Participant	Baseline pre-testing sessions (percentage of correct responding)			
		1	2	3	4
magic	ST	75	**83.3**	**100**	**91.6**
magic	KJ	**100**	**100**	-	-
magic	IB	72.7	**87.5**	**83.3**	**83.3**
magic	LB	**83.3**	**83.3**	**100**	-
magic	SS	**90.0**	**100**	-	-
magic	DE	**91.6**	-	-	-
table-top	SM	75	**83.3**	-	-
table-top	FR	**91.6**	-	-	-
table-top	BS	**83.3**	-	-	-

Participants' Performances in Phases 2, 3, and Training

Participants' performances on B-A and B-C test trials throughout Phases 2 and 3 respectively, and their performances on B-A trials throughout the training phase, are summarised and presented individually (see Appendix K for a detailed session-by-session analysis of each participant's performance).

In Phases 2 and 3, in order to demonstrate derivation of the target novel (B-A and B-C) relations, the participants were required to respond with at least 80 percent accuracy on trials of *both* novel relations (i.e., B1-A1 *and* B2-A2 or B1-C1 *and* B2-C2) within one experimental session (i.e., one block of 12 test trials).

Participant ST

ST received only two experimental sessions in Phase 2.1. She did not demonstrate derivation of the symmetrical B-A relations following 8 A-B non-ostensive exposure trials; she exhibited an exclusive stimulus preference on B-A test trials.

Participant BS

BS did not pass the B-A symmetry tests in Phase 2 following 10 non-ostensive exposure trials. However, his performance on the initial eight trials conducted in B-A test sessions was at criterion level. It was possible that BS had derived the novel relations yet failed to achieve criterion level over a block of 12 test trials as a result of his apparent increasing lack of interest in experimental sessions. It was deemed that additional B-A test sessions would further reduce BS's attention to test trials, and thus he proceeded directly to Phase 3.

In Phase 3, B-C test trials were presented in only one session; BS did not pass this test. In addition, he failed to achieve criterion level on B-A tests conducted in this phase; in fact, his performance on these trials declined from Phase 2. He again tired quickly of the procedure, refusing to cooperate for 12 trials in each session, and, specifically, appeared to be bored of the novel objects.

Phase 2 was thus repeated with the new Stimulus Sets 3 and 4. In this second repetition only four test trials per session were conducted in an attempt to maximise BS's attention to test trials. Again he did not pass the B-A symmetry tests, and neither did he label the novel objects throughout this phase. BS took no further part in the study.

Participant LB

LB did not pass the B-A symmetry tests in Phase 2; she demonstrated both stimulus and location preferences on test trials in these sessions. Despite correctly labelling the A2 stimulus on one occasion, she consistently labelled the novel objects with her own names -- A1 as "heavy" and A2 as a "phone".

Throughout the training phase, LB was given generic training, training by exclusion, and training by descriptive samples. In each procedure she failed to achieve criterion level on B-A training trials; this appeared to be a result of her increasing lack of cooperation in experimental sessions. Throughout the training sessions, LB again rarely produced the novel words; rather, she consistently labelled the novel objects with her own names. Eventually the study was abandoned because LB refused to participate further.

Participant KJ

In Phase 2, KJ did not pass the B-A symmetry tests following 16 non-ostensive exposure trials; she demonstrated a preference for the A1 stimulus. Throughout this phase she occasionally labelled the novel objects; when she did so, she labelled the objects correctly in only half of these instances, thus confirming that she had not acquired the novel relations.

KJ did not achieve criterion level on B-A trials in generic training sessions; her exclusive stimulus preference (A1) remained evident and correction trials were ineffective in encouraging KJ to select the A2 stimulus.

Although responding at criterion level on exclusion trials and related control trials in training by exclusion sessions, KJ failed to achieve criterion level on B-A trials; she continued respond according to her stimulus preference.

In training by descriptive samples, her stimulus preference remained evident and she failed to achieve criterion level even on descriptive + novel sample trials. Similarly, her stimulus preference persisted throughout training by increased rewards and training by token rewards, and thus KJ never achieved criterion level on B-A trials.

Throughout these five training procedures KJ occasionally, and inconsistently, labelled the novel objects; the inaccuracies in her informal vocalisations further confirmed that she had not learned the novel relations. As KJ's stimulus preference could not be eradicated, and she failed to achieve criterion level on B-A training trials, she took no further part in the study.

Participant IB

IB did not pass the B-A symmetry tests in Phase 2 following 26 non-ostensive exposure trials; he exhibited both stimulus and location preferences on test trials. Throughout these sessions he typically echoed the novel words presented on exposure trials and occasionally echoed the novel auditory samples presented on test trials. He did not, however, label the novel objects throughout this phase.

IB did not achieve criterion level on B-A training trials throughout generic training, training by exclusion (despite achieving criterion level on exclusion and control trials), training by descriptive samples (despite achieving criterion level on descriptive + novel sample trials), training by increased rewards, training by token rewards, and training including ostensive exposure trials. He continued to exhibit both stimulus and location preferences on B-A training trials throughout these sessions.

Throughout the training phase IB occasionally echoed the novel words presented on exposure and training trials. In addition, he began to label the novel objects more frequently as training progressed. However, he produced the B2 stimulus ("Bosch") with a greater frequency than B1, using it to label both novel objects. Further, his informal vocalisations of both novel words were inconsistent (i.e., not to criterion level) and thus confirmed that he had not acquired the specific target relations.

Participant FR

FR did not pass the B-A symmetry tests with Stimulus Sets 1 and 2; in these sessions she exhibited a location preference. Further, she did not produce the novel words informally throughout this phase, and she responded below chance level on the

A-B naming test conducted, thus confirming that she had not acquired the novel relations.

As a result, FR received five consecutive training procedures, namely: generic training, training by proximity, training by exclusion, A-B training, and training by descriptive samples. In the initial four training procedures, FR failed to achieve criterion level on A-B and B-A training trials (this was despite achieving criterion level on exclusion trials and related control trials in training by exclusion). Prior to A-B training, FR rarely echoed the novel words, and although she occasionally labelled the objects in response to prompts, in each instance she produced the B1 stimulus "Tak". This pattern of vocalisations was maintained in A-B training, in which she continued to produce B1 with a greater frequency than B2.

In the final training procedure -- training by descriptive samples -- she achieved criterion level on B-A trials. In addition, she frequently labelled the objects both spontaneously and when prompted, producing the correct novel word in 88.46% of these instances; in cases in which she produced the wrong label she corrected herself. Thus her informal vocalisations provided complementary evidence that she had acquired the novel A-B relations.

FR failed the B-C tests in Sessions 1 to 12 of Phase 3; initially, it appeared that she may have formed the reversed relations (i.e., B1-A2 and B2-A1). Although her labelling of the novel objects (A-B matching) continued to be accurate, her labelling of the novel shapes was inconsistent, and thus there was no evidence that she had derived the transitive C-B relations, or had indeed acquired the C-A exposed relations.

However, in Session 13, FR demonstrated evidence of the emergence of C-B transitive relations in her accurate labelling of the novel shapes on exposure trials; this in turn suggested that she had acquired the C-A (shape-object relations). Thus, in order to determine such, a C-A test was conducted. Her criterion level performance in this session confirmed that she had acquired the C-A relations, and in the subsequent session she also demonstrated evidence of derivation of the symmetrical A-C relations. In addition, FR went on to pass the B-C equivalence test in Session 15, aged 28 months and 20 days. Although this was not maintained over two subsequent B-C test sessions, her performance overall in Sessions 15 to 17 marginally exceeded criterion level. In these sessions her C-B performance was also accurate -- when labelling the novel shapes she produced the correct word in 83.3 percent of the instances; when she produced the wrong words she invariably corrected herself.

In the second repetition of the procedure, with Stimulus Sets 3 and 4, FR demonstrated immediate derivation of the symmetrical B-A relations, aged 29 months and 2 days, following non-ostensive A-B exposure trials; further, she maintained this performance in three subsequent sessions. Despite this she did not label the novel objects throughout these sessions. FR then went on to demonstrate immediate derivation of the B-C equivalence relations, aged 29 months and 7 days, following C-A exposure trials.

Participant DE

DE did not pass the B-A symmetry tests with Stimulus Sets 1 and 2; he demonstrated a stimulus preference in Phase 2 sessions. Although he echoed both of the novel words presented on exposure trials, he did not label the novel objects .

DE subsequently achieved criterion level on B-A trials following only two generic training sessions; criterion level responding was maintained in sessions in which the feedback and rewards for correct responses were removed. This performance was inconsistent with his informal vocalisations: in contrast to Phase 2, he now produced only B2; he echoed only this novel word on both exposure and training trials, and frequently said, "Bosch gone," following both A1-B1 *and* A2-B2 exposures.

DE initially failed the B-C tests presented in Phase 3; this appeared to be because he was unfamiliar with the new response requirements on test trials (the magic box was no longer employed on B-C test trials). His informal vocalisations in these early sessions reflected his apparent confusion: he repeatedly echoed the novel words presented on exposure and test trials, or repeatedly said, "Bosch gone,"; these rarely corresponded with the objects present.

B-A trials were thus conducted in the table-top context in order to familiarise DE with the required responses. He performed at criterion level in these sessions and also went on to pass the subsequent B-C equivalence tests aged 26 months and 23 days. His lack of confusion was apparent in his informal vocalisations: he echoed the novel word presented on each B-C trial once only as he made a comparison selection and he passed an A-B naming test conducted at the end of this phase.

In the second repetition of the procedure, with Stimulus Sets 3 and 4, DE demonstrated immediate derivation of the symmetrical B-A relations aged 27 months.

DE initially failed the subsequent B-C tests in Phase 3; instead, he appeared to have formed the incorrect relations thus demonstrating evidence of URCSs. He did not label the novel objects or shapes throughout these sessions. Following a break in testing, B-A tests were conducted to re-familiarise him with the procedure on which he responded above criterion level. B-C testing was resumed and DE demonstrated derivation of the equivalence relations aged 29 months and 18 days. In addition, he passed both a C-A and an A-C symmetry test. Throughout these sessions DE frequently, and accurately, labelled the novel objects and shapes when prompted demonstrating evidence of A-B and C-B matching, and thus confirmed that he had derived the equivalence relations.

Participant SS

SS did not demonstrate derivation of the B-A relations following 34 A-B non-ostensive exposure trials; she exhibited stimulus preferences in these sessions and rarely produced either of the novel words.

SS was then given generic training and training by exclusion. Following criterion level responding on exclusion trials and control trials, she also achieved criterion level on B-A trials; this performance was maintained in one session in which the feedback and rewards for correct responding were removed. SS did not produce the novel words throughout the training phase.

In Phase 3, SS did not pass the B-C equivalence tests. Despite this, there was some evidence that SS has derived the transitive C-B relations: on C-A exposure trials she frequently labelled the novel shapes; in 81 percent of these instances she did so correctly. In addition, in contrast to the previous phases, SS correctly labelled the novel objects (A-B matching) both spontaneously and when prompted, thus confirming that she had acquired the novel A-B relations.

Participant SM

SM did not pass the B-A symmetry tests following 14 non-ostensive exposure trials. Although she often echoed the novel words in these sessions, she produced only one instance of incorrect labelling.

SM received generic training, training by exclusion, training by descriptive samples, and training by increased rewards. In the first three training procedures SM did not achieve criterion level on B-A trials. Throughout the initial two training procedures she frequently echoed the novel words, yet did not label the novel objects. However, in the final training procedure -- training by increased rewards -- SM satisfied criterion level on B-A trials. Her informal vocalisations were inconsistent with this performance: although she began to label the novel objects, in every instance she used the novel word "Bosch".

SM did not pass the subsequent B-C equivalence tests in phase 3. Her performance on B-A trials also declined, and thus she received further generic B-A training. As she again achieved criterion level on B-A trials, C-A exposures and B-C testing were resumed. However, SM did not demonstrate derivation of the B-C equivalence relations in these sessions; she also failed both C-A and A-C tests conducted at the end of this phase. Whilst SM often correctly labelled the novel objects, when prompted to label the novel shapes her responses did not satisfy criterion level and she typically produced the novel word "Bosch"; this further confirmed that she had not derived the equivalence relations.

Summary of Results

Phase 2. A-B Non-Ostensive Exposures and B-A Testing

As is shown in Table 7.5, none of the participants achieved criterion level on B-A symmetry tests following A-B non-ostensive exposure trials.

Table 7.5

Participants' overall performance on B-A symmetry tests in Phase 2.

Participant	B-A test performance	No. of exposures (in total / to criterion)
ST	fail	8
BS	fail	10
LB	fail	14
KJ	fail	16
IB	fail	26
FR	fail	16
DE	fail	14
SS	fail	34
SM	fail	14

Eight of the participants exhibited patterns of preferential responding (i.e., stimulus and/or location preferences). The remaining participant -- BS -- although failing to achieve criterion level overall, did show some evidence of derivation of the B-A relations in his responses on the initial eight trials conducted in each session.

The participants' informal vocalisations throughout these sessions further indicated that they had not acquired the novel relations. Although the majority of the participants echoed the novel words presented on exposure and test trials, with varying frequencies, they all rarely labelled the novel objects. Some participants never labelled the novel objects (BS, IB, and FR), and some labelled the objects in only one instance

(LB, SS, SM); such sporadic vocalisations are not indicative of whether the participants acquired the novel relations. Only participants KJ and DE more frequently labelled the novel objects; KJ did so inaccurately, and DE used only the B2 stimulus to label both objects.

Training Phase

Two of the participants who failed B-A tests did not receive B-A training: ST took no further part in the study following Phase 2, and BS proceeded straight to Phase 3 after having demonstrated preliminary evidence of derivation of the B-A relations.

As a result, seven participants received B-A training (see Table 7.6). Three of the participants -- LB, KJ, and IB -- did not achieve criterion on B-A trials despite receiving between three and six training procedures each, and thus they took no further part in the study.

Table 7.6

Participants' overall performance in the training phase.

Participant	B-A training performance	Training procedure in which criterion was achieved	Total No. of training trials (to criterion or end of phase)
LB	fail	-	56
KJ	fail	-	142
IB	fail	-	294
FR	pass	descriptive samples	320
DE	pass	generic	32
SS	pass	exclusion	80
SM	pass	increased rewards	189

These participants' vocalisations further indicated that they had not acquired the novel relations. LB labelled the novel objects with her own chosen names. KJ rarely labelled the objects in the first two training procedures, and when she did so she used "Tak" to label both; she did not label the objects in the following two procedures; and in the final one she labelled both of the objects a "Bosch". IB produced a similar pattern of vocalisations: in the first training procedure (T1) he rarely labelled the novel objects; in the following three procedures (T3, T5, and T6) he never labelled the objects; in T7 he frequently labelled both objects with the novel word "Bosch"; and in T8 he began to label the objects more accurately, using both novel words, although these vocalisations were not at criterion level (i.e., were below 80 percent correct).

The remaining four participants -- FR, DE, SS, and SM -- achieved criterion level on B-A trials as a result of different training procedures (see Table 7.6). Each of these participants also maintained criterion level performance on B-A trials in the absence of feedback and rewards for correct responding, and thus progressed to Phase 3 of the study.

SS did not produce the novel words throughout the training phase. The remaining participants showed some similarities in their vocalisations. FR, in training procedures in which she failed to achieve criterion level, rarely echoed the novel words, and used "Tak" to label both novel objects; this pattern was not evident in training by descriptive samples in which she often, and accurately, labelled the novel objects. Both DE and SM produced only one of the novel words throughout training; DE echoed only "Bosch" on exposure trials and said, "Bosch gone," on both A1-B1 and A2-B2 trials, and SM, despite echoing both of the novel words, used only the novel word "Bosch" to label both of the objects -- this was the case even in sessions where criterion level was achieved on B-A trials.

Phase 3. C-A Non-Ostensive Exposures and B-C Testing

Five participants received C-A non-ostensive exposure trials and B-C tests (see Table 7.7). Participant BS, who proceeded to this phase after demonstrating some preliminary evidence of having derived the B-A relations in Phase 2, did not pass the B-C equivalence tests; in comparison to his performance on the earlier B-A tests, this was again most likely a result of a lack of interest in the procedure.

Table 7.7

Participants' overall performance on B-C tests in Phase 3.

Participant	B-C test performance	No. of C-A exposures (in total / to criterion)
BS	fail	2
FR	pass	86
DE	pass	6
SS	fail	14
SM	fail	16

Four participants -- FR, DE, SS, and SM -- received C-A exposures and B-C tests following B-A training. Two of these participants achieved criterion level on B-C test trials: FR and DE received 86 and 6 exposure trials, respectively, before passing the B-C tests. (Note that it is possible that DE would have achieved criterion level following fewer exposure trials, but a change in the response requirements hindered his performance on test trials in the initial sessions.) Before achieving criterion level on B-C tests, FR demonstrated evidence of having derived the transitive C-B relations in her vocalisations; this suggested that she had acquired the C-A relations. This was confirmed on subsequent C-A and A-C symmetry tests, and from this point FR passed B-C equivalence tests.

The remaining two participants -- SS and SM -- did not pass the B-C tests. There was no contradictory evidence of acquisition of the novel relations in their informal vocalisations.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing -- Repetition 1

Three participants received A-B exposures and B-A testing with Stimulus Sets 3 and 4 (see Table 7.8).

Prior to this phase BS had not received B-A training, but had proceeded to this point in the study following A-B and C-A exposures and related B-A and B-C tests, on both of which he performed below criterion level. As this was deemed to be due to his lack of interest in test trials, the procedure in this phase was simplified for BS. Despite this, he again failed to pass the B-A symmetry tests.

The remaining two participants -- FR and DE -- proceeded to this stage after receiving A-B and C-A exposures, related B-A and B-C testing, and B-A training. Both FR and DE demonstrated immediate derivation of the novel relations; their performance on the first B-A test, following only two A-B exposure trials, was errorless (100 percent accuracy on both B3-A3 and B4-A4 trials). Both DE and FR rarely echoed the novel words presented on exposure and test trials, and never labelled the novel objects throughout this phase.

Table 7.8

Participants' overall performance on B-A tests in Phase 2 -- repetition 1.

Participant	B-A test performance	No. of exposures (in total / to criterion)
BS	fail	6
FR	pass	2
DE	pass	2

Phase 3. C-A Non-Ostensive Exposures and B-C Testing -- Repetition 1

After passing the B-A tests in Phase 2, FR and DE were given C-A non-ostensive exposure trials and B-C tests with Stimulus Sets 3 and 4 (see Table 7.9); both of the participants achieved criterion level on B-C test trials in this phase.

Table 7.9

Participants' overall performance on B-C tests in Phase 3 -- repetition 1.

Participant	B-C test performance	No. of exposures (in total / to criterion)
FR	pass	2
DE	pass	8

FR demonstrated immediate derivation of the equivalence relations following only 2 exposure trials, and DE, although initially appearing to have formed the incorrect relations, passed the B-C test following eight exposure trials.

In the early sessions DE did not label either the novel objects or shapes, but typically echoed the novel words on exposure and test trials. However, in the later sessions he correctly labelled the novel objects and shapes on many occasions, further indicating that he had derived the A-B and C-B relations.

DISCUSSION

The participants' performances on B-A and B-C test trials are briefly discussed with respect to their acquisition of the novel word-referent relations and their derivation of three member equivalence classes between the novel stimuli. In addition, where participants failed to achieve criterion level on test trials, characteristic patterns of responding are identified.

In Phase 1 of the study, all but one of the participants achieved the baseline testing criterion, thus verifying the prerequisites for responding on auditory-visual matching-to-sample test trials. The one participant who failed to achieve criterion level took no further part in the study.

In contrast to Studies 2 and 3, none of the participants in the present study passed B-A symmetry tests following non-ostensive impending word exposure trials. All but one of the participants exhibited patterns of preferential responding on B-A trials throughout Phase 2; and each of the participant's vocalisations of the novel words were typically sporadic and inaccurate, thus confirming that they had not acquired the novel relations. This was the case for participants in both the basic table-top context and the magic context.

Thus unreinforced impending word non-ostensive exposure trials proved to be inefficient in effecting acquisition of the novel target relations. These data are inconsistent with previous cognitive/developmental research, the authors of which claim to have shown that young normally developing children, of an age younger than those of the present study, are able to demonstrate immediate comprehension of new words following limited non-ostensive exposures (e.g., Tomasello & Barton, 1994; Tomasello, Strosberg, & Akhtar, 1996). However, such studies have been variously criticised for their lack of methodological control (see Chapter 2). In contrast, the present study provided a stringently controlled investigation of word learning. Under such conditions, which afford an assessment of real word learning, it appears that non-ostensive exposures are ineffective in producing rapid acquisition of novel word-referent relations, at least in children as young as those in the present study.

Following Phase 2, one participant --BS -- proceeded to Phase 3 of the study. This was because, despite failing to achieve criterion level on B-A trials overall, his performance on the initial trials in each session were at or above criterion level. In Phase 3, BS failed the one B-C test conducted as a result of a lack of attention in the test procedure. By this point in the study, BS had tired of the novel objects and was increasingly inattentive throughout experimental sessions. As a result, A-B exposure and B-A tests were repeated with Stimulus Sets 3 and 4 in a simplified procedure; again BS failed to achieve criterion level on B-A tests. It is possible that BS failed to achieve criterion level on test trials as he had not received a history of conditional responding at any point in the study.

Seven participants underwent B-A training in the present study. Throughout this phase various procedures were employed in order to train the B-A (word-object) relations. Of these seven participants, three did not achieve criterion level on B-A training trials despite receiving between three and six different training procedures each: LB failed to achieve criterion level as a result of a lack of interest in the procedure, and both KJ and IB exhibited stimulus and/or location preferences that persisted throughout each training procedure.

The remaining four participants achieved criterion level on B-A training trials and continued to respond with 80 percent accuracy or above on unreinforced B-A test trials. Each of these participants achieved criterion level following differing training procedures: DE immediately satisfied criterion level on generic training trials, SS following training by exclusion, FR following training by descriptive samples, and SM following training by increased rewards. Only FR demonstrated emergent labelling of the novel visual stimuli, thus confirming that she had acquired the novel relations.

After demonstrating acquisition of the B-A relations in the training phase, these participants progressed to Phase 3. It appeared that correct responding on B-A trials did not reliably facilitate participants' performances on subsequent B-C test trials: only half of these participants passed subsequent B-C tests, and in cases in which they did pass B-C tests, they did not do so immediately. Participants' performances in Phase 3 were as follows.

Two of the participants failed B-C tests. SS failed B-C tests despite continuing to respond at criterion level on B-A test trials and demonstrating derivation of the transitive C-B (shape-word) relations in her informal vocalisations. SM's performance on B-A trials in Phase 3 fell below criterion level. As a result, training trials were again presented and, following criterion level performance on these and accurate emergent labelling of the novel objects, SM was administered C-A exposures and B-C tests; she did not demonstrate derivation of the equivalence relations. This is not surprising: she also failed to demonstrate acquisition of the exposed C-A relations and derivation of the symmetrical A-C relations; in addition, there was no evidence of derivation of the transitive C-B relations in her informal vocalisations throughout experimental sessions.

In contrast to SS and SM, DE and FR passed B-C equivalence tests in Phase 3. DE did so following 6 exposure trials; if he had not been confused by the change in response requirements between experimental contexts it is possible that he would have immediately passed the B-C tests. In addition, he also passed an A-B naming test for the first time at this point in the study. In contrast, FR passed B-C tests following a total of 86 C-A non-ostensive exposure trials. Initially, she appeared to have formed the incorrect relations (i.e., related B1 with C2 and B2 with C1); her labelling of the novel shapes was also below criterion level indicating that she had not derived the C-B transitive relations. However, in a subsequent session her accurate C-B labelling during C-A non-ostensive exposure trials suggested that she had acquired the C-A relations: as her labelling of the novel objects (A-B) was maintained, the combination of A-B relations with C-A relations gives rise to C-B via transitivity. In order to confirm that FR had, at this point, acquired the C-A relations as a result of the exposure trials, she was administered C-A and A-C tests. On both of these she achieved criterion level and also passed the B-C equivalence tests conducted subsequently. In these sessions she also achieved criterion level in her emergent labelling of the novel shapes (shape-word relations), thus further demonstrating derivation of the C-B transitive relations.

FR and DE were given a repetition of the procedure with Stimulus Sets 3 and 4. Interestingly, both participants now demonstrated immediate derivation of the B-A symmetrical relations following only two non-ostensive exposure trials. Further, both participants also went on to pass the B-C equivalence tests, thus demonstrating the acquisition of symbolic relations between the target stimuli. DE initially failed B-C tests; his responses indicated that he had formed the incorrect novel relations. Following a break in testing, DE passed B-C tests aged 29 months and 18 days; he also passed a C-A and an A-C symmetry test conducted at the end of this phase. Thus it appeared that prior training of conditional responding with Stimulus Sets 1 and 2 facilitated performance on B-A and B-C tests with new stimulus sets.

In summary, in the present study, A-B non-ostensive impending word exposure trials were ineffective in establishing acquisition of the target novel word-referent relations; typically, this was also the case in Studies 1 to 3. Subsequent training of the auditory-visual B-A relations proved difficult and a number of training procedures were required in order to bring participants' responding under control of the novel auditory samples; no one training procedure proved most effective to this end. The facilitative effect of this exemplar training on subsequent Phase 3 performance was limited: where participants passed B-C tests they did not do so immediately and required more C-A exposure trials than participants in previous studies.

However, following criterion level responding on B-A training trials and subsequent B-C test trials, two participants went on to demonstrate immediate derivation of the B-A symmetrical relations following A-B non-ostensive exposures of new stimulus sets; they also both went on to pass B-C equivalence tests with these stimulus sets. It thus appeared that a history of conditional responding improved performance on a second repetition of the procedure.

In the present study, only A-B and C-A non-ostensive exposure trials were conducted; in addition, these were tightly controlled such that the related auditory and visual stimuli were presented uni-directionally. As a result, criterion level responding on B-A and B-C test trials demonstrates the derivation of the symmetry and equivalence relations respectively.

As a control for cueing was not implemented for some of the participants, it may be argued that their accurate performance on test trials was established through experimenter cues. However, this is unlikely. First, all the participants failed B-A tests in Phase 2 (repetition 1); why didn't experimenter cues affect their responding from the outset of testing? Second, it proved difficult to train the participants B-A relations with feedback and rewards for correct responding; this would not have been the case had experimenter cueing been functional.

It might also be argued that unreinforced conditional selection (URCS) established participants' criterion level performance on test trials. It is noted that FR initially responded conditionally according to the incorrect stimulus pairings on B-C tests in Phase 3 (repetition 1) and DE did so on B-C tests in Phase 3 (repetition 2). It is likely these were URCS. Both participants had previously participated in the training phase, and by repetition 2 DE had achieved criterion level on B-A training trials, B-C test trials, and subsequent B-A tests with new stimulus sets. A history of conditional responding within the experimental context, whilst facilitating performance on subsequent tests, may also increase the likelihood of URCS. However, DE's and FR's subsequent criterion level performance on B-C tests cannot easily be attributed to URCS. Not only did they pass B-C tests, but a network of relations was established at the same time: these participants also achieved criterion level on C-A and A-C symmetry tests and demonstrated emergent labelling of the novel objects and shapes (A-B and C-B relations). It is highly unlikely that this pattern of selections across these tests could be produced by URCSs in conjunction with chance.

In the present study, as in Studies 1, 2, and 3, patterns of preferential responding were prevalent and were again pervasive. All the participants exhibited stimulus and/or location preferences at some point in the study. The prior identification of these in the free play session, and the selection of two equally appealing objects, did not eradicate such response patterns; preferences developed over the course of testing. Where these developed they were typically resistant to change: KJ and IB exhibited stimulus and/or location preferences that were impervious to change despite the administration of a number of training procedures designed to eradicate such responding. Thus such patterns of responding hindered participants' performances on test trials. From the results of this and previous studies, it appears that stimulus preferences, although not present in pre-testing, develop with greater contact with the novel objects within the test trial context, and thus may be a symptom of the failure to acquire the novel relations.

The introduction of the new magic context, although not hindering participants' performances, did nothing to facilitate participants' response accuracies on target test trials. Although it initially sustained participants' attention throughout experimental sessions, they appeared to tire of the apparatus quickly. It appeared that the magic scenario itself was too complicated, and the later switch to the table-top context often awakened participants' interest in experimental sessions. In future, studies should attempt to implement a less elaborate context and one involving less activity with the novel object once selected. Also, the magic context was not applicable to Phase 3 test sessions; a new procedural context in which both B-A and B-C tests can be incorporated would be advantageous. Further, the modification of the carrier phrase in which the target word was presented on A-B exposure trials did nothing to facilitate acquisition of the target relations.

As the implementation of exemplar training in Studies 3 and 4, and the implementation of the new context and modified carrier phrases in the present study, did little or nothing to facilitate participants' performances on test trials, the present line of investigation was ended here. It was felt that little else could be done to simplify the experimental context, and make the procedure more engaging, for participants of this age within the time constraints.

A final study was conducted which comments in depth on an element of the procedure given relatively little attention in previous studies: the exposure learning of novel word-referent relations following unreinforced exclusion/fast mapping exposure trials. Thus far exclusion exposure trials have been relatively ineffective in producing acquisition of the target relations. This may have been a result of the presentation of these trials late in the general procedure. This is investigated in Study 5.

CHAPTER 8

STUDY 5

EXPOSURE LEARNING OF MULTIPLE NOVEL RELATIONS: FAST MAPPING/ EXCLUSION EXPOSURE TRIALS

Chapters 1 and 2 outlined research that has been conducted to investigate the exposure learning of novel stimulus relations following fast mapping/exclusion trials in both cognitive/developmental psychology and behaviour analysis. As a result of such research, authors have made two claims regarding exposure learning following fast mapping/exclusion trials.

First, fast mapping/exclusion is a robust phenomenon; virtually all participants over the cognitive age level of two years will select the novel comparisons on fast mapping/exclusion trials (e.g., see Wilkinson, McIlvane, & Dube, 1996, 1998). This is indeed what was found in the present series of studies. In Studies 1 to 3, in which unreinforced exclusion exposure trials and related control trials were presented, six of nine participants achieved criterion level. In Study 4, in which reinforced exclusion trials and related control trials were presented in the training phase, all six participants achieved criterion level on these trials. Thus, overall, in Studies 1 to 4, 12 of 15 participants responded reliably on exclusion and control trials.

Second, it is claimed by cognitive/developmental researchers that the ability to pass tests of fast mapping is related to the vocabulary spurt (e.g. Mervis & Bertrand, 1993, also see Chapter 1 and 2); that correct responding on fast mapping trials involves the acquisition of new word-referent relations. However, as was discussed in Chapter 2, correct responding on fast mapping/exclusion trials does not guarantee the acquisition of new items of vocabulary. This has been repeatedly demonstrated in behaviour analytic exclusion research in which it has been shown that, even in cases in which participants have responded at criterion level, or without error, on exclusion and control trials, not all of these will go on to pass subsequent learning outcome tests (e.g., Dixon, 1977; McIlvane & Stoddard, 1981, 1985).

Indeed, this has been the general trend in the present series of studies. In Studies 1 to 3, six participants achieved criterion level on A-B exclusion exposure trials and related control trials; however, only two of these passed subsequent B-A learning outcome tests, and only one of these did so reliably (i.e., maintained criterion level performance over three sessions). Further, in Study 4, exclusion trials and control trials were employed as a method for training B-A relations (i.e., correct responses on exclusion and control trials were reinforced). All six participants who received this training responded at criterion level on both exclusion trials and related control trials; however, only one of these participants went on to pass subsequent learning outcome tests. Thus, overall, whilst 12 participants achieved criterion level on exclusion and control trials, only three passed subsequent learning outcome tests.

The findings of Studies 1 to 4 thus question the above proposition. However, it is noted that in Studies 1 to 3, exclusion exposure trials and related control trials were presented at the end of Phase 2 following unreinforced non-ostensive and ostensive exposure trials and related learning outcome testing; in Study 4, these were presented following non-ostensive exposures and learning outcome testing, and prior B-A training procedures. It is possible that the participants may have passed subsequent learning outcome tests had they not received the prior extended history of unreinforced testing. Had exclusion trials and control trials been conducted at the outset of these studies, participants may have performed better on learning outcome tests. This is investigated in the present study.

In Study 5, participants were given only exclusion exposure trials and related control trials of two novel relations from the outset of testing; the necessity of the exposure and testing of multiple relations was outlined in Chapter 2 and was confirmed by participants' performances in Study 1. The procedural specifics for these trials remained the same as exclusion exposure and control trials presented in Phase 2 of Studies 1 to 3. Acquisition of these relations was assessed with unreinforced learning outcome tests: these were auditory-visual matching-to-sample trials identical to the B-A test trials conducted in Studies 1 to 3.

In cases in which participants failed to achieve criterion level responding on exclusion exposure and control trials in the present study, a number of modifications to the procedure were implemented in order to bring their responses under control of the auditory samples. In addition, in cases in which participants achieved criterion level on these trials, but failed to pass learning outcome tests, a procedure of successive introduction of the target relations was introduced; such a procedure has been proposed to facilitate learning under such conditions (Wilkinson & Green 1998; Wilkinson & McIlvane, 1994; Wilkinson et al., 1996; see Chapter 2, Section 2.3.2).

In summary, Study 5 investigated the exposure learning of multiple novel word-referent relations following fast mapping/exclusion exposure trials in a tightly controlled context. Specifically, this study was designed to assess the robustness of the phenomenon and to determine whether acquisition of the target relations is a robust outcome of correct responding on these trials.

METHOD

Participants

Seven preschool children, ranging in age from 21 to 27 months, were recruited from Clebran Private Day Nursery in Llandudno, North Wales (see Table 8.1). Written informed consent for their participation was obtained from their parents/guardians following the receipt of a letter detailing the aims and procedures of the study (see Appendix A). Prior to the commencement of the study each participant's receptive and expressive vocabulary was assessed by the use of the MacArthur Communicative Development Inventory: Words and Gestures (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick, & Reilly, 1993); this was in order to select familiar auditory-visual relations for use in experimental sessions. This also provided an assessment of participants' expressive and receptive vocabulary levels (see Table 8.1).

Table 8.1

Participants' gender, age and MCDI scores at the start of the study.

Participant	Gender	Age at start Months:days	MCDI receptive	MCDI expressive
JT	F	21:24	311	255
BT	M	23:22	323	150
CM	M	24:04	325	79
EJ	F	24:26	198	146
LN	F	25:03	395	395
RR	M	25:21	261	135
IW	M	27:01	353	250

Note. M=Male; F=Female.

From the responses on the MCDI it was ensured that each of the participants were post-vocabulary spurt. The criterion for classifying participants as having undergone the vocabulary spurt was the acquisition of at least 50 words in production; this criterion is typically employed by a number of cognitive/developmental researchers (e.g., Mervis & Bertrand, 1994; Woodward, Markman, & Fitzsimmons, 1994).

Prior to the commencement of the study, the experimenter (E) spent several informal sessions interacting with each participant within the nursery environment in order that the participants were familiarised with the surroundings and E.

At the end of the study, each participant's parents/guardians were debriefed as to the aims and procedures employed, and their child's performance throughout the study; this was by personal letters sent to parents/guardians regarding only their own child's performance.

Apparatus and Materials

Setting and Apparatus

Sessions were conducted between one and five times per week, dependent upon the participant's attendance at the nursery. All experimental sessions were conducted in a research room provided at Clebran Day Nursery. This was equipped with a childsize table and two childsize chairs. All other furniture and toys were removed from the room, where possible, in order to minimise distractions. In order to allow post-session analysis, and reliability assessment, all sessions were video recorded. To this end the room was equipped with a portable video camera (Panasonic M10) mounted on a tripod; this was installed in the corner of the room so that an unobscured view of E and participant was provided.

A set of pre-prepared record sheets was required for each participant. For each session, an appropriate record sheet detailed the order of presentation of auditory samples and positions of visual comparisons for all trial types per session. Throughout the session the participants' responses were recorded by E who marked their comparison selections on the relevant record sheet.

A selection of children's toys were required to engage the participants during intervals between trials, and for participants to play with freely at the end of each session. The participants were also given small stickers or stars at the end of each session as a reward for their general cooperation and attention; the presentation of these was never contingent upon their performance on test trials within the session.

Familiar Stimuli

Familiar visual stimuli consisted of plastic farm animals; these comprised a pig (10 cm x 5 cm), a cow (12.5 cm x 6.5 cm), a horse (12.5 cm x 9.5 cm), and a rabbit (6 cm x 5 cm). Familiar auditory stimuli consisted of their corresponding conventional names. Their familiarity to each participant, in terms of expressive and receptive vocabulary, was determined in a free play session, and from their parents/guardians' responses on the MCDI parental vocabulary checklist. Where stimuli were found to be unfamiliar to the participants, the auditory-visual relations were substituted (e.g., sheep, dog).

Novel Stimuli

Novel visual stimuli. Novel visual stimuli consisted of a variety of three-dimensional multi-sensory objects, namely: a multi-coloured plastic "Slinky spring" (7.5 cm x 6.5 cm); a triangular "Galt Pocket Alarm", that produced flashing lights and sounds when its button was pressed (4 cm x 4.5 cm); a pink and white concertina snail, that produced a squeak when depressed (4.5 cm x 19.5 cm); a multi-coloured "Koosh ball", made of thick red, yellow, or blue elastic strands (10 cm in diameter); a white "Koosh ball" made of fine silken elastic strands (9 cm diameter); and a cylindrical "Giggle stick" that simulated a laughing sound when it was shaken up and down (17.5 cm x 2.5 cm). These objects were selected in order that they were novel and appealing to the participants, were visually distinct from one another, and were easily manipulable by participants of this age range. Two of these objects were selected as the novel visual stimuli for each participant.

Novel auditory stimuli. The novel auditory stimuli consisted of the nonsense words "Tak" [tak], "Bosch" [bɔʃ], "Kiekie" [kiki], and "Os" [ɔz] (Lipkens, Hayes and Hayes, 1993). These nonsense words were selected in order that they were novel to the participants, were distinct from one another, and were easily pronounceable. Two of these auditory stimuli were selected for each participant and were related arbitrarily to each of the two novel visual stimuli. (Typically, "Tak" and "Bosch" were initially selected as novel auditory samples for each participant.)

Procedure

General Procedure

The general procedure was divided into two phases (each of which are described in detail later). In Phase 1, pre-testing, novel visual stimuli were selected for each participant, and it was verified that the participants possessed the prerequisite skills for responding on auditory-visual matching-to-sample trials.

In Phase 2, the participants were exposed to two novel auditory-visual relations through exclusion exposure trials, and were tested for the subsequent acquisition of these relations through learning outcome trials. Phase 2 was divided into two sub-phases: Phases 2.1 and 2.2. In Phase 2.1, the exposure of the novel relations was conducted through the use of traditional exclusion trials, interspersed with control trials; in Phase 2.2, modified exclusion exposure trials were employed.

All trial types in the study were presented in a matching-to-sample format, and comprised the presentation of an auditory sample and two visual comparisons (see Table 8.2). These trials were conducted using the following procedure.

The participant and E were seated opposite each other at the table. On each trial the participant was presented with two visual comparisons that were placed on the table before him or her. As these were being placed down the auditory sample was presented, dictated by E (in the carrier phrase appropriate to the individual participant), and he or she was requested to select the correct corresponding comparison. For example, the participant was asked, "Where is the X?" or, "Which one is the X?" (where X was the auditory sample). Questions were asked at least twice on each trial before the participant was permitted to respond, thus maximising the participant's attention to the auditory stimulus.

Table 8.2

Matching-to-sample trial types presented in Study 5.

		Comparisons	
Trial type	Sample	S+	S-
Baseline	"Pig"	pig	cow
Control	"Pig"	pig	tak
	"Cow"	cow	bosch
Exclusion	"Tak"	tak	pig
	"Bosch"	bosch	cow
Learning outcome	"Tak"	tak	bosch
	"Bosch"	bosch	tak

On all trial types the participants were required to manually indicate a clear and unambiguous choice between the two visual comparisons. If the participants distinctively selected one comparison followed by the other remaining comparison, their first response was recorded. In cases in which the participants selected both comparisons simultaneously, the comparisons were removed and the trial was reconducted until a clear and codeable response was provided. Once the participants produced an unambiguous response the comparisons were removed from the table and the next trial was conducted. If the participants failed to make a codeable response on the third repetition of a trial, that particular trial was abandoned, the visual stimuli were removed, and the next trial was conducted.

Within all sessions the position of comparisons was counterbalanced, across all trials per session, in order that visual stimuli appeared as correct and incorrect comparisons, with equal frequency, in both left and right hand positions. This served to discourage the emergence of preferential responding.

All matching-to-sample trial types were unreinforced (exceptions to this are noted in the 'Modifications to the general procedure' section). Exclusion exposure trials were unreinforced in order to provide mere exposure to, as opposed to training of, the novel auditory-visual relations. All learning outcome trials were unreinforced in order to assess acquisition of the novel relations.

Phase 1. Pre-testing

1.1. Free play session. A free play session was conducted in order to confirm that the novel stimuli were unfamiliar to the participants. The six novel objects were presented to the participants in an informal setting and they were encouraged to play freely with them. The participants' verbal and non-verbal behaviours were observed in order to determine whether they consistently labelled any of the objects, and to identify the existence of stimulus preferences. From this session two novel visual stimuli, that were equally appealing to the participants, were selected for use in Phase 2.

1.2. Baseline pre-testing sessions. In order to familiarise the participants with the procedures to be employed throughout the study, and to ensure that they were able to respond correctly on matching-to-sample trials, a baseline pre-testing session was conducted. In this session the participants were presented with a minimum of 12 baseline trials: matching-to-sample trials of the familiar auditory-visual relations (see Table 8.2). All baseline trials were unreinforced.

This session was repeated, where necessary, until the baseline pre-testing criterion was achieved: at least 80 percent correct responding within one baseline pre-testing session (i.e., one block of 12 baseline trials).

Where the participants failed to achieve the baseline pre-testing criterion, correct responses on baseline trials were rewarded with verbal praise and applause from the experimenter. Once the baseline criterion level had been achieved, then these rewards were gradually removed and baseline pre-testing sessions were repeated until criterion level was satisfied in the absence of feedback and rewards.

Phase 2.1. Traditional Exclusion Exposures and Learning Outcome Testing

In Phase 2.1, the participants were exposed to two novel auditory-visual relations, and their subsequent acquisition of these relations was assessed with learning outcome trials.

Exclusion exposure sessions. Participants were exposed to the novel relations through the use of exclusion trials. At the beginning of each session the participant was allowed to play freely with the novel visual stimuli; this was in order to minimise preferential responding later in the session. In each session a minimum of four trials was presented, with sessions predominantly consisting of a total of eight trials.

Within each session, half of the trials were exclusion exposure trials (see Table 8.2), in which the sample was a novel auditory stimulus, and the comparisons were the corresponding novel visual stimulus (S+) and one familiar visual stimulus (S-). Exclusion trials consisted of equal numbers of trials of each novel relation (i.e., equal numbers of trials in which "Tak" and "Bosch" were presented as the auditory samples).

The remaining half of the trials in each session were control trials (see Table 8.2), in which the sample was a familiar auditory stimulus, and the comparisons were the corresponding familiar visual stimulus (S+) and one novel visual stimulus (S-).

Learning outcome sessions. In each session the participants were presented with a minimum of 12 learning outcome trials in which the sample presented was a novel auditory stimulus, and the comparisons were the two novel visual stimuli (see Table 8.2). Each novel auditory stimulus was presented as a sample on half of the trials, so that there were an equal number of learning outcome trials of each novel relation within each session.

Phase 2.2. Modified Exclusion Exposures and Learning Outcome Testing

The general procedure described above was employed for all participants. In Phase 2.2, interventions were implemented in cases in which individual participants failed to respond correctly on exclusion exposure trials and control trials, or failed to produce evidence of learning outcome. The interventions were as follows.

Stimulus aversion. Some of the participants demonstrated an aversion to the selection of types of visual comparisons. For example, RR demonstrated an aversion to familiar comparisons on exclusion and control trials, and BT, in contrast, exhibited an aversion to novel comparisons on exclusion and control trials. A number of procedures were implemented, in succession, in order to establish correct responding.

Contrast trials. The first intervention was that of contrast trials. These involved the manipulation of the carrier phrase in which the auditory sample was dictated. On trials in which the participants were requested to select their aversive stimulus, the request was presented in contrast to their preferred stimulus. For example, in RR's case, on control trials he was requested, "Where is the [familiar], not the [novel], where is the [familiar]." For BT, who demonstrated an aversion to novel comparisons, the reverse was used: on exclusion trials he was requested, "Give the [novel], not the [familiar], give the [novel]." Once correct responding was established, and the aversion overcome, traditional exclusion exposure trials or control trials were then presented. If responding remained at criterion level on these trials then learning outcome trials were presented.

Directly demonstrative trials. The second intervention implemented was that of directly demonstrative trials. On trials in which the participants' aversive stimulus was the correct comparison , they were requested to select the comparison that was directly indicated by E. That is, E would request, "Give me this one," and point to the correct comparison. Thus the participant need only attend to E's demonstration of the correct response. Once the participant responded at criterion level, selecting all visual stimuli with equal frequency, traditional exclusion and control trials were again presented. Once criterion level responding was established on traditional exclusion and control trials, learning outcome trials were presented.

Ostensive trials. If the two previous interventions failed to produce criterion responding on traditional exclusion and control trials, then a third was implemented. Here ostensive exclusion or control trials substituted the trial type where the aversive stimulus was the correct comparison. For example, if the participant exhibited a novel stimulus aversion, then on exclusion trials the participant would be requested, "Give me the [novel],"; this request was accompanied, simultaneously, by E's manual indication of the correct comparison. Once criterion level responding was achieved on ostensive exclusion or control trials, traditional exclusion and control trials were again presented. When criterion level was achieved on traditional exclusion and control trials, learning outcome trials were also presented.

Substitution of one novel relation. In contrast to BT and RR, participant CM exhibited a different stimulus aversion: he demonstrated an aversion to only one visual stimulus on both exclusion and learning outcome trials, that corresponding to "Tak". As a result, this relation was substituted with a further novel relation -- "Kiekie". Thus, for CM, the two novel relations consisted of "Bosch" and "Kiekie" in Phase 2.2 of the study.

Rewarded exclusion and control trials. If participants failed to achieve criterion level on exclusion and control trials, then correct responding on these trials was rewarded with verbal praise and applause provided by E. Once criterion level responding was achieved learning outcome trials were presented.

Successive introduction of novel relations. In cases in which the participants had demonstrated criterion level responding on exclusion and control trials, yet failed to achieve criterion level on learning outcome trials, a procedure of successive introduction of the novel relations was employed. This was adapted from a procedure employed by Wilkinson and McIlvane (1994). Here, the participants were initially exposed to only one of the novel relations using traditional exclusion exposure trials. Thus exclusion exposure sessions consisted of equal numbers of control trials and traditional exclusion exposure trials of only one novel relation (e.g., where "Tak" was the first novel relation exposed, all exclusion exposure trials involved the presentation of "Tak" as the novel auditory stimulus and a familiar object (S-) and the corresponding novel object (S+) as comparisons). The second novel relation was then introduced in contrast to the first, in the form of learning outcome trials (e.g., the second novel relation -- "Bosch" -- was introduced in trials where "Bosch" was presented as the novel auditory stimulus, and the two novel objects [corresponding to "Bosch" (S+) and "Tak" (S-)] as comparisons).

Set 2 stimuli. In cases in which the participants achieved criterion level responding on exclusion exposure trials and control trials, yet failed to demonstrate learning outcome, the procedure was repeated with new stimulus sets; these comprised two further novel visual stimuli and the corresponding novel auditory stimuli.

Participants' Vocalisations

The participants' informal vocalisations of the novel words throughout experimental sessions were recorded. In particular, the context in which the utterance occurred, the objects present at the time, and the surrounding discourse were noted in order that vocalisations could be classified into one of three main categories: spontaneous labelling, prompted labelling, echoing. These categories are described in detail in Study 1 (see Chapter 4, method section).

RESULTS

The participants' performances in Phase 1 of the study are initially presented. Following this, their performances in Phase 2 are summarised individually. Participants' performances on each trial type, and their informal vocalisations of the target words, throughout each experimental session are detailed in Appendix L.

Phase 1. Pre-testing

1.1. Free Play Session

Participants' verbal and non-verbal behaviours confirmed that the objects were unfamiliar to them. Further, stimulus preferences were identified and two objects that were equally appealing were selected as the target visual stimuli for each participant.

1.2. Baseline Pre-testing Session

Participants' performances in the baseline pre-testing sessions are presented in Table 8.3. Five of the participants -- JT, IW, LN, RR, and, CM -- progressed to Phase 2 having achieved the baseline criterion level in the absence of feedback or reinforcement for correct responding.

Participant BT also progressed to Phase 2 of the study following 10 baseline pre-testing sessions. Although he performed with 100 percent accuracy in the second session, his responses were frequently ambiguous and trials were often repeated. Thus a further three sessions were conducted in which his responding dropped below criterion level. As a result, three additional sessions, Sessions 6 to 8 inclusive, were presented in which correct responses on baseline trials were rewarded. As his responding increased above criterion level in these sessions, the rewards were gradually phased out. In the final two sessions, BT satisfied the baseline pre-testing criterion level in the absence of feedback and rewards.

Participant EJ failed to achieve criterion for progression to Phase 2. Although she performed above criterion level in two consecutive sessions, further sessions were conducted as her responses were frequently ambiguous and necessitated the repetition of many baseline trials. In the subsequent sessions her performance declined further, and her general level of attention and interest also declined progressively. As a result, she took no further part in the study.

Table 8.3

Participants' performances in baseline pre-testing sessions. (Bold text denotes sessions in which criterion level was achieved.)

	Baseline pre-testing sessions (Percentage of correct responding)									
Participant	1	2	3	4	5	6	7	8	9	10
EJ	76.9	66.6	**83.3**	**83.3**	66.6	66.6	-	-	-	-
JT	**83.3**	**82.4**	**91.6**	-	-	-	-	-	-	-
BT	66.6	**100**	75	66.6	41.6	**100** *	**83.3** *	**100** *	**91.6**	**100**
IW	**91.6**	**100**	-	-	-	-	-	-	-	-
LN	**100**	-	-	-	-	-	-	-	-	-
RR	**83.3**	**100**	-	-	-	-	-	-	-	-
CM	**83.3**	**83.3**	**91.6**	-	-	-	-	-	-	-

Note. * denotes baseline pre-testing sessions in which trials were rewarded.

Participants' Performances in Phase 2

Participants' performances in Phase 2 of the study are summarised individually. (Participants' responses in individual experimental sessions are presented in Appendix L.)

Participant JT

In Phase 2.1, JT achieved criterion level on both exclusion exposure trials and control trials. Despite this, she did not pass the subsequent learning outcome tests; she exhibited a stimulus preference. Her informal vocalisations also indicated that she may have formed her own labels for the novel visual stimuli.

In Phase 2.2, the procedure was repeated with Set 2 stimuli. Although JT responded without error on both exclusion trials and control trials, she failed to achieve criterion level on the related learning outcome trials.

Participant IW

In Phase 2.1, IW, although performing without error on control trials, did not achieve criterion level on exclusion exposure trials. Not surprisingly, he also failed to achieve criterion level on the subsequent learning outcome tests.

In Phase 2.2, the novel relations were introduced in succession. In the initial two sessions IW did not satisfy criterion level on 'Bosch" exclusion trials, despite responding without error on related control trials. As a result, correct responses on exclusion and control trials were rewarded in the remaining three sessions; in these, he achieved criterion level on both trial types. Despite this, IW continued to fail subsequent learning outcome tests. IW's inconsistent use of the novel words in his informal vocalisations further confirmed that he had not acquired the target relations.

Participant LN

In Phase 2.1, LN achieved criterion level on both traditional exclusion exposure trials and control trials. She did not, however, pass subsequent learning outcome tests; in these sessions she exhibited a strong stimulus preference. Although she echoed the target words throughout this phase she rarely labelled the novel objects.

In Phase 2.2, the novel relations were introduced in succession. In the initial exclusion exposure sessions LN failed to achieve criterion level on both exclusion exposure trials and control trials. When rewards for correct responding were introduced, she performed at criterion level on control trials whilst responding on exclusion trials remained below criterion. As was expected, LN did not pass the learning outcome test presented at the end of this phase.

Participant BT

Although achieving criterion level on control trials in Phase 2.1, BT did not respond above criterion level on exclusion exposure trials; he exhibited a novel stimulus aversion.

In Phase 2.2, a number of modified exclusion trials were presented in order to eliminate BT's stimulus aversion. Contrast exclusion trials did not serve to efficiently encourage BT to select the novel visual stimuli and were thus abandoned. Both directly demonstrative exclusion trials and ostensive exclusion trials were subsequently presented; whilst BT responded above criterion level on both of these modified exclusion trial types, the effect failed to be maintained on traditional exclusion exposure trials presented subsequently; thus BT's novel stimulus aversion was not eliminated.

Participant RR

Although RR responded above criterion on exclusion exposure trials, he failed to achieve criterion on control trials; he exhibited a familiar stimulus aversion. Thus in Phase 2.2, two interventions were implemented in order to encourage RR to select the familiar visual stimuli on control trials. Both the interspersion of baseline trials, and the presentation of contrast control trials, failed to eliminate RR's stimulus preference; he continued to select the novel visual stimuli on the majority of control trials.

Participant CM

In Phase 2.1, CM, although responding above criterion level on control trials, failed to achieve criterion level on exclusion exposure trials, and predictably, on subsequent learning outcome trials. This appeared to be a result of an aversion for one of the novel visual stimuli.

As a result, in Phase 2.2 the aversive stimulus ('Tak') was removed and CM was given exposures to the remaining novel relation and a further new one. Initially these were introduced successively, with 'bosch' being exposed first and the new relation -- 'kiekie' -- being introduced in contrast to this in learning outcome sessions. CM responded above criterion level on 'bosch' exclusion trials, but did not show learning outcome of the novel relations. As no stimulus aversion was evident, these relations were then introduced in traditional exclusion exposure sessions. Again, CM responded above criterion on both exclusion and control trials. However, he failed to demonstrate acquisition of the target relations on subsequent learning outcome tests.

Summary of Results

Phase 2.1. Traditional Exclusion Exposure and Learning Outcome Testing

Six participants were given traditional exclusion exposure trials and control trials, and were tested for subsequent learning outcome of the novel relations in Phase 2.1. Their performances on these trial types are shown in Table 8.4.

Two of the six participants -- JT and LN -- achieved criterion level on both exclusion and control trials; thus indicating that their responses were controlled by the auditory stimuli presented. Despite this, neither of these participants passed the subsequent learning outcome tests, and thus failed to demonstrate evidence of acquisition of the novel relations following exclusion exposure trials; both LN and JT exhibited a stimulus preference on learning outcome trials, and, in addition, JT appeared to have formed her own names for the novel visual stimuli.

Table 8.4

Participants' performances on test trial types in Phase 2.1.

	Performance on test trial types			
Participant	Exclusion	Control	Learning outcome	Patterns of responding identified
JT	✓	✓	x	stimulus preference
IW	x	✓	x	-
LN	✓	✓	x	stimulus preference
BT	x	✓	-	novel stimuli aversion
RR	✓	x	-	familiar stimuli aversion
CM	x	✓	x	aversion to one novel stimulus

The remaining four participants did not achieve criterion level on both exclusion and control trials. Participants BT and RR exhibited stimulus aversions to the novel visual stimuli and the familiar visual stimuli respectively, thus they were not given learning outcome trials. Participant CM exhibited an aversion to one of the novel visual stimuli on both exclusion and learning outcome trials, and thus failed to achieve criterion level on both. The remaining participant -- IW -- did not satisfy criterion level on exclusion trials, and also, predictably, failed to pass subsequent learning outcome tests.

Phase 2.2. Modified Exclusion Exposure and Learning Outcome Testing

With one of the participants -- JT -- the procedure was repeated with new sets of stimuli; again she achieved criterion level on both exclusion and control trials but did not pass subsequent learning outcome tests.

Participants IW and LN were introduced to the novel relations in succession in Phase 2.2, and produced similar patterns of responding. IW initially failed to achieve criterion level on exclusion trials, thus correct responses on these trials were rewarded in subsequent sessions. With the inclusion of rewards IW achieved criterion level on both exclusion exposure trials and control trials, but did not pass learning outcome tests. LN initially failed to achieve criterion on both exclusion exposure trials and control trials. With the inclusion of rewards for correct responses she satisfied criterion on control trials but not exclusion exposure trials; predictably, she also failed the learning outcome tests.

BT and RR were given modified exclusion and control trials, respectively, in order to eliminate their stimulus aversion. Whilst these trials encouraged BT to select his aversive stimuli on modified exclusion trials, the effect was not maintained on traditional exclusion exposure trials, and thus his stimulus aversion was not eliminated. In RR's case, even the modified control trials did not encourage him to select his aversive stimuli. Learning outcome tests were not given to either of these participants in Phase 2.2.

CM's aversive stimulus was replaced and the novel relations were first introduced in succession and then in traditional exposure sessions. In both of these procedures CM achieved criterion level on exclusion and control trials, but failed to pass the subsequent learning outcome tests.

DISCUSSION

Participants' performances on exclusion exposure and control trials are initially discussed. Next, participants' performances on learning outcome trials are discussed with respect to the exposure learning of novel word-referent relations following exclusion exposure trials.

Initially, in Phase 1, all but one of the participants achieved the baseline criterion level, thus verifying the prerequisites for responding on auditory-visual matching-to-sample trials. Subsequent failure to achieve criterion level on test trial types cannot therefore be attributed to a failure to understand the demands of the task itself.

First, In Phase 2.1, participants were given traditional exclusion exposure trials, and related control trials, of two novel auditory-visual relations. Of the six participants who received these trials, only two achieved criterion level on both exclusion exposure trials and control trials (one of these participants also did so in a second repetition of the procedure).

Second, learning outcome tests were conducted in order to determine whether correct responding on exclusion/fast mapping trials is sufficient to give rise to acquisition of the novel word-referent relations. In the present study, none of the participants who achieved criterion level on exclusion exposure trials and control trials passed subsequent learning outcome tests; this was the case whether traditional, modified, or reinforced exclusion trials were conducted. These data are consistent with participants' performances in Studies 1 to 4: of 12 participants in these studies who achieved criterion level on exclusion trials and control trials, all but three failed subsequent learning outcome tests. These results are thus consistent with behaviour analytic research that has shown that correct responding on exclusion trials does not guarantee a subsequent learning outcome of the exposed relations (e.g., Dixon, 1977; McIlvane & Stoddard, 1981, 1985). These data sound a warning to cognitive/ developmental researchers who claim to have shown that young normally developing children are able to pass comprehension tests following above chance performance on fast mapping trials (e.g., Golinkoff et al., 1992; Mervis & Bertrand, 1994). As stated in Chapter 2, such studies lacked controls that permit conclusions regarding real word learning to be drawn; the present study, in contrast, provided a more controlled test of the exposure learning of novel stimulus relations following exclusion exposure trials. Thus the present results question the proposition that the ability to pass tests of fast mapping is related to the rapid acquisition of vocabulary (cf., Mervis & Bertrand, 1994); this is because participants' performances in the present study do not demonstrate the acquisition of specific items of vocabulary following exclusion exposure trials.

The results of the present study thus confirm that the participants' failure to achieve criterion level on exclusion exposure trials and control trials, and related subsequent learning outcome testing, in Studies 1 to 4 was not artefactual: this was not a result of the administration of these trials at the end of an extended period of unreinforced testing. Participants demonstrated such patterns of responding from the outset of testing in the present study.

Also of interest in the present study was the possible facilitative effect of the successive introduction of the target novel relations (Wilkinson, Dube, & McIlvane, 1996). In the present study, this procedure was implemented for three participants who initially failed to pass learning outcome tests in Phase 2.1; such a procedure has been proposed to facilitate learning by reducing the amount of information to be processed within experimental sessions (Wilkinson & McIlvane, 1994). In each case, this did not serve to improve responding on learning outcome trials. For IW and CM, successive introduction of the novel relations served no added benefit for learning outcome despite their criterion level responding on exclusion and control trials; for LN, this procedure even appeared to impair her performance on exclusion trials. It is possible that a successive introduction procedure may facilitate performance if implemented from the outset of testing. In the present study this was introduced only in Phase 2.1, following traditional exclusion exposure sessions; perhaps the discrepancy between exposure trials presented in these sessions (i.e., the reduction in the number of relations exposed within one experimental session) confused participants and hindered their performance.

As was observed in Studies 1 to 4, in the present study patterns of preferential responding were identified. In particular, stimulus preferences/aversions were prevalent and were pervasive; this was also noted in the training phase of Study 4. Almost all of the participants in the present study demonstrated a stimulus aversion/preference at some stage. Despite the inclusion of various modified exclusion trials, participants' preferences were not eliminated; although these trials served to mask such preferences, criterion level responding was not maintained on subsequent traditional exclusion trials. Such preferential responding has been evidenced with both animate and inanimate objects in the present series of studies; this is despite pre-testing in which stimulus preferences were identified and preferred visual stimuli substituted.

In summary, the results of the present study question the proposition that the ability to respond accurately on fast mapping trials is related to the vocabulary spurt; that correct responses on fast mapping/exclusion trials guarantee acquisition of the novel word-referent relations exposed. None of the participants who achieved criterion level on exclusion and control trials in the present study demonstrated subsequent learning outcome -- acquisition -- of the novel word-referent relations. These results were consistent with participants' performances in Studies 1 to 4.

CHAPTER 9

GENERAL DISCUSSION AND CONCLUSIONS

The present series of studies adopted a cross-disciplinary approach employing paradigms and methodologies from cognitive/developmental psychology and behaviour analysis. Cognitive/developmental researchers have developed paradigms to study the exposure learning of novel word-referent relations following unreinforced exposures presented in non-ostensive, ostensive, and fast mapping contexts (e.g., Carey & Bartlett, 1978; Tomasello & Barton, 1994; Woodward, Markman, & Fitzsimmons, 1994). Similarly, behaviour analysts have developed paradigms and methodologies that are of relevance to the exposure learning of novel stimulus pairings, and have also provided evidence to suggest that children are able to derive emergent relations from unreinforced exposures (e.g., Lipkens, Hayes, & Hayes, 1993; Smeets, Leader, & Barnes, 1997). The results of studies employing these paradigms have led authors to suggest that such exposure learning is an efficient method of acquiring new vocabulary; that children are able to learn the correspondences between new words and their referents from limited exposures in situations in which reinforcement is not provided for their appropriate responding.

However, in Chapters 2 and 3, numerous methodological criticisms were levelled at previous exposure learning research conducted within both traditions. These pertain to the paucity of methodological control employed and bring into question the validity of the data generated from these studies. As a result, the authors' conclusions regarding real word learning are rendered equivocal.

In addition to the methodological limitations of these studies, a further fundamental criticism was levelled at the cognitive/developmental research: even if participants in these studies were to demonstrate the emergence of new auditory-visual relations, there is no evidence that the relations acquired are symbolic and thus possess linguistic properties (see Schafer & Plunkett, 1998; Woodward et al., 1994). Behaviour analytic studies of stimulus equivalence provide an experimental methodology for assessing symbolic responding. However, studies of this kind conducted with young normally developing children have been limited in number and poorly controlled (see Chapter 3 for a discussion of this issue).

The present series of studies thus attempted to provide answers to two questions.

First, can young children demonstrate the acquisition of specific word-referent relations from non-ostensive, ostensive, or fast mapping/exclusion exposures in stringently controlled conditions?

Second, in cases in which such learning is unequivocally evidenced, are the relations acquired symbolic; are they equivalence relations?

The results of the present series of studies are addressed below with reference to these research questions.

9.1. Exposure Learning of a Single Novel Relation in Stringently Controlled Conditions

In virtually all the cognitive/developmental research conducted authors have investigated young children's acquisition of a single novel relation. The results of such studies have led authors to claim that young children are able to demonstrate immediate comprehension of a new word from very limited unreinforced exposures presented in non-ostensive, ostensive, and fast mapping contexts (e.g., Mervis & Bertrand, 1994; Tomasello et al., 1994, 1996; Woodward et al., 1994).

However, these claims are contentious. The paucity of methodological control employed in these studies leads one to question whether participants' accurate responses on comprehension test trials are false positive responses, and, in particular, whether participants have acquired a one-to-one relation between the specific target word and referent exposed. In order to demonstrate real word learning, it was stated in Chapter 2 that necessary controls must be implemented in order to eliminate experimenter cueing, to assess false positive responses as a result of patterns of unreinforced conditional selection (URCS) or preferential responding, and to demonstrate unequivocally that participants' accurate responses on comprehension test trials are the result of the acquisition of specific one-to-one mappings (see Chapter 2). These controls were implemented in Study 1, in which the acquisition of a single novel word-referent relation was assessed in stringently controlled conditions.

Specifically, in order to determine that participants had acquired a specific one-to-one mapping between the novel auditory and visual stimulus, target and control trials of each test trial type were conducted. In Chapter 2, it was argued that participants may produce false positive responses on comprehension tests by selecting the target visual stimulus because it was the only one previously labelled by the experimenter. Similarly, they may produce the target word on naming tests simply because it is the only novel word previously produced by the experimenter. In order to rule out such false positives one must ensure that participants do not select the target visual stimulus on control trials -- distracter comprehension test trials in Study 1 -- in which the auditory sample is a novel word other than the target name. Similarly, one must ensure that participants do not produce the target name on control trials in which they are requested to label a distracter novel visual stimulus -- distracter naming test trials in Study 1. These necessary controls, along with more general controls for the elimination or assessment of experimenter cueing and false positive responding on the basis of URCS, were implemented in Study 1. This study thus attempted to answer the following question: can young children demonstrate exposure learning of a single novel word-referent relation in stringently controlled conditions?

Four participants were given at least seven impending word non-ostensive exposures, ostensive exposures, and fast mapping/exclusion exposures to a single novel relation. One participant failed comprehension tests following non-ostensive exposure trials alone. The remaining three participants failed to achieve the required criterion pattern of responding on comprehension tests and naming test trials following each exposure trial type.

The results were thus inconsistent with claims made by cognitive/developmental researchers that young children are able to acquire novel word-object relations following such unreinforced exposures (e.g., Mervis & Bertrand, 1994; Tomasello & Barton, 1994; Woodward et al., 1994). However, given the paucity of methodological control employed in such cognitive/developmental studies, the results were not entirely unexpected.

As stated earlier, false positive responses may account for participants' accurate comparison selections on comprehension test trials in studies in which a single novel relation is exposed. Indeed, this appears to be the case. Empirical support for this claim was provided by TW's performances on comprehension and naming test trials in Study 1. Following ostensive exposure trials, TW selected the target visual stimulus on 66.6 percent of target comprehension test trials. This response accuracy exceeded the 33.3 percent chance level in Study 1, and would have satisfied Woodward et al.'s criterion for acquisition of the target relation. However, on closer inspection it is evident that TW had not, in fact, acquired the target relation. He also selected the target visual stimulus on 86.6 percent of distracter comprehension test trials, thus indicating that his responses on target trials were not controlled by the target word. Instead, it appeared that he simply selected the only visual stimulus to have been previously labelled by the experimenter. This pattern of responding was also reflected in his performance in naming test sessions in which he produced the target word in response to requests to label both the target and distracter visual stimulus. Although CV did not demonstrate this pattern of responding on comprehension test trials, she did produce a pattern of responses similar to TW's on naming test trials.

The inclusion of the necessary controls in Study 1 thus confirmed that participants' comparison selections on comprehension test trials in studies in which a single novel relation is exposed can be false positive responses: participants may produce accurate responses by simply selecting the only novel visual stimulus to have been labelled within the course of the study. Even in cases in which control trials are presented, it was noted in Chapter 2 that participants may produce false positive responses across both target and distracter comprehension test trials by responding on the basis of shared familiarity -- matching the auditory and visual stimuli on the basis that they are equally familiar within the experimental context (see Chapter 2, Section 2.3). In order to control for such responding, multiple novel relations must be exposed concurrently and tested in juxtaposition such that tests of acquisition comprise learning outcome trials.

Moreover, if exposure learning is to be related to the rapid acquisition of vocabulary, then it is necessary to show that young children are able to acquire multiple new words simultaneously (see Bates, 1993b; Wilkinson, Dube, & McIlvane, 1996). Thus it seems that conclusions regarding the efficiency of exposure learning as a language acquisition strategy cannot be drawn from studies in which a single novel relation is exposed. As a result, in the remaining studies -- Studies 2 to 5 -- multiple novel relations were exposed concurrently and tested in juxtaposition in order to afford unequivocal conclusions regarding the exposure learning of new vocabulary.

9.2. Exposure Learning of Multiple Novel Relations in Stringently Controlled Conditions

Chapter 2 outlined a number of cognitive/developmental and behaviour analytic studies that have investigated the concurrent exposure and testing of multiple novel relations (Lipkens, Hayes, & Hayes, 1993; Lucariello, 1987; Ross, Nelson, Wetstone, & Tanouye, 1986; Schafer & Plunkett, 1998; Tomasello & Farrar, 1986; Whitehurst, Kedesdy, & White, 1982). Again, the authors of these studies claim that young children are able to demonstrate the immediate comprehension of new word-referent relations following limited unreinforced exposure trials presented in non-ostensive or ostensive contexts; no studies of the acquisition of multiple relations have been conducted in a fast mapping context, yet it is still claimed that this is an efficient method of acquiring new vocabulary (Mervis & Bertrand, 1993, 1994). However, like the single target relation studies, these were variously criticised for their paucity of methodological control. Patterns of false positive responding on comprehension test trials may have accounted for the significantly above chance responding produced by participants in these studies: again, false positive responses may be produced as a result of URCS or experimenter cueing. In order to demonstrate the acquisition of specific relations between the target stimuli, controls must be implemented in order to eliminate, or to assess, such responding. Thus, in Studies 2 to 5, these issues were addressed and the necessary controls were implemented in order to investigate young children's exposure learning of multiple word-object relations in stringently controlled conditions.

Studies 2 to 5 investigated the exposure learning of two novel relations, introduced concurrently and tested in juxtaposition, in controlled conditions. Again, exposures were presented in non-ostensive, ostensive, and exclusion/fast mapping contexts, and participants' acquisition of the novel relations was assessed following each exposure trial type. In order to determine whether participants acquired the word-referent relations, their performances' on B-A tests, following A-B non-ostensive exposure trials, A-B ostensive exposure trials, and B-A exclusion exposure trials are discussed.

Throughout Studies 2 to 5, five participants acquired the novel target relations. These participants demonstrated exposure learning following non-ostensive, ostensive, or fast mapping/exclusion trials.

In Study 2, one participant -- LS -- achieved criterion level on B-A test trials following ten impending word non-ostensive exposure trials; she was aged 31 months and 10 days when she passed this test. In addition, when she achieved criterion level on B-A tests, she demonstrated emergent labelling (A-B naming) of the novel objects. In Study 3, SR also demonstrated immediate acquisition of the target relations following non-ostensive exposures; he was aged 25 months and 18 days. He passed the first B-A test following only one impending word non-ostensive exposure trial of each of the novel relations.

One participant in Study 3 -- SB -- failed B-A tests following 14 non-ostensive exposure trials. However, he subsequently demonstrated acquisition of the novel relations following 36 ostensive exposure trials; he was aged 30 months and 1 day when he passed this test. In experimental sessions in which he achieved criterion level on B-A tests, he also demonstrated emergent labelling of the novel objects (A-B naming) in his informal vocalisations.

The remaining two participants to demonstrate exposure learning under controlled conditions did so following fast mapping/exclusion exposures in Study 3. Both TS and SJ failed to achieve criterion level on B-A test trials following 32 and 16 non-ostensive exposure trials respectively; similarly, they failed to pass B-A tests following 50 and 14 ostensive exposures respectively. In both cases, they also failed to pass A-B naming tests and did not accurately label the novel objects informally in these experimental sessions.

Both participants then went on to achieve criterion level on exclusion exposure trials and related control trials and subsequently passed B-A tests, thus demonstrating acquisition of the novel relations. TS passed B-A tests following eight exclusion exposure trials and was aged 32 months and 2 days; he also passed an A-B naming test during this sub-phase. SJ passed B-A tests, aged 30 months and 6 days, following 30 exclusion exposure trials. SJ received a greater number of exclusion exposures because he was given exclusion exposure trials alone, exclusion exposure trials interspersed with baseline trials, and finally, exclusion exposure trials interspersed with control trials. It was only when he achieved criterion level on exclusion exposure trials and related control trials that SJ acquired the target relations. In comparison to TS, SJ also passed an A-B naming test and accurately labelled the novel objects informally in experimental sessions in which he achieved criterion on the B-A tests.

The present studies are the first to demonstrate the exposure learning of novel word-referent relations following impending word non-ostensive exposures. Only one previous study -- Whitehurst et al. (1982) -- presented exposures in such a context; the authors failed to provide any convincing evidence of acquisition of the novel relations as a result of these trials.

Importantly, these studies are the first to demonstrate exposure learning by young children in stringently controlled conditions. This is for two reasons.

First, multiple relations were exposed concurrently and tested in juxtaposition. As a result, criterion level responding on auditory-visual matching-to-sample test trials -- learning outcome trials -- demonstrated the acquisition of specific one-to-one mappings between the target auditory and visual stimuli.

Second, participants responses' on B-A test trials cannot be readily attributed to false positive responding: participants' responses were not the result of patterns of preferential responding, URCS, or experimenter cueing.

The performances of these participants thus demonstrated that some young children aged 25 months and above are able to acquire novel word-referent relations following non-ostensive, ostensive, and fast mapping/exclusion exposure trials. Further, for these children, only limited exposures were required in order to effect acquisition: one participant even demonstrated acquisition of the novel relations following the absolute minimum of only one exposure trial of each novel relation.

A further research question was investigated in the present studies: were the acquired relations symbolic -- equivalence -- relations? This extended the exposure and testing of the novel relations with these participants, and attempted to extend the findings of cognitive/developmental exposure learning research in general. These data are discussed in the next section.

9.3. Exposure Learning of Symbolic Relations in Stringently Controlled Conditions

A fundamental criticism of the cognitive/developmental research was addressed in Chapter 3: the failure of authors to demonstrate that novel word-referent relations acquired through exposure learning are symbolic relations. In cases in which multiple novel relations were exposed and tested, and in which the authors claim to have found evidence of the acquisition of these relations, they have failed to demonstrate that the acquired relations have symbolic properties. That is, that participants understand that target word refers to or stands for the corresponding target object or picture. In their failure to do so, they have thus failed to provide unequivocal evidence of real word learning.

The behaviour analytic stimulus equivalence paradigm provides a methodology for assessing the symbolic properties of relational responding. However, behaviour analytic studies of stimulus equivalence relevant to young children's exposure learning of novel stimulus relations have been limited in number: only one such study has been conducted (Lipkens, Hayes, & Hayes, 1993). Like previous cognitive/developmental research, this was also criticised for its paucity of methodological control.

In order to extend the findings of cognitive/developmental and behaviour analytic research, participants in the present series of studies were given tests of stimulus equivalence following exposures to baseline relations (A-B and C-A). Most notably, the exposure and test trials were conducted in stringently controlled conditions in order to demonstrate, unequivocally, the derivation of symbolic -- equivalence -- relations, and thus afford conclusions regarding real word learning. Four of the five participants who achieved criterion level on B-A tests in Studies 2 and 3 were exposed to a third set of stimuli -- Set C, novel shapes -- via C-A non-ostensive exposure trials. They were then given B-C equivalence tests. Their performances on these tests, and on the previous B-A tests are now discussed.

In Study 2, recall that LS demonstrated the derivation of B-A relations following ten A-B non-ostensive exposures. Subsequently, in Phase 3, she passed B-C tests following the minimum requirement of only one non-ostensive exposure trial of each of the C-A relations; she was aged 31 months and 18 days. However, although it is tempting to claim that LS demonstrated emergent equivalence relations, procedural flaws in this study render such conclusions equivocal. Ultimately, the direction of stimulus presentations on both A-B and C-A non-ostensive exposure trials were not controlled, and it is possible that she was unintentionally exposed to the symmetrical B-A and A-C relations. This being the case, criterion level performance on B-C tests only demonstrates evidence of the derivation of transitive relations: combining the B-A and A-C exposed relations transitively gives rise to B-C relations. Thus LS's performance on B-C test trials, whilst demonstrating acquisition of the novel relations, at best, demonstrates only transitivity. It is, therefore, not unequivocally concluded that the relations were symbolic equivalence relations. In the subsequent studies the direction of stimulus presentations on non-ostensive exposure trials were controlled in order to provide stringent tests of equivalence.

In Study 3, SR demonstrated derivation of the symmetrical B-A relations following only one A-B non-ostensive exposure trial of each object-word relation. The permanency of these emergent word-object relations was demonstrated by the fact that he continued to respond at criterion level on B-A matching tests and A-B naming tests some 13 and 28 days, respectively, after the discontinuation of the A-B exposure trials. After experiencing only four C-A non-ostensive exposure trials (two of C1-A1 and to of C2-A2) he passed the B-C equivalence tests. He was aged 26 months at this time, the youngest in the present series of studies to pass these tests. He also responded above criterion level on the first eight trials of C-A and A-C symmetry tests. His C-A and A-C performance then deteriorated; he had already tired of the procedure as was indicated by his fussiness and disinterest in experimental sessions, and the development of preferential patterns of responding. Overall, SR had performed consistently for long enough to show that he had acquired the novel relations, and as the non-ostensive exposure trials were controlled with respect to the direction of stimulus presentations, it was concluded that SR demonstrated the derivation of symbolic relations between the target words, objects, and shapes.

Recall that in Study 3, TS and SJ demonstrated acquisition of the novel relations following 8 and 30 exclusion exposure trials respectively. As B-A relations were exposed on exclusion trials, evidence of symmetry, and hence evidence of the symbolic nature of these word-object relations, is provided by their emergent labelling of the novel objects (see Figure 9.1).

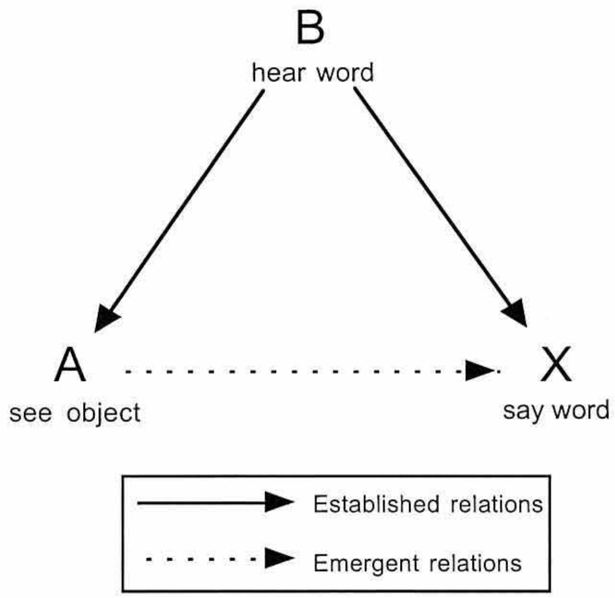

Figure 9.1. Schematic representation of the role of emergent labelling in demonstrating the acquisition of symmetrical B-A relations following B-A exclusion exposure trials. Arrows point from sample to comparison stimuli.

For TS and SJ, B-A relations (hear word-see object) were established via exclusion exposure trials. TS and SJ also echoed the novel words in experimental sessions; these might be termed B-X relations (hear word-say word). They also demonstrated emergent labelling of the novel objects in A-B naming tests and in their informal vocalisations, In order for this to occur, they were required to combine transitively A-B relations with B-X relations; they thus demonstrated emergent symmetrical A-B relations.

TS did not participate in any further testing. SJ, however, demonstrated immediate derivation of the B-C equivalence relations following only one non-ostensive exposure trial of each novel relation aged 30 months and 23 days; he also passed a C-B test conducted subsequently. Note that for this participant, both B-C and C-B tests constituted tests of equivalence and indicated the derivation of symmetrical A-B and A-C relations: combining, transitively, the exposed B-A relations with A-C relations derived via symmetry gives rise to B-C relations; and combining, transitively, the exposed C-A relations with the A-B relations derived via symmetry gives rise to C-B relations.

Finally, SB, also in Study 3, demonstrated acquisition of the novel relations following 36 A-B ostensive exposure trials. By virtue of the bi-directional nature of these exposures, his criterion level B-A and A-B performance does not provide unequivocal evidence of symmetry. However, he went on to demonstrate immediate derivation of the B-C equivalence relations following the minimum requirement of only one non-ostensive C-A exposure trial of each novel relation; he was aged 30 months and 4 days when he passed this test.

In summary so far, five participants in the present series of studies demonstrated acquisition of multiple novel word-referent relations following unreinforced exposures presented in three contexts. In each case, they also accurately labelled the novel objects thus demonstrating evidence of acquisition of A-B relations; in the case of TS and SJ, this provides evidence of symmetry of the exposed relations. Further, in cases in which subsequent exposure and testing was conducted, each participant also passed B-C tests following C-A exposure trials. For participants SR, SJ, and SB, criterion performance on B-C tests provided evidence of emergent equivalence relations between the novel words, objects, and shapes, thereby demonstrating that the relations acquired were indeed symbolic. For participant LS, this performance demonstrated evidence of transitivity. Of these four participants, three passed B-C tests immediately requiring only the minimum number of C-A exposure trials, and the remaining participant required only two exposures of each of the novel relations.

The above participants' successes on B-C tests cannot be readily attributed to false positive responses as a result of experimenter cueing or URCS. For each of these participants experimenter cueing was eliminated by the implementation of a blind testing procedure. For SR, TS, SJ, and SB, their responses on B-A pre-testing sessions indicated no prior associations between the target words and objects, and thus their criterion level performance cannot be attributed to URCS. Although this pre-testing measure was not implemented for LS, her responses in early B-A test sessions, in which she did not achieve criterion level, were not URCSs: she did not respond conditionally in these sessions. Moreover, when she passed these tests she also demonstrated emergent labelling of the novel objects (A-B naming); it is unlikely that URCSs by chance would establish both A-B and B-A relations.

The present results demonstrate that children as young as 26 months are able to acquire symbolic word-referent relations from unreinforced exposures presented in stringently controlled non-ostensive, ostensive, and fast mapping/exclusion contexts; in particular, it was shown for the first time that these children were able to do so following non-ostensive impending word exposures. In addition, these children demonstrated the acquisition of purely visual stimulus relations following non-ostensive exposure trials. These studies thus extend the findings of Smeets et al. (1997). In their study, five year olds demonstrated the derivation of visual-visual equivalence relations following non-ostensive exposure to the baseline relations. The present research demonstrated such learning in children aged 26 to 32 months, thus much younger than the five year olds tested by these authors. Cognitive/developmental authors have not previously investigated the acquisition of visual-visual stimulus relations; thus the present series of studies demonstrate that exposure learning is not confined to the acquisition of auditory-visual relations alone.

The present studies also speak to the behaviour analytic literature presented in Chapters 1 and 3. Only one behaviour analytic study has investigated a young child's derivation of equivalence relations between linguistically relevant stimuli following exposure trials presented in a naturalistic context (Lipkens, Hayes, & Hayes, 1993). The authors claim to have found evidence of emergent equivalence relations in a normally developing child of an age younger than those in the present studies: 23

months 20 days (Lipkens, Hayes, & Hayes, 1993). However, this study has been variously criticised for its lack of methodological control (see Chapters 2 and 3; also see McIlvane & Dube, 1996; Saunders & Green, 1996), and thus the validity of the data is questionable. The present studies are the first to have demonstrated the exposure learning of equivalence relations in a stringently controlled context, and provide evidence of the youngest participant -- SR, aged 26 months -- in the published literature thus far to have passed an equivalence test in such conditions.

For three of the above participants -- SR, SJ, and SB -- the exposure trials were an effective method of introducing and establishing acquisition of equivalence relations. In studies of stimulus equivalence the convention is to directly train participants the baseline relations via reinforcement for correct responses. In such studies participants have required a great deal of training in order to establish criterion level responding on baseline relations both auditory-visual and visual-visual (e.g., Devany, Hayes, & Nelson, 1986; Dugdale, 1988). Lipkens, Hayes & Hayes (1993) found it difficult to train their participant, aged approximately 17 months, criterion responding on auditory-visual matching-to-sample trials; Charlie required 77 name-picture training trials and modifications of the basic training procedure before achieving criterion level on these trials. Likewise, Augustson and Dougher (1992) found difficulty training visual-visual conditional discriminations; whilst six and four year old children achieved criterion on these trials, their two year old participant failed to achieve criterion on visual-visual relations following 200 trials. In contrast, the present participants demonstrated rapid acquisition of both auditory-visual and visual-visual relations without requiring *any* reinforcement for responding to the novel stimuli in question.

Although five participants in Studies 2 and 3 demonstrated the acquisition of symbolic relations from limited unreinforced exposures, this does not represent the whole picture. Although these data demonstrate that young children's exposure learning under controlled conditions is indeed possible, throughout Studies 2 to 5 there was a great deal of variability in individual participants' performances. This is discussed in the following section.

9.4. Variability in the Data

In Studies 2 to 5, in which multiple novel word-referent relations were concurrently exposed and tested in juxtaposition, a great deal of variability was evidenced in participants' performances. The five participants who demonstrated acquisition of the novel relations represent only a minority of children; the majority of participants failed B-A tests following either non-ostensive, ostensive, or fast mapping/exclusion exposure trials (see Table 9.1).

Table 9.1.

Number of participants who received non-ostensive, ostensive, and exclusion exposure trials and passed subsequent B-A tests in Phase 2 of Studies 2 to 5.

	Exposure trial type		
Study	A-B non-ostensive	A-B ostensive	B-A exclusion
2	1/4	0/2	0/1
3	1/9	1/8	2/4
4	0/9	-	-
5	-	-	0/2
Total	2/22	1/10	2/7

Note. Only participants who achieved criterion level on both exclusion and related control trials are represented in this table.

Of 24 participants who received exposure trials in Phase 2 of these studies (and responded at criterion level on exclusion and related control trials), only five demonstrated acquisition of the novel relations. Very few participants (2/22) passed B-A tests following A-B non-ostensive exposure trials, and fewer still passed following

A-B ostensive exposures (1/10); likewise, only a minority of participants who responded at criterion level on both exclusion exposure trials and related control trials passed subsequent B-A tests (2/7).

The majority of participants thus failed to demonstrate acquisition of the novel relations. This, at first, may seem surprising. Given the claims made by cognitive/developmental psychologists regarding the efficiency of young children's exposure learning, it might seem that the present data are inconsistent with previous findings, and that the variability in the present participants' performances was unanticipated. However, following closer inspection of cognitive/developmental data, it is argued that the present series of results might have been expected. This is discussed in the following section.

9.5. The Present Results and Exposure Learning Literature

In Chapter 1, the existing exposure learning literature was presented. This chapter outlined the various exposure learning paradigms and procedures employed by cognitive/developmental researchers and the related performance outcomes in such studies. From the results of this research, authors have claimed that the exposure learning of novel word-referent relations is an efficient method of rapidly acquiring vocabulary for young children, and thus might be related to the vocabulary spurt (e.g., Mervis & Bertrand, 1993, 1994; Carey & Bartlett, 1978; Woodward et al., 1994). Authors claim their results have shown that children of 13 months and above are able to demonstrate immediate comprehension of a new word following limited unreinforced exposures to words and their referents in non-ostensive, ostensive, and fast mapping/exclusion contexts, and that post-vocabulary spurt children have no trouble in passing such tests. Further, behaviour analytic authors claim to have shown that children as young as 17 months can acquire novel word-referent relations, and that children as young as approximately 23 months can pass subsequent tests of stimulus equivalence, thereby demonstrating that the relations acquired have symbolic properties. On face value, it would appear that the results of the present series of studies are inconsistent with this research: of the participants in the present studies, all post-vocabulary spurt and aged 21 months and above, only a minority acquired symbolic word-referent relations following exposure trials.

However, on closer inspection of the existing literature it seems unreasonable to expect that the majority of participants in the present studies would have passed such tests. Despite the claims made by cognitive/developmental psychologists, there is no sound evidence to suggest that exposure learning is indeed a robust phenomenon or an efficient method of acquiring new vocabulary. Because of the paucity of methodological control employed in all of these studies, the authors failed to unequivocally demonstrate evidence of real word learning, and, therefore, did not provide concrete evidence of the efficiency of exposure learning.

Even in the most tightly controlled cognitive/developmental study of the acquisition of a single new word-object relation the data are not entirely convincing. Woodward et al. (1994), in their series of studies, gave 13 and 18 month old children nine exposures to a target relation in an ostensive context -- the context proposed to be most facilitate of exposure learning (Baldwin & Markman, 1989). Despite claiming that 13 months olds and above are able to demonstrate comprehension of a new word, the data generated in these studies were variable. First, in only two of their studies -- Studies 1 and 3 -- were preference control trials conducted; thus in Studies 2 and 4 there is no evidence that participants' above chance selections of the target object on comprehension test trials were anything other than false positive responses as a result of stimulus preferences. Second, the participants' performances across these studies were variable: the 13 month olds responded significantly above chance in Study 3, yet failed to do so in Study 1; the 18 months olds responded significantly above chance in

Study 1, yet failed to do so in Study 3. The procedures between studies differed only in the specific testing procedure employed. If participants were able to acquire novel relations from exposure trials then they should have passed comprehension tests in all studies. Over Studies 1 and 3, the 13 month olds produced accurate responses on only 55 percent of comprehension test trials. Similarly, the overall group average of the 18 month olds across Studies 1 and 3 was 68 percent accuracy. Thus across Studies 1 and 3 the overall performances of the two groups are modest and close to chance level (especially in the case of the 13 month olds), and do not meet the stringent criteria adopted by behaviour analytic researchers, and that adopted in the present series of studies. It is also of importance to note that these response accuracies may also reflect false positive responses, thus casting further doubt on the authors' claims regarding word learning.

In addition, the calculation of group mean scores in general do not reflect the performance of individual participants. It is likely that some of the participants responded correctly on all test trials, whereas some failed to respond correctly on any trials. Also, it is possible that all the participants responded correctly on some of the test trials; this being the case, the authors did not demonstrate reliable evidence of acquisition of the novel relation. If participants have indeed acquired a new word, they should respond correctly on 80 percent or more of the comprehension test trials (see Sidman, 1980). Despite this variability in the data, and the failure to demonstrate individual participant's reliable responding on test trials, Woodward et al. claim that ostensive exposure learning is an efficient method of acquiring new vocabulary.

There is also little sound evidence of the acquisition of novel word-referent relations following non-ostensive exposure trials. Studies of such exposure learning have also produced modest response accuracies; this is even in cases in which multiple novel word-referent relations have been exposed and tested (e.g., Whitehurst, Kedesdy, & White, 1982). In addition, all these studies are more poorly controlled than that of Woodward et al. (1994; see Chapter 2 for a discussion of these issues).

Further, there have been no better controlled cognitive/developmental studies of the acquisition of word-referent relations following fast mapping exposures, despite the claims that fast mapping is an efficient language acquisition strategy (Mervis & Bertrand, 1994). Behaviour analytic exclusion research, as stated in Chapter 2, is more stringently controlled by virtue of the convention of the concurrent introduction of multiple novel stimulus relations. Although very few studies have been conducted with young normally developing children in naturalistic language learning contexts, the results of exclusion studies in general sound a warning to the above claims.

Correct responding on exclusion trials does not guarantee acquisition of the novel relations introduced. This has been repeatedly demonstrated in behaviour analytic research. Even in cases in which participants have responded at criterion level, or without error, on exclusion and related control trials, not all of these will go on to pass subsequent learning outcome tests (e.g., Dixon, 1977; McIlvane & Stoddard, 1981, 1985). This has been the case even in studies in which participants have been provided with reinforcement for correct responses on exclusion and control trials. Thus these studies question the proposition that correct responding on fast mapping exposure trials may be related to rapid vocabulary acquisition, and thus may effect exposure learning.

As a result of these considerations, it is evident that the exposure learning data provided by cognitive/developmental psychologists is variable, poorly controlled, and does not provide convincing evidence of young children's acquisition of new vocabulary. The results of the present series of studies are thus not surprising: there is no reason to expect that the majority of children would have demonstrated exposure learning in such stringently controlled conditions in the present studies. The fact that the majority of participants failed comprehension tests in the present studies, in which sources of false positive responding were controlled for, provides support for the criticisms levelled at these earlier studies. We do not know whether participants in these earlier studies would also have failed such tests had the authors controlled for possible sources of false positive responding.

In summary thus far, it is concluded that some young children are able to acquire *symbolic* word-referent relations following limited unreinforced exposures in all three contexts: when the participants in the present studies passed B-A and B-C tests they typically did so with relative ease. However, these participants were in the minority: the majority of participants (19/24) failed to pass B-A tests in the early stages of the studies. Given the paucity of previous research these findings were not entirely unexpected, and suggest that, contrary to the claims made by cognitive/developmental authors, exposure learning is not necessarily an efficient method of acquiring new vocabulary for all young children.

However, alternative explanations may be posited for the present participants' failure to acquire the target relations. First, it is possible that participants initially failed B-A tests as a result of a lack of experience of conditional responding. Second, it might be argued that, as a result of the methodological rigour employed, participants' failures to acquire the novel word-referent relations in the present studies were artefactual. These issues are discussed in the following two sections, respectively.

9.6. A History of Conditional Responding

A trend was noted in the performances of the four participants -- LS, SR, SJ, and SB -- who passed B-A tests and subsequent B-C tests. Not all of the participants immediately passed tests of acquisition of the novel relations in Phase 2. Whilst SR did so, LS required 10 A-B non-ostensive exposure trials, SB required 36 A-B ostensive exposure trials, and SJ required 30 B-A exclusion exposure trials (these are equal numbers of trials of each of the novel relations). However, their performances on subsequent B-C tests in Phase 3, in each case, were rapid. Whilst SR required four C-A non-ostensive exposure trials, only two more than the minimum required for equivalence testing, LS, SJ, and SB required only the minimum of one non-ostensive exposure of each of the novel C-A relations, thus demonstrating immediate derivation of the B-C relations. (Recall that for SR, SJ, and SB, this provided evidence of emergent equivalence relations; for LS this demonstrated only emergent transitive relations). Also note that participants SJ and TS did not pass B-A tests following non-ostensive and ostensive exposure trials; however, following criterion level responding on matching-to-sample exclusion exposure trials and control trials, they went on to pass the B-A tests. It appeared that a history of conditional responding facilitated these participants' performances on subsequent matching-to-sample tests. Thus the question was asked: would providing a history of conditional responding to participants who initially failed B-A tests facilitate their performances on subsequent tests? Perhaps exemplar training with novel stimuli would be one factor that would facilitate participants' acquisition of the novel relations.

This was investigated in Studies 3 and 4. In these, participants who initially failed to acquire the novel word-referent relations were given B-A training to criterion. Rewards for correct responding were then phased out, and, following criterion level performance on B-A tests, they proceeded to Phase 3 of the study. A total of nine participants received B-A training in these studies. Of these, six achieved criterion level on B-A trials and went on to receive subsequent C-A exposures and B-C equivalence tests.

Of these six participants, three achieved criterion level on subsequent B-C equivalence tests. In Study 3, KN failed to pass B-A tests following non-ostensive, ostensive, and fast mapping exposure trials. However, following exemplar training she went on to demonstrate immediate emergent equivalence relations passing the B-C tests following only one C-A non-ostensive exposure trial of each novel relation; in addition, she also passed a C-B test demonstrating derivation of the transitive relations.

In Study 4, DE and FR received B-A training after failing to achieve criterion level on B-A tests following non-ostensive exposures alone. DE required only six C-A exposure trials in order to pass the B-C equivalence tests; his failure to pass immediate tests may have been a result of a change in response requirements, and it is likely that he would have passed these early tests if this had not occurred. Indeed, this is what was found. On subsequent A-B non-ostensive exposures and related B-A testing with new stimulus sets DE demonstrated immediate derivation of the symmetrical B-A relations. In addition, he passed B-C tests following only eight C-A non-ostensive exposure trials; he also passed a C-A and an A-C symmetry test, and demonstrated derivation of the C-B transitive relations in his informal vocalisations.

In contrast, FR initially failed B-C tests in Phase 3. She required 74 C-A exposure trials before passing a C-A test and an A-C symmetry test, and required a total of 86 C-A non-ostensive exposure trials before demonstrating derivation of emergent equivalence relations. Although it appeared that B-A training did not facilitate her performance on the subsequent B-C tests, when FR was introduced to new stimulus sets she demonstrated immediate derivation of symmetrical B-A relations following the minimum requirement of only one non-ostensive exposure trial of each relation; moreover, she then demonstrated immediate derivation of equivalence relations following only two non-ostensive C-A exposure trials with these stimulus sets.

Thus it appeared that, for these participants at least, a history of conditional responding within the experimental context facilitated their performance on subsequent test trials. Again, the criterion level performance of these participants cannot be readily attributed to patterns of false positive responding by virtue of the controlled nature of the studies.

Note, however, that although the provision of exemplar training seemed effective in facilitating performance on subsequent tests for these three participants, the effectiveness of the B-A training in general was variable. Three participants -- CL, SS, and SM -- who achieved criterion level on B-A trials as a result of training did not go on to pass B-C tests in Phase 3. In CL's case, is was possible that this was a result of the failure to phase out rewards on B-A trials before proceeding to A-C exposures and B-C testing; thus it is not certain whether his subsequent failure to demonstrate derivation of equivalence relations was a result of the ineffectiveness of a history of conditional responding, or was the result of a procedural flaw. For SS and SM the rewards were phased out prior to Phase 3, yet there did not appear to be any beneficial effects of a prior history of conditional responding.

Although the above six participants achieved criterion level on B-A trials, there was a great deal of variability in the number of training trials required to satisfy criterion level: DE and CL required only 32 and 36 generic training trials respectively before passing B-A tests; SS and SM achieved criterion level on B-A trials following a total of 80 and 89 training trials respectively; KN and FR required a total of 215 and 320 training trials respectively in order to satisfy criterion level. Note also that no one training procedure appeared more effective than the others: participants achieved criterion level on B-A trials as a result of various training procedures. Whilst some participants achieved criterion level following only generic training, some participants required up to five training procedures.

For three participants -- LB, KJ, and IB -- the training procedures were ineffective in establishing criterion level responding on B-A trials. These participants did not achieve criterion level despite receiving numerous training procedures and a total of 56, 142, and 294 training trials respectively. LB became disinterested in the procedure, and both KJ and IB exhibited stimulus preferences that were resistant to change. Thus for some participants it appeared difficult in these circumstances to train the baseline B-A relations. This is not entirely unexpected given the difficulty of training both auditory-visual and visual-visual conditional discriminations in children of two years documented in existing literature (e.g., Augustson & Dougher, 1992; Lipkens, Hayes, & Hayes, 1993).

Although the provision of a history of conditional responding was facilitative of subsequent matching-to-sample performances for some participants, the efficacy of B-A training was variable. In order to devise an efficient training procedure for young children, and to more fully assess the role of exemplar training in young children's derivation of equivalence relations, further investigation is required.

9.7. Why Might Participants Have Failed to Acquire the Novel Relations? Future Directions

As stated in Section 9.4, there was much variability in the data in the present series of studies. Whilst this was not expected given the paucity of methodological control employed in previous studies, it might be asked why some participants demonstrated exposure learning of the target novel relations, yet, for the majority, the exposure trials appeared ineffective in establishing the word-referent mappings. Whilst five participants passed B-A tests, and thus demonstrated acquisition of the novel relations following limited unreinforced exposures, for the remaining 19 participants the exposure trials did not appear to effect acquisition.

It might be argued that these 19 participants had in fact learned the target relations, yet did not demonstrate such on the B-A test trials, and indeed the B-C test trials, presented. It is possible that the participants' failures to demonstrate acquisition of the target word-referent relations were artefactual.

In the present series of studies measures were employed in order to control for, or to assess, sources of false positive responding on auditory-visual matching-to-sample (multiple choice) test trials. Thus, as was intended, these studies investigated exposure learning in stringently controlled conditions: participants were unable to achieve criterion level responding on test trials as a result of a pattern of false positive responding. Paradoxically, these controls may have complicated the task at hand and may have given rise to a further pattern of false responding: participants' inaccurate responses may have been the result of a pattern of *false negative* responding.

The rigorous methodological measures employed in the present studies may have left the experimental context somewhat artificial and removed from naturalistic language learning situations; specifically, this may have been the result of lengthy periods of unreinforced testing.

In each of the studies a single case methodology was employed. The demonstration of an individual participant's acquisition of the target relations, in the absence of false positive responding, thus necessitated the repeated presentation of blocks of unreinforced test trials. Such unreinforced testing does not mirror naturalistic language learning contexts and may have reduced participants' interest in the procedure. For example, in everyday language learning situations children are typically reinforced for demonstrating that they have learned a new word-referent relation. During picture book reading, a caregiver might request a child to point to a picture that he or she has recently heard labelled. If the child does so correctly, he or she is typically immediately rewarded and praised for his or her appropriate response. However, in the present series of studies, in which participants were presented with repeated blocks of unreinforced test trials, they did not receive rewards for correct responses throughout the entirety of testing. This is unlike the naturalistic situations that we can readily imagine and may have led to the artificiality of the testing context: children would not be required to repeatedly demonstrate their acquisition of a new relation to such an extent before receiving any rewards or praise.

As a result, in the present series of studies, the administration of unreinforced blocks of test trials may have reduced participants' motivation and attention to the test trials, and decreased their general level of interest in the experimental procedures and test sessions. Such a decline in motivation and attention may have led participants to perform below their potential on test trials, thus producing false negative responses. Similarly, the participants' lack of general interest in experimental procedures may have led to their reduced attention to the exposure trials; this may have prevented them from benefiting from these exposure trials and thus learning the target relations.

The dangers of false negative responding in the present series of studies were recognised, and thus a number of measures and procedural elements were implemented in an attempt to prevent such responding. These various measures were employed in order to provide naturalistic conditions as far as possible, to increase participants' general interest in, and attention to, experimental sessions, and to facilitate learning. These measures are discussed below.

First, it might be argued that some participants were unable to cope with the demands of the tasks in general. This is dismissed as a plausible explanation. Each participant passed baseline pre-tests before progressing to Phase 2, thus verifying the prerequisites for responding on auditory-visual matching-to-sample trials. Further, in Study 3, a B-A pre-testing session confirmed that participants were able to respond on matching-to-sample trials in which novel stimuli were presented as samples and comparisons.

Second, it might be argued that participants failed to attend to test trials and did not demonstrate acquisition of the novel relations as a result of a lack of interest in the testing procedure. This, again, is unlikely. Auditory-visual matching-to-sample test trials were employed in order to enable an early assessment, and provide a sensitive measure, of young children's word learning. The test procedures were conducted in naturalistic contexts paralleling those employed by cognitive/developmental researchers and the contexts of early language learning situations in general. Specific measures were also designed and implemented to alleviate boredom in experimental sessions and to maximise and sustain participants' interest: inter-trial intervals; the use of pre-tested multi-sensory objects selected for their appeal to individual participants and to children of this age in general; the use of a glove puppet to which participants' cooperation was directed; the interspersion of token rewarded baseline trials among target relation test trials; the implementation of a new "magic" context in Study 4 designed to engage participants' attention; and the direction of participants' focus away from comparison selections per se to the performance of an activity with the chosen objects.

Third, it might be argued that participants did not fully attend to the stimuli presented in exposure trials. That is, it might be possible that they did not attend to the specific features of the novel words and objects. However, measures were implemented in order to maximise participants' attention to these stimuli. In non-ostensive and ostensive exposure trials, the novel objects were presented only when all other visual stimuli were removed from the participants' view, and participants were encouraged to play freely with these objects. Similarly, on C-A exposure trials participants were encouraged to touch the novel shapes and note their defining characteristics before the corresponding novel objects were revealed. Participants were also shown the novel objects for longer durations and were permitted greater physical contact with these objects than in exposure trials typically presented in cognitive/developmental studies. Ostensive exposure trials were presented in an attention-following context which has been shown to be facilitative of exposure learning in young children (e.g., Tomasello & Farrar, 1986). In Study 5, in cases in which participants failed to achieve criterion level on exclusion and control trials, modified trial types were presented in order to facilitate criterion level performance and subsequent learning outcome.

With respect to the novel words, these were invariably presented when the participant was silent and was looking at the experimenter. It is noted that the majority of participants echoed the novel words presented on exposure trials. Although such vocalisations do not provide evidence of acquisition of the novel relations, they do at least indicate that participants have attended to the specific features of the target words. There is no similar confirmatory evidence of participants' attention to the target visual stimuli available.

Fourth, if participants did indeed attend to the stimulus presentations on exposure trials, then what might have contributed to the ineffectiveness of these trials in producing acquisition of the novel relations? In contrast to conventional stimulus equivalence research, the baseline relations in the present studies were exposed rather than directly trained. In baseline "training" participants are typically required to produce a sample and a comparison response indicating that they have attended to the stimuli. However, in non-ostensive and ostensive baseline exposure trials, in the present studies, participants were not required to respond at all to the stimuli. Thus there is nothing in such exposure trials that requires participants to learn the correspondences between the stimulus pairings.

It is possible to provide suggestions for the ineffectiveness of A-B non-ostensive exposure trials conducted in the present studies. Participants may have been confused as to the relationship between the novel words and objects in these trials. In Studies 1, 2, 3 and 5, the novel target word, on A-B non-ostensive exposure trials, was presented in the carrier phrase "That was a X" (where X was the novel word) just after the object was dropped into a box. There is nothing in such a carrier phrase, or in the target word itself, that signifies the word's status as a noun, and thus that it is a label for the object the participant has just seen; it could equally refer to the action of hiding the novel object or of dropping the object in the box. This possibility was examined in Study 4, in which the carrier phrase utilised on A-B exposure trials was modified. Despite this modification none of the participants acquired the target relations.

It is also possible that participants were not motivated to attend to the specific features of the novel stimuli presented on these trials; they may have been unaware that the novel object and word were to be related and thus did not attend to specific characteristics of the stimuli. In order to alert participants to the relation between the stimuli presented, and to set the context for learning, familiar relation exposure trials were interspersed among A-B exposure trials in Study 3. Similar measures have been adopted by cognitive/developmental psychologists (Schafer & Plunkett, 1998; Whitehurst, Kedesdy, & White, 1982). Again, these did not facilitate exposure learning of the novel relations: none of the four participants who received non-ostensive exposure trials in this context passed the subsequent B-A tests, and neither did they show any improvement in their performance on these tests in comparison to B-A tests conducted after A-B non-ostensive exposures were presented alone.

In Study 5, exclusion exposure trials alone were presented. The results of this study indicated that the participants' failure to acquire the novel relations following these trials in previous studies was not the result of a prior extended history of unreinforced testing. Also, in cases in which participants failed to demonstrate learning outcome on these trials a successive introduction procedure was employed. Such a procedure has previously been found to facilitate learning outcome in participants with moderate to severe mental retardation (Wilkinson & Green, 1998; Wilkinson & McIlvane, 1994; see also Wilkinson, McIlvane & Dube, 1996). However, this proved ineffective with the young normally developing children in the present studies. It is possible that the successive introduction of novel relations may facilitate learning outcome if the procedure is introduced from the outset of testing, rather than after a history of unreinforced testing on exclusion, control, and learning outcome trials. This requires investigation in future studies.

The use of the magic context in Study 4 did little to facilitate learning: none of the participants in this context demonstrated acquisition of the novel relations. The context was employed in order to shift the participants' focus of attention from comparison selections per se to performing an activity with the object selected. Such procedures have been implemented by cognitive/developmental researchers (e.g., Dollaghan, 1985; Woodward et al., 1994). It is possible that such a modification would have been beneficial had it not been utilised within this magic context. Whilst the magic show provided initial appeal for the participants this was short lived: the performance of magic with the comparison selected became repetitive and tiresome. The procedure was thus deemed too elaborate for participants of this age. It is possible that involving the comparison selections within an activity would facilitate learning, but in future studies a simpler context that more closely parallels naturalistic situations encountered in children's everyday play with objects is required.

Patterns of preferential responding were prevalent in the present series of studies; the majority of participants demonstrated evidence of stimulus and/or location preferences at some point in the study. Where these were evident they were pervasive and resistant to change despite repeated exposures to the novel relations, and in some cases -- FR, KJ, IB, BT -- despite measures designed specifically to bring their responding under control of the auditory samples on test trials. These were not evident in pre-testing sessions, even in Study 3 in which extended B-A pre-testing was conducted, and they appeared to develop with greater contact with the novel objects on test trials. Notably, participants rarely exhibited patterns of preferential responding on B-C test trials in which they were required to select the novel shapes. Thus it is possible that the development of stimulus preferences was a result of the use of objects as Set A stimuli; multi-sensory 3-dimensional objects may encourage preferential responding in young children. The use of 2-dimensional stimuli may have reduced the development of stimulus preferences and perhaps more participants would have passed

B-A tests had novel pictures been employed. This may be investigated in future studies in an attempt to provide more sensitive tests of equivalence in young children.

In the present studies it was noted that participants often echoed the target words and frequently used them to label the novel objects, albeit inaccurately. Many participants (e.g., CL, KJ, RP) produced only one of the novel words and used it to label both objects. RP, for example, also frequently selected both objects and said, "Two Taks," or, "Two Bosch." Therefore it appeared that many participants used only one word to label both novel objects exposed within the same context. The exposure of both novel relations within the same context may have overridden the acquisition of specific relations, and may have encouraged participants to group the two objects and words together: participants may have grouped the A stimuli together as 'novel objects' and the B stimuli together as 'novel words'. On exclusion trials on which correct responses were rewarded. this may have been further exacerbated: participants were rewarded for selecting *a* novel object upon presentation of *a* novel word. It is likely they were then confused when presented with *a* novel word and requested to select *between* two novel objects. Parallels may be evidenced in natural early language learning situations. For example, young children often learn a variety of colour terms together and learn that they relate to various hues. However, when asked to label a hue they may often give incorrect colour terms; they know that the words and hues are related but do not initially differentiate between the specific stimuli. In order to investigate whether participants failures on B-A tests may be a result of the exposure of both relations within the same context, in future studies the novel target relations could be exposed in different contexts in order to encourage the acquisition of specific relations between the auditory and visual stimuli; to encourage participants to group the stimuli across rather than within modalities.

In order to provide more effective exposure trials, and to provide more sensitive measures of comprehension in general, it would be advantageous to conduct naturalistic observations of children's early language learning situations. Perhaps subtle reinforcing contingencies are in evidence in these situations that were missing in the exposure and test trials conducted in the present studies. Naturalistic observations of child-caregiver interactions in everyday situations would provide a rich source of data for a functional analysis of such contingencies. Research of this nature has been conducted by Moerk (1990), who re-analysed Brown's (1973) longitudinal data of verbal interactions between an 18 month old child and her mother. Further functional analyses of such interactions would provide much needed insight into the natural process of language acquisition.

9.8. Conclusions

The present series of studies is a rare attempt to investigate normally developing young children's word learning in naturalistic yet controlled conditions. In doing so, the present research provides the first controlled studies of the exposure learning of multiple novel word-referent relations in children aged 21 months and above. These results suggest that the exposure learning of symbolic word-referent relations is possible, and provide the first evidence of the derivation of equivalence relations by young children in rigorously controlled conditions.

However, the majority of participants in the present studies failed to demonstrate acquisition of the target relations. Given the lack of methodological rigour employed in previous studies of exposure learning, such variability should perhaps have been expected. From these present data one might even be tempted to conclude that exposure learning is not as efficient a strategy of vocabulary acquisition as is posited by cognitive/developmental psychologists. However, this conclusion cannot be drawn with certainty given the possibility of false negative responding identified in the present studies.

These studies represent a first attempt at combining the work of cognitive/developmental and behaviour analytic psychologists to closely study the strategies that might be involved in early language learning. Although the present studies provide an analysis of important methodological considerations for the study of language acquisition, further research is required to understand more fully the conditions under which children so young so rapidly acquire language.

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APPENDIX A

CONSENT LETTERS ADMINISTERED TO PARENTS/GUARDIANS OF POTENTIAL PARTICIPANTS (see overleaf)

Tir na n-Og
MEITHRINFA DDYDD · DAY NURSERY
LÔN POPTY, BANGOR, GWYNEDD, LL57 1DZ.
FFÔN/TELEPHONE: (0248) 370742

Dear Parent/Guardian,

We are interested in finding out how children acquire vocabulary, that is, how they learn to relate words they hear to pictures or objects they see. We want to know whether children who merely hear us say a novel word in the presence of a novel picture can, as a result of this exposure, point to the picture when we say the word. We also want to know whether such incidental learning also applies to relations which do not involve words at all, but merely pictures and shapes. After the child has learned the word-picture relation, we will attempt to teach a shape-picture relation. The shape will be printed on the cover of a small book and the child will simply be required to lift up the cover to reveal the picture hidden underneath. We will then check to see whether the child has learnt to relate the shape to the picture by presenting the shape alongside others and asking the child to show us where the picture is hiding.

Although these procedures are very straightforward, they will provide us with valuable information on how children learn about the world around them. In order to complete the study in full, we estimate we will need to conduct two or three sessions a week for around two months. Each session will be very short (around 10 minutes) and will be presented as an undemanding and enjoyable game.

When the study has finished, a summary of the findings will be given to all parents whose children took part. Information from the study will be treated strictly confidentially (for example, the children will be given different names in the reports, and each parent will only be told which name corresponds to their child). In this and all other respects the study will conform to the general guidelines for research at Tir na n-Og.

Please could you let us know whether or not you would like your child to participate in this study by completing the slip below and returning it to Sue Kennedy, the Nursery Manager. If you would like further information before giving your consent, please let Sue know and she will arrange a time for us to come and meet you. Thank you very much.

Yours faithfully,

Dr. Neil Dugdale (Project Supervisor & Co-Director, Tir na n-Og)
Samantha Johnson
(Department of Psychology)

I do / do not * give consent for my child to participate in this study. (*delete as appropriate)

Date.............................

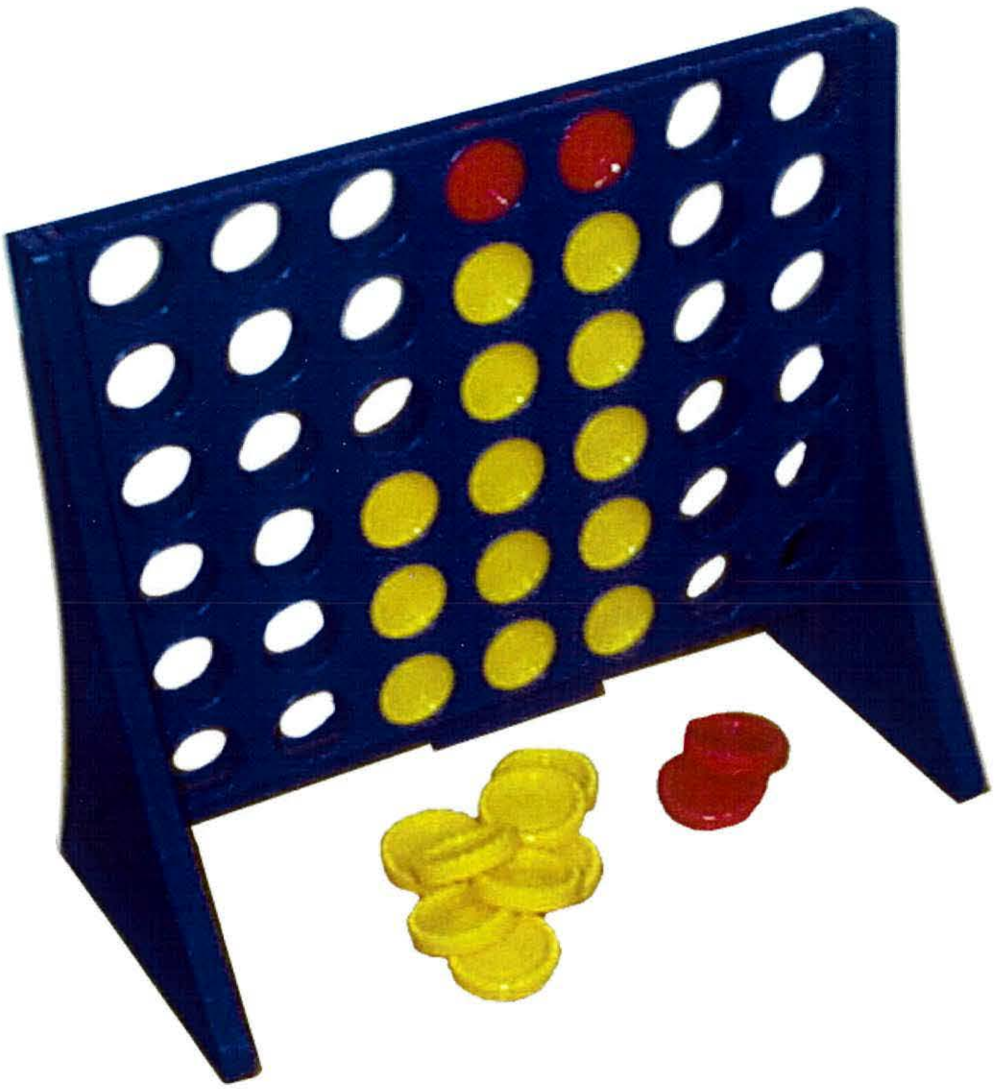
Signature of Parent/Guardian..

Child's Name.. nd/sj

...l Cymru · University of Wales
...ANGOR

APPENDIX B

MB GAMES "CONNECT 4" GAME UTILISED FOR TOKEN REINFORCEMENT IN EXPERIMENTAL STUDIES



APPENDIX C

FAMILIAR AND NOVEL VISUAL STIMULI EMPLOYED IN STUDY 1

Figure C.1. Familiar visual stimuli employed in Study 1.

Figure C.2. Novel visual stimuli employed in Study 1.

APPENDIX D

STUDY 1 DATA

Participant RJ

Phase 2.1. Non-Ostensive Exposures and Comprehension Testing

Participant RJ received seven experimental sessions throughout Phase 2.1. In each of these sessions he was given one non-ostensive exposure trial. Although he was attentive during the exposure trial, RJ never completed comprehension testing in any session, and was distracted from the outset. In Sessions 1, 3, 5, 6, and 7, RJ refused to respond on any comprehension test trial. Where he did produce responses on these trials, in Sessions 2 and 4, he demonstrated patterns of preferential responding. In Session 2, two trials were conducted; on both of these trials he selected the spring, and subsequently refused to respond on further trials in preference for playing with this object. In Session 4, four comprehension test trials were conducted; on each of these trials he selected the object in the centre location.

In order to encourage RJ to respond on the comprehension test trials, baseline trials, on which correct responses were rewarded, were conducted at the beginning of, and interspersed among, comprehension trials. His response accuracy on these trials was 69.6 percent. The inclusion of baseline trials failed to encourage him to respond on the comprehension test trials; even where he produced a run of correct responses on a set of baseline trials he continued to refuse to respond on comprehension test trials. As a result, RJ took no further part in the study.

Participant BC

Phase 2.1. Non-Ostensive Exposures and Comprehension Testing

Participant BC received a total of 13 non-ostensive exposure trials to the target relation presented in five experimental sessions. In the first session, only one exposure trial was presented; in each of the remaining four sessions, three exposure trials were presented.

In four of the experimental sessions, 12 comprehension test trials were presented; in Session 4, however, only 11 trials were presented as a result of experimenter error. Thus BC received a total of 59 comprehension test trials (30 target trials and 29 distracter trials) throughout Phase 2.1. Her performance on these trials is illustrated in Figure D1.

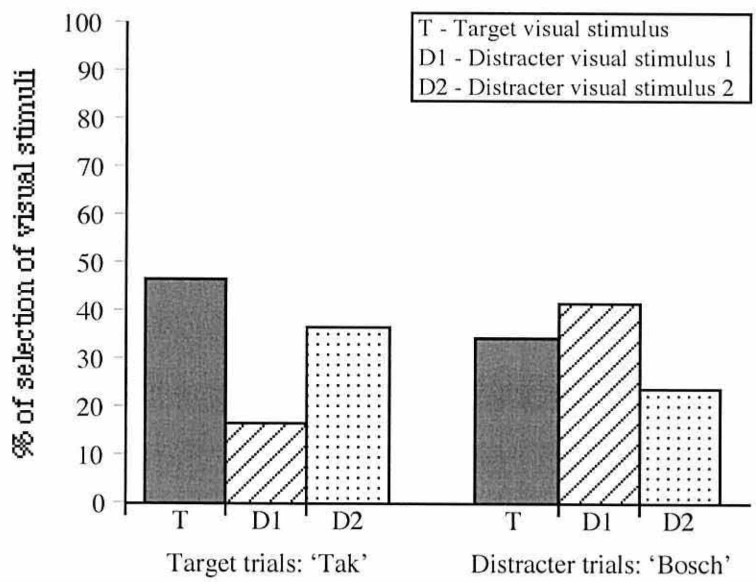


Figure D1. Participant BC: Percentage of selection of each visual comparison on target and distracter comprehension test trials in Phase 2.1.

BC did not satisfy the criterion pattern of responding. She responded with only 46.6 percent accuracy on target comprehension trials, and she selected the target visual stimulus on 34.4 percent of distracter trials. Thus BC exhibited a weak stimulus preference for the selection of the target visual stimulus, which she selected on 24/59 (approximately 41 percent) comprehension test trials. The Distracter Visual Stimuli 1 and 2 were selected with equal frequency (17/59 and 18/59 trials respectively). Thus BC did not demonstrate acquisition of the target relation as a result of non-ostensive exposure trials.

Vocalisations. BC did not label the target visual stimulus, either spontaneously or in response to prompts. She echoed the target auditory stimulus in four instances, and the distracter auditory stimulus in two instances.

Phase 2.2. Ostensive Exposures and Comprehension Testing

BC was administered three experimental sessions across which seven ostensive exposure trials were presented. In the first session, she received one ostensive exposure trial; in each of the remaining two sessions, she received three ostensive exposure trials.

BC was presented with 12 comprehension test trials in each of the experimental sessions; thus she received a total of 36 comprehension test trials (18 trials of each type) in Phase 2.2. Her performance on these trials is illustrated in Figure D2.

Again, BC did not achieve criterion for acquisition of the target relation. Correct responding on target trials was below criterion level; BC selected the target visual stimulus on only 38.8 percent of these trials; she selected the target visual stimulus with a greater frequency on distracter trials -- 61.1 percent. She continued to exhibit a weak stimulus preference for the target visual stimulus which she selected on half of all comprehension test trials presented (18/36 trials). The Distracter Visual Stimuli 1 and 2 were again selected with approximately equal frequency (8/36 and 10/36 trials respectively). Thus BC did not demonstrate acquisition of the target relation as a result of ostensive exposure trials.

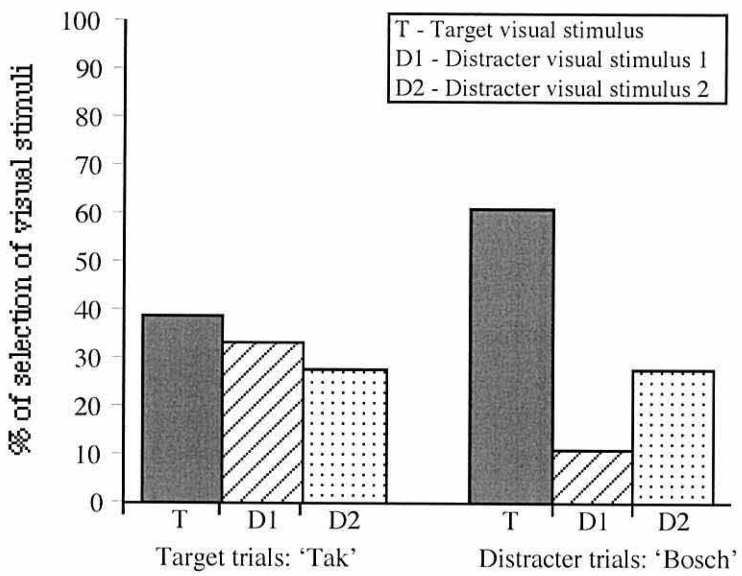


Figure D2. Participant BC: Percentage of selection of each visual comparison on target and distracter comprehension test trials throughout Phase 2.2.

Vocalisations. BC echoed the target word once throughout Phase 2.2.

Naming test. BC was administered a formal naming test session at the end of Phase 2.2. This comprised 32 free recall trials: 21 familiar trials, 6 target trials, and 5 distracter trials.

BC responded correctly on only 2/6 target trials. Of her incorrect responses on these trials, in one instance she produced a familiar word, and she failed to produce any response on the remaining three trials. She also failed to produce a codeable response on all the distracter trials.

Note that BC also failed to perform above criterion on familiar naming trials (61.1 percent correct).

Phase 2.3. Exclusion Exposures and Comprehension Testing

BC was administered six experimental sessions in Phase 2.3. In each of the first five sessions she was presented with baseline trials, exclusion trials, and control trials; exclusion and control trials were unreinforced, and correct responses on baseline trials were rewarded. Throughout these sessions she received a total of 29 baseline trials, 20 exclusion trials, and 22 control trials. Her performance on these trials is presented in Figure D3.

In these initial 5 sessions BC responded with 100 percent accuracy on control trials and baseline trials (see Figure D3). However, her responding on exclusion trials was below criterion with only 10 percent correct responding (2/20 correct responses). She preferred to select the familiar visual stimuli on all trial types.

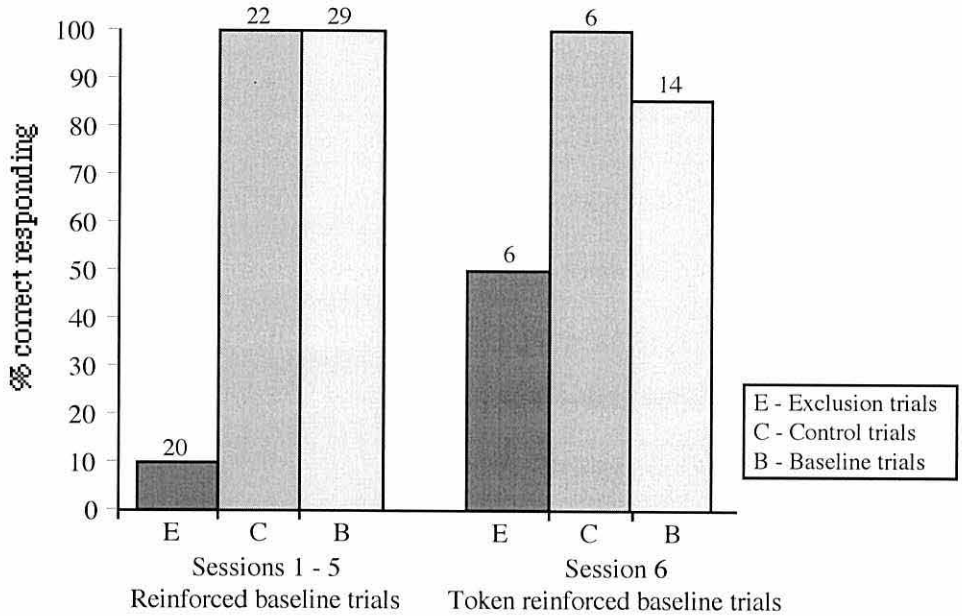


Figure D3. Participant BC: Percentage of correct responding on exclusion trials, control trials, and baseline trials throughout Phase 2.3. (Numerals above bars indicate the total number of each trial type presented.)

In the final session, Session 6, a token reward system was introduced: BC was presented with a token for each correct response on baseline trials. Exclusion trials and control trials remained unreinforced. It was hoped that the inclusion of rewards for correct responding on baseline trials would increase her overall level of co-operation and her correct responding on exclusion trials and control trials. Her performance on these trials is also illustrated in Figure D3.

Correct responding on baseline trials and control trials remained above criterion level with response rates of 85.7 percent and 100 percent accuracy respectively. However, although the inclusion of the token reward system served to improve BC's correct responding on exclusion trials, to 50 percent, she continued to respond below criterion level.

Comprehension test trials were conducted in each of the first three experimental sessions; thus BC received a total of 36 comprehension test trials (18 target trials and 18 distracter trials). Her performance on these trials is illustrated in Figure D4.

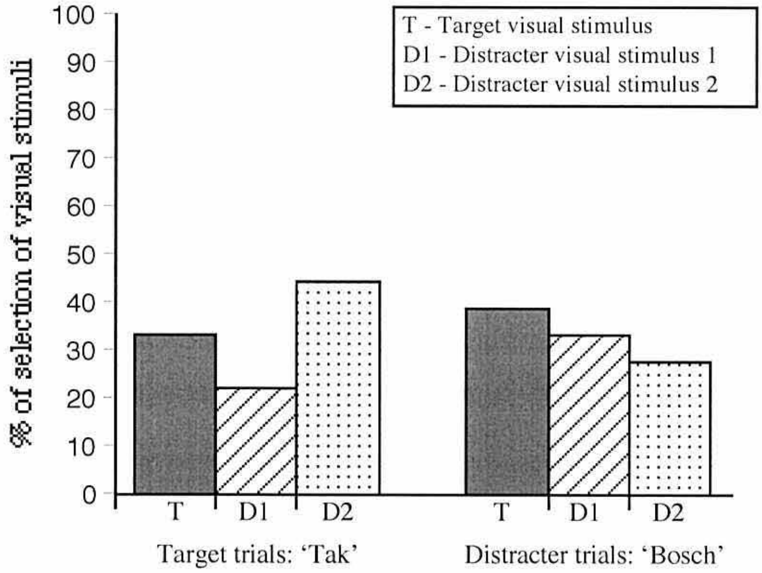


Figure D4. Participant BC: Percentage of selection of each visual comparison on target and distracter comprehension test trials throughout Phase 2.3.

Once again BC did not satisfy the criterion for acquisition of the target relation: her selection of the target visual stimulus on target trials remained below criterion level at 33.3 percent. No stimulus preferences were exhibited with all visual stimuli being selected with approximately equal frequency (13/36, 10/35, and 13/36 selections of the target, Distracter 1, and Distracter 2 visual stimuli respectively).

Vocalisations. BC did not produce either the target or distracter auditory stimulus throughout Phase 2.3.

Exposure of a Second Target Novel Relation

BC received three non-ostensive exposure trials to a second target novel auditory-visual relation. This relation consisted of the auditory stimulus "Bosch" which was previously presented as the sample on distracter trials. The corresponding visual stimulus was the snail -- the visual stimulus previously presented as Distracter Stimulus 2 on comprehension test trials.

BC was given 12 comprehension test trials following the exposure trials. These consisted of six trials of each target novel relation; that is, six trials in which "Tak" was presented as the auditory sample, and six trials in which "Bosch" was presented as the auditory sample. The Distracter Visual Stimulus 1 continued to be presented as the distracter stimulus on comprehension test trials of both target relations. Her performance on these trials is illustrated in Figure D5.

BC did not satisfy criterion for acquisition of the target relations. Although she produced 100 percent correct responding on 'Tak' trials, her responses on 'Bosch' trials were below criterion (33.3 percent correct). Further, she selected the 'Tak' visual stimulus on 66.6 percent of 'Bosch' target trials. This indicated a stimulus preference for the spring -- the 'Tak' target visual stimulus -- which she selected on 10/12 test trials. Thus she did not demonstrate acquisition of specific relations between the target stimuli.

Vocalisations. BC produced only one instance of echoing throughout this session; this was an echo of the target auditory stimulus presented on a comprehension test trial.

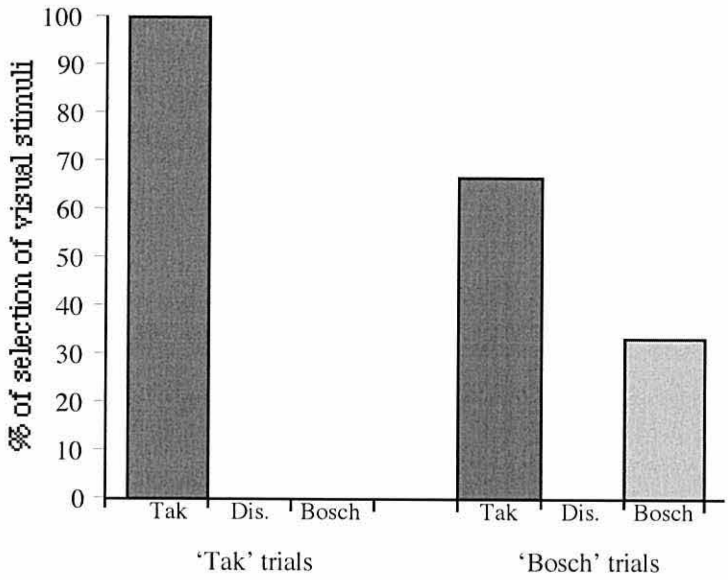


Figure D5. Participant BC: Percentage of selection of each visual comparison on 'Tak' and 'Bosch' target comprehension test trials.

Participant CV

Phase 2.1. Non-Ostensive Exposures and Comprehension Testing

CV received four experimental sessions throughout Phase 2.1. In the first session, she received one exposure trial, and in each of the remaining three sessions, she received three exposure trials.

In each of the four experimental sessions, 12 comprehension test trials were presented; thus CV received a total of 48 comprehension test trials (24 target trials and 24 distracter trials) throughout Phase 2.1. Her performance on these trials is illustrated in Figure D6.

CV did not satisfy the criterion for acquisition of the target relation. She selected the target visual stimulus on only 8.3 percent (2/24) of all target trials. As can be seen in Figure D6, CV exhibited a stimulus preference for the castanets -- the Distracter Visual Stimulus 2 -- which she selected on 75 percent of target trials and 66.6 percent of distracter trials. Further, she rarely selected the target visual stimulus (3/48 trials). Thus CV did not demonstrate acquisition of the target relation following non-ostensive exposure trials.

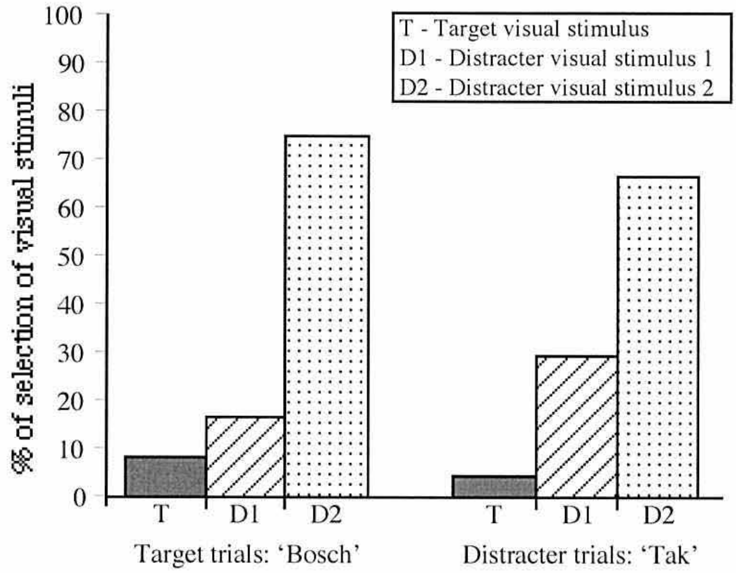


Figure D6. Participant CV: Percentage of selection of each visual comparison on target and distracter comprehension test trials throughout Phase 2.1.

Vocalisations. CV echoed the target auditory sample on 8/10 non-ostensive exposure trials presented. In each of these instances she repeated E1's presentation of the target word either by simply repeating, "Bosch," or echoing, "That Bosch." She did not, however, produce the target auditory sample or the distracter auditory sample on comprehension test trials, or label the target visual stimulus either spontaneously or in response to prompts.

Phase 2.2. Ostensive Exposures and Comprehension Testing

Throughout Phase 2.2, CV had six experimental sessions in which she received 12 ostensive exposure trials. In each of the first three sessions she received one exposure trial, and in each of the remaining three sessions she received three exposure trials.

Although CV was administered comprehension test trials in each experimental session, her performance in only the latter four of these are reported. This is due to an experimenter error in the first two sessions conducted. In these early sessions, although the correct target relation was exposed, one of the visual comparisons presented on the comprehension test trials was incorrect: an incorrect object -- the spring -- was presented as Distracter Visual Stimulus 1. In both of these sessions only one comprehension test trial was presented before the session was abandoned. In both cases, CV exhibited a strong preference for the spring. She refused to attend to the test trial and wanted to play freely with this object. As a result, no codeable responses were produced and therefore reported from these sessions.

In each of the remaining four sessions, the correct visual stimuli were presented on comprehension test trials and CV's attention and co-operation was regained. In each of these sessions she responded on all 12 comprehension test trials presented, thus receiving a total of 48 trials (24 target trials and 24 distracter trials). CV's performance on these trials is illustrated in Figure D7.

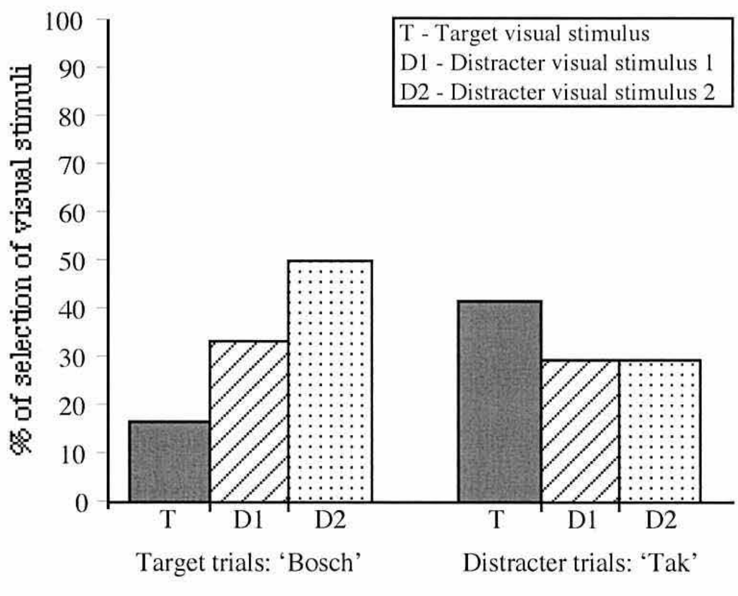


Figure D7. Participant CV: Percentage of selection of each visual comparison on target and distracter comprehension test trials throughout Phase 2.2.

Again, she did not satisfy the criteria for acquisition of the target relation. She selected the target visual stimulus on only 16.6 percent of target trials. Indeed, she selected the target visual stimulus on a greater proportion of distracter trials (41.6 percent). Her stimulus preference for the Distracter Visual Stimulus 2 declined in intensity throughout this phase of the study with all three visual stimuli being selected more equally (14/48, 15/48, and 19/48 selections of the target, Distracter 1, and Distracter 2 visual stimuli respectively).

Vocalisations. Throughout this phase, CV produced the target auditory stimulus with greater frequency. She echoed the target auditory sample presented on 6/12 exposure trials; in each instance she echoed the word presented (i.e., "Bosch") or approximated the carrier phrase in which the stimulus was presented (e.g., "This the Bosch").

In addition, she correctly labelled the target visual stimulus when prompted on five occasions. On four of these occasions her correct labelling occurred before the target auditory sample had been presented in that particular session (i.e., before the first exposure trial in each experimental session). This suggests that CV may have mapped the relation between the target stimuli. However, her vocalisations do not provide unequivocal evidence that she had learned a *specific* relation between the target stimuli. That is, it is not certain whether CV treated the target auditory visual stimulus as a name for the specific target visual stimulus or as a name for all novel visual stimuli; this is because she was not requested to label the novel distracter stimuli informally in this way. Conclusive evidence is only provided in formal naming test sessions in which participants are requested to label both the target visual stimulus and a distracter visual stimulus.

Phase 2.3. Exclusion Exposures and Comprehension Testing

CV received three experimental sessions in Phase 2.3. In the first session, she received one exclusion exposure trial and two control trials. Baseline trials were not included throughout this session. In each of the remaining two sessions she received three unreinforced exclusion exposure trials, three unreinforced control trials, and three baseline trials on which correct responses were rewarded with verbal praise. On each of these trial types, throughout all three sessions, CV responded without error. Further, her correct responding on control trials and baseline trials indicated that her correct selection of the target visual stimulus on exclusion trials was controlled by the auditory sample presented.

CV received a total of 36 comprehension test trials (18 distracter trials and 18 target trials) throughout Phase 2.3. Her performance on these trials is presented in Figure D8.

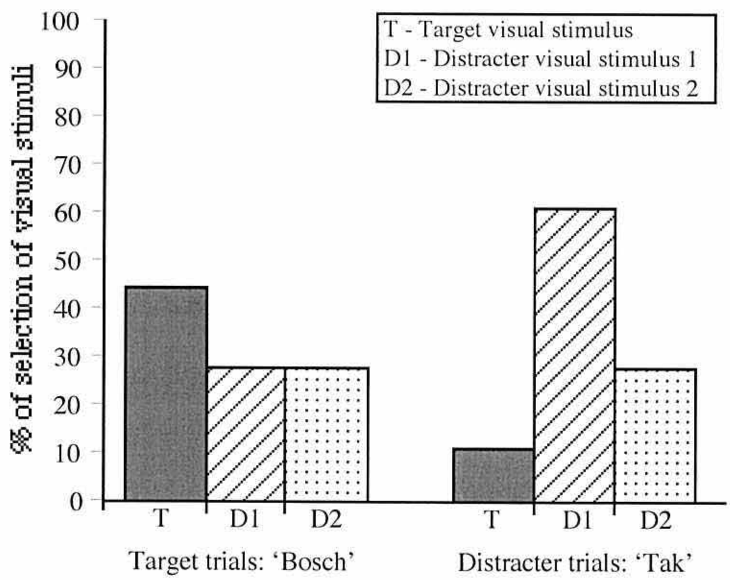


Figure D8. Participant CV: Percentage of selection of each visual comparison on both target and distracter comprehension test trials throughout Phase 2.3.

Once again, she did not achieve the criterion for acquisition of the target relation. She selected the target visual stimulus on only 44.4 percent of all target trials.

Although this is greater than in previous phases it remains below criterion level. CV's preference for the Distracter Visual Stimulus 2 was not identified in this phase; however, the Distracter Visual Stimulus 1 was selected on the majority of comprehension test trials (16/36 trials), with the remaining two stimuli being selected with equal frequency (10/36 trials for each stimulus).

Vocalisations. CV produced two instances of correct prompted labelling of the target visual stimulus throughout this phase of the study. She also produced the distracter auditory stimulus in the final comprehension test session; this was an echo of the auditory sample presented on a distracter comprehension test trial.

Naming test. CV was administered a formal naming test session at the end of Phase 2.3. This comprised 27 free recall trials: 15 familiar trials, 7 target trials, and 5 distracter trials.

CV did not demonstrate that she had learned a specific relation between the target auditory and visual stimuli. She produced the correct auditory stimulus on 86.6 percent of familiar trials (13/15 correct responses). This indicated that she understood the nature of the test trials themselves. On one of the incorrect trials she failed to produce a response. On the remaining familiar trial, on which she responded incorrectly, she produced the target stimulus "Bosch"; this was likely to be a consequence of two preceding target trials in which she correctly produced the target auditory stimulus (i.e., "Bosch").

On target trials, CV responded with 100 percent accuracy suggesting that she may have formed a mapping between the target and auditory visual stimuli. However, her responding on distracter trials was zero percent: she also produced the target auditory stimulus on each of these trials. This indicates that CV had not, in fact, learned a *specific* relation between the target auditory and visual stimuli. Rather, it appeared that she was not labelling per se, that her utterances were not controlled by the objects presented. When requested to label the novel objects she merely produced the target auditory stimulus -- the only novel word previously exposed within the course of the study.

Exposure of a Second Target Novel Relation

In the final session of the study CV was exposed to a second target novel auditory-visual relation. This consisted of the distracter auditory stimulus "Tak", previously presented as the auditory sample on distracter trials. The corresponding visual stimulus was the alarm, the object previously presented as Distracter Visual Stimulus 1. This was selected as the target stimulus as CV did not exhibit a preference for this particular object in previous sessions. She received three non-ostensive exposure trials to this second target relation.

Following the exposure trials, CV received 12 comprehension test trials. These comprised six trials of each target novel relation (i.e., six trials in which "Tak" was presented as the auditory sample and six trials in which "Bosch" was presented as the sample). The Distracter Visual Stimulus 2 continued to be presented as the distracter stimulus on each comprehension test trial. CV's performance on these trials is illustrated in Figure D9.

CV did not demonstrate acquisition of the target relations. Her level of correct responding on both trial types did not exceed 16.6 percent: on 'Tak' target trials CV never selected the correct comparison, and on 'Bosch' target trials she selected the correct comparison with only 16.6 percent accuracy. It appeared that CV was beginning to respond conditionally for the first time within the course of the study, although her comparison selections were in accordance with the incorrect reversed relations: on 'Tak' target trials she selected the 'Bosch' visual stimulus on 4/6 trials, and on 'Bosch' target trials she selected the 'Tak' visual stimulus on 5/6 trials presented; this approached criterion level for reversed relations. Further test trials were not conducted due to time constraints on the study.

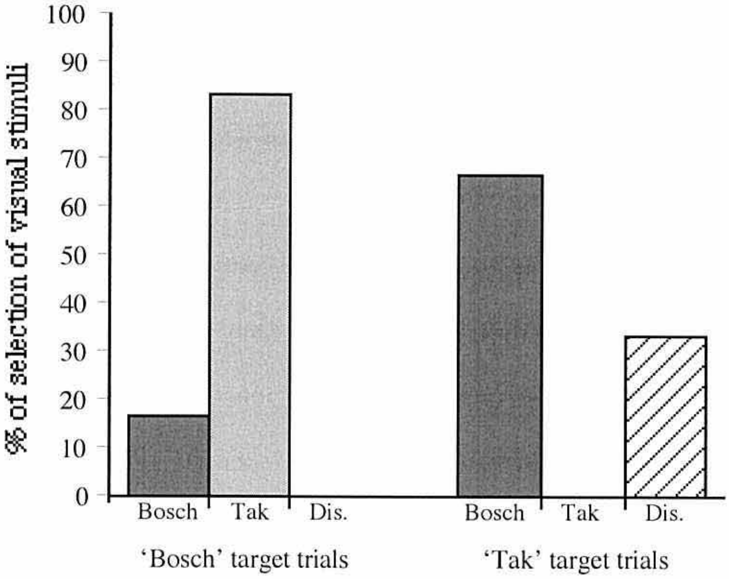


Figure D9. Participant CV: Percentage of selection of each visual comparison on 'Tak' and 'Bosch' target comprehension test trials.

Vocalisations. Throughout this session CV produced two instances of echoing. In both cases she echoed the auditory stimulus "Tak" presented on exposure trials. She also correctly, and spontaneously, labelled the Tak visual stimulus.

In addition, CV correctly labelled the 'Bosch' target visual stimulus, twice, in response to prompts from E1. Note that 'Bosch' exposure trials were not presented in this session (only exposure trials of the second target relation -- Tak -- were presented). Further, CV had not encountered the auditory stimulus "Bosch" for one month prior to her productions of this word in this session. When CV was prompted to label the 'Tak' target visual stimulus she did not produce a response; note that she did not label this visual stimulus with the target word "Bosch".

From her vocalisations, and her performance on related comprehension test trials, it appeared that CV was beginning to learn that the original target word was related to one specific target visual stimulus, yet was not related to the other. When asked to label the original target object in exposure trials she continued to produce the original target word; although this was the correct novel word, these vocalisations may not be labelling per se, she may have continued to produce this target word as she did so in earlier naming tests and informal vocalisations irrespective of the visual stimulus presented. However, she did not label the second visual stimulus with this label, rather she did not produce a response; having had little experience of the second target relation it was likely that she was unable to recall the second target word. Thus it appeared that, although she had not acquired the specific target relations, she was beginning to learn that the target words were related to the specific target objects. This is reflected in her conditional responding (albeit not to criterion level) on comprehension test trials: she demonstrated evidence of relating the words and objects together yet it appeared that she was unsure of the specific relations.

Participant TW

Phase 2.1. Non-Ostensive Exposures and Comprehension Testing

TW had five experimental sessions throughout Phase 2.1, in which he received a total of eight non-ostensive exposure trials. In each of the first two sessions, he was presented with one exposure trial, and in each of the remaining three sessions, he received three exposure trials.

In each session he was also given 12 comprehension test trials. In each of the first three sessions he produced responses on all 12 trials. However, in the fourth session he produced responses on only eight trials before refusing to co-operate further. Thus in the final session, Session 5, the comprehension test trials were interspersed with reinforced baseline trials. This served to increase his general level of attention, and he again produced responses on all 12 comprehension test trials.

Thus TW produced codeable responses on 56 comprehension test trials (28 target trials and 28 distracter trials) throughout Phase 2.1. His performance on these trials is illustrated in Figure D10.

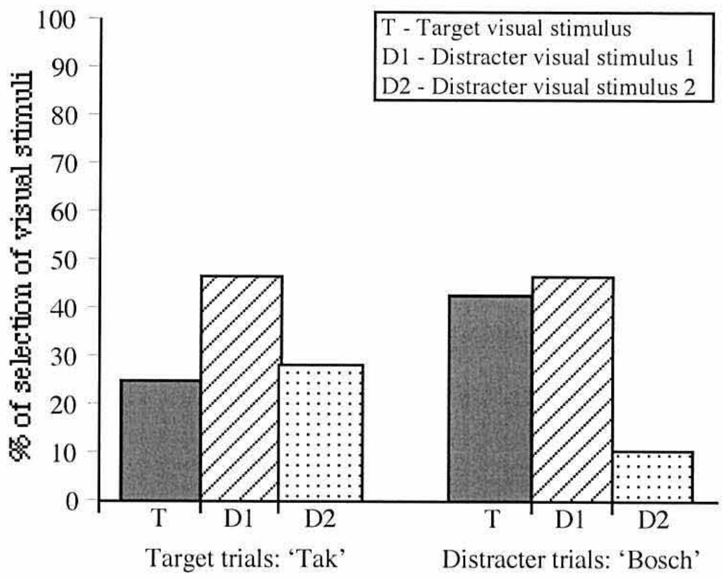


Figure D10. Participant TW: Percentage of selection of each visual comparison on target and distracter comprehension test trials throughout Phase 2.1.

TW did not satisfy the criteria for acquisition of the target relation following non-ostensive exposure trials. He responded with 25 percent accuracy on target trials. He selected the target visual stimulus with a greater frequency on distracter trials (42.8 percent). He also exhibited a weak preference for the selection of the Distracter Visual Stimulus 1 -- the alarm -- which he selected on 26/56 trials presented.

Vocalisations. TW produced many vocalisations of the target auditory stimulus throughout this phase of the study. On three occasions he echoed the target auditory sample presented on target comprehension test trials; in only one instance was his utterance accompanied by his selection of the correct corresponding target visual comparison.

TW correctly labelled the target visual stimulus twice in response to prompts. In addition, he correctly, and spontaneously, labelled the target visual stimulus on seven separate occasions. On 5/7 occasions correct labelling occurred on exposure trials two and three in experimental sessions. Here the target object would be removed from the box, ready for an exposure trial, and TW would say, "Tak," or, "That's Tak," as the object appeared in his view.

The remaining two utterances occurred in a different context. The first of these also occurred in exposure trials. In this instance he correctly labelled the target visual stimulus before the first exposure trial had been presented, that is, before the target name was presented in that experimental session. In the final instance, TW was requested to select "Bosch" on a distracter test trial. In response, he selected the Tak visual stimulus, held it to E2, and said, "This is Tak."

It appears from TW's vocalisations that he may have learned a specific relation between the target stimuli despite failing to demonstrate this on comprehension test trials. However, his vocalisations do not provide conclusive evidence of this; this is because he was never requested to label either of the distracter novel visual stimuli. As a result, it is uncertain whether TW treated the target auditory stimulus as a name for the specific corresponding target visual stimulus, or as a name for all novel visual stimuli. In order to determine which was the case a formal naming test was conducted.

Naming test. TW was administered a formal naming test at the end of Phase 2.1. This comprised 22 free recall test trials: 14 familiar trials, 4 target trials, 4 distracter trials.

TW responded correctly on all familiar trials indicating that he understood the nature of the task itself. On target trials, he responded correctly on 3/4 trials. On the one incorrect trial he failed to produce any response. On two of the distracter trials TW also failed to produce any response. However, on the remaining two distracter trials he produced the target auditory stimulus. This indicates that he had not learned a specific relation between the target auditory and visual stimuli. As in CV's case, it appeared that his productions of the target word were not instances of labelling per se because they were not controlled by the novel visual stimuli. Instead, when requested to label a novel visual stimulus, he merely produced the target word -- the only novel word to have been associated with an exposure trial within the context of the study.

Phase 2.2. Ostensive Exposures and Comprehension Testing

TW was administered four experimental sessions throughout Phase 2.2. In each of these sessions he was presented with three ostensive exposure trials to the target relation. These exposure trials differed in nature to the ostensive exposure trials presented to participants BC and CV. In exposure trials presented to participants BC and CV, the target auditory stimulus was always dictated in the carrier phrase "This is a X" (where X was the target auditory stimulus). However, in exposure trials presented to TW, the carrier phrase was often manipulated. For example, whilst TW was playing with the target visual stimulus E1 dictated the target auditory stimulus in the phrase "What are you doing with the X?" or "What noise does that make? What noise does the X make?" (where X was the target auditory stimulus). In all other ways the exposure trials remained identical in nature to those presented to the other participants.

TW was presented with 12 comprehension test trials in each of the four experimental sessions. However, one of these sessions, Session 3, was abandoned as TW was distracted and refused to respond on any test trial. Further, he only responded on six test trials in Session 1 due to a general lack of attention. Thus TW produced responses on a total of 30 comprehension test trials in Phase 2.2 (15 target trials and 15 distracter trials). His performance on these trials is illustrated in Figure D11.

As in Phase 2.1, TW did not achieve the criterion for acquisition of the target relation. His selection of the target visual stimulus on target trials was below criterion (66.6 percent correct responding). Further, he also selected this stimulus on 86.6 percent of distracter trials. This indicates a preference for the selection of the target visual stimulus, which he selected on 23/30 trials presented. As a result, TW did not demonstrate that he had learned a relation between the target stimuli following ostensive exposure trials.

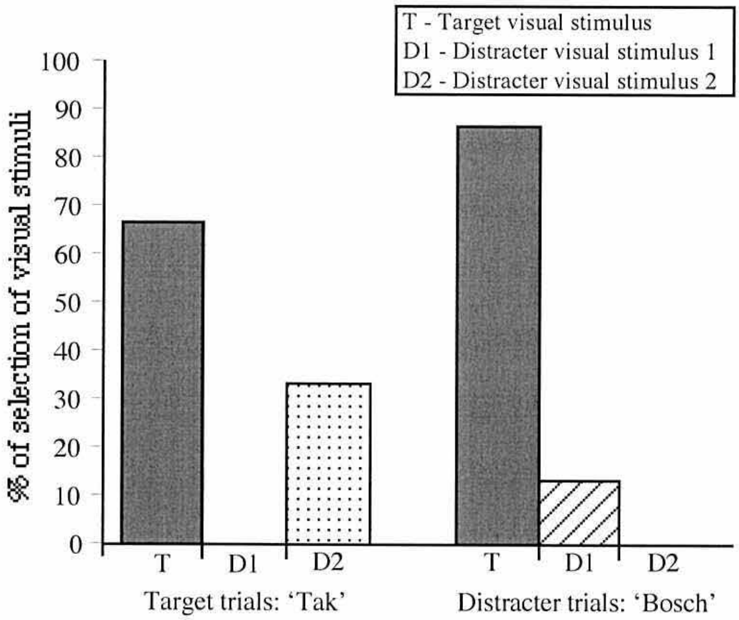


Figure D11. Participant TW: Percentage of selection of each visual comparison on target and distracter comprehension test trials throughout Phase 2.2.

Vocalisations. Throughout Phase 2.2, TW echoed the target auditory stimulus on three occasions. In the first instance, this was an echo of the target auditory stimulus presented on an exposure trial. The remaining two vocalisations were an echo of the auditory sample presented on a target comprehension test trial.

TW also echoed the distracter auditory stimulus on two occasions; both of these vocalisations were instances of echoing of the auditory sample presented on a distracter trial, and both were accompanied by his selection of the incorrect visual comparison -- the target visual stimulus.

In addition, TW demonstrated that he *may* have learned something of the target relation. On seven occasions he correctly, and spontaneously, labelled the target visual stimulus throughout the exposure trials. On two occasions this spontaneous labelling occurred before the first trial: before the target auditory stimulus had been presented in that session. The remaining vocalisations occurred on trials two and three. In each of these instances the target stimulus was removed from the box and placed in TW's view. He then labelled the object before its corresponding name was presented, by E1, on that trial. However, as stated earlier, although these vocalisations suggest that TW may have learned the target relation, the evidence is inconclusive. As no informal requests to label the distracter visual stimuli were administered in this phase, then it is uncertain whether TW treated the target auditory stimulus as a name for the specific target visual stimulus or was simply producing the only novel label he had previously encountered on exposure trials within the context of the study. In order to determine such, distracter naming test trials must be conducted.

Phase 2.3. Exclusion Exposures and Comprehension Testing

TW received four experimental sessions throughout Phase 2.3. In each of the three initial sessions, TW received only unreinforced exclusion trials and unreinforced control trials. Throughout these sessions, he received a total of seven exclusion trials and seven control trials. TW did not respond above criterion level on either exclusion or control trials (see Figure D12).

In order to encourage TW to respond correctly on exclusion trials and control trials, and to increase his general level of attention in the test trials presented, a token reward system was introduced in the final session -- Session 4. Here he was presented with 17 baseline trials; these were rewarded with the presentation of one token for each correct response. He also received five exclusion trials and two control trials; these trials remained unreinforced. TW's performance on these trials is also presented in Figure D12.

The inclusion of the token reward system served to increase his level of correct responding on exclusion trials to 80 percent. However, his level of correct responding on control trials decreased, and responding on baseline trials, even where rewarded with tokens, was below criterion level. This suggests that his selection of the correct target visual stimulus on exclusion trials was not controlled by the specific auditory sample presented.

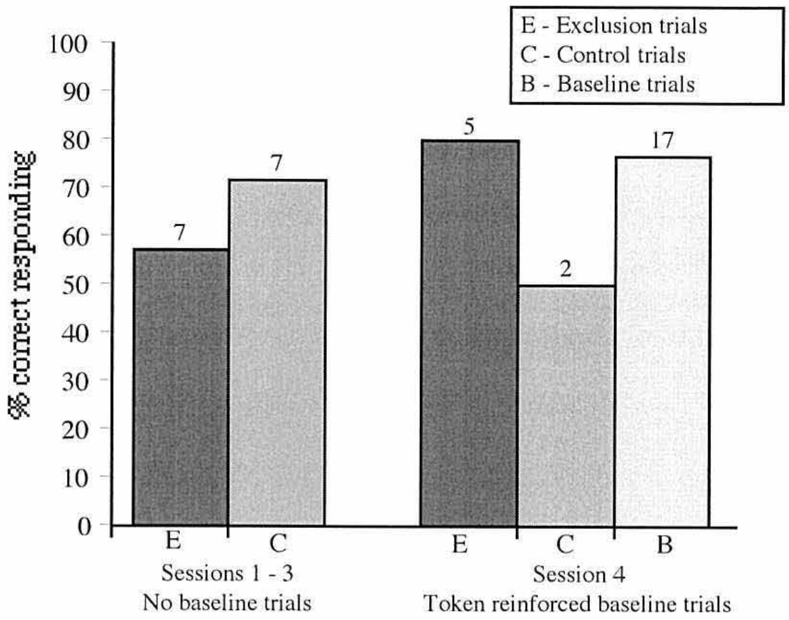


Figure D12. Participant TW: Percentage of correct responding on exclusion, control, and baseline trials throughout Phase 2.3. (Numerals above bars indicate the total number of each trial type presented.)

Twelve comprehension test trials were presented in the first experimental session. In the remaining sessions test trials were not conducted as TW's responses on exclusion trials were below criterion level. Thus, TW's responses on only 12 test trials are reported in this phase of the study. His performance on these is illustrated in Figure D13.

Again, TW did not achieve criterion for acquisition of the target relation. On every target trial he selected the target visual comparison, thus producing 100 percent correct responding. However, TW also selected the target visual stimulus on 66.6 percent of the distracter trials. Thus he continued to exhibit a preference for the target visual stimulus which he selected on 10/12 comprehension test trials presented. This suggests that his selection of this stimulus on target trials was not controlled by the specific auditory sample, but was a result of a preference for that particular comparison.

Vocalisations. TW did not produce either the target or the distracter auditory stimuli throughout Phase 2.3.

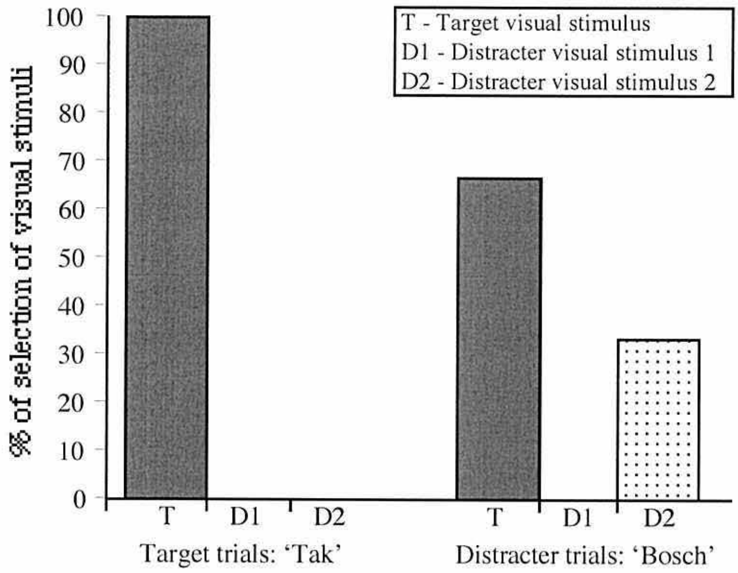


Figure D13. Participant TW: Percentage of selection of each visual comparison on target and distracter comprehension test trials throughout Phase 2.3.

Exposure of a Second Target Novel Relation

TW received three non-ostensive exposure trials to a second target novel relation. This relation consisted of the auditory stimulus "Bosch" that was previously presented as the auditory sample on distracter comprehension test trials. The corresponding visual stimulus was the castanets: the object previously presented as the Distracter Visual Stimulus 2 on comprehension test trials.

Although TW was very attentive throughout the exposure trials he refused to respond on any comprehension test trial, requesting to return to the nursery playroom. As a result, the session was abandoned before any test trials were able to be conducted.

Vocalisations. Throughout the exposure trials TW echoed the target auditory stimulus presented on two occasions.

APPENDIX E

FAMILIAR AND NOVEL VISUAL STIMULI EMPLOYED IN STUDY 2

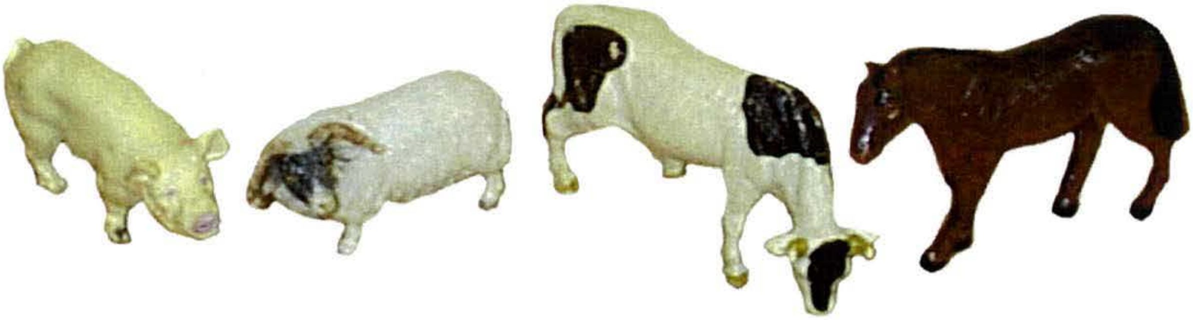


Figure E.1. Familiar visual stimuli employed in Study 2.

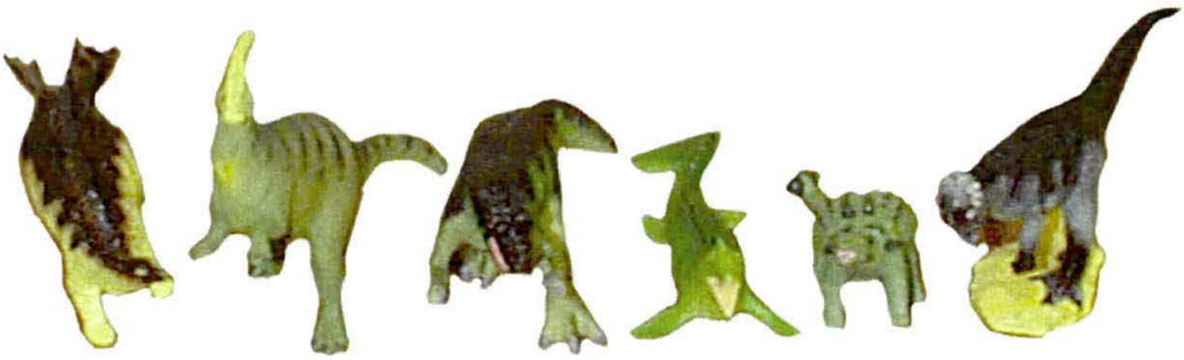


Figure E.2. Set A stimuli -- novel objects -- employed in Study 2.

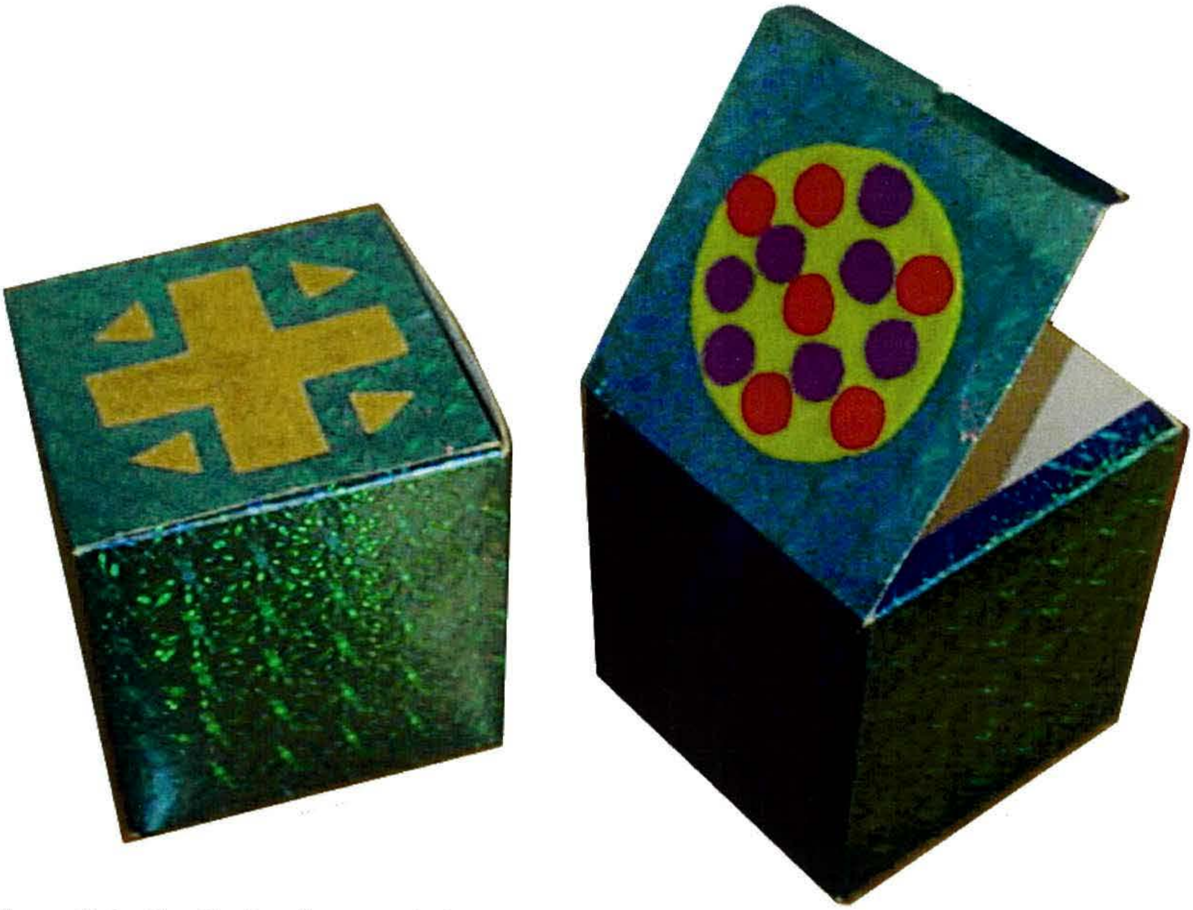


Figure E.3. Set C stimuli -- novel shapes -- employed in Study 2.

APPENDIX F

STUDY 2 DATA

Participant RH

Phase 2. A-B Exposures and B-A Testing

RH received experimental sessions in Phase 2.1 alone before testing was abandoned.

Phase 2.1. A-B non-ostensive exposure trials and B-A testing. RH received two experimental sessions in this phase. In Session 1, she received two exposure trials, during which she was attentive throughout. However, during the presentation of the subsequent B-A trials, RH was inattentive and uncooperative. She took longer to respond on each successive trial, and, as a result, only six trials were conducted (three of each relation); on these trials she produced two correct responses (one on each relation), two incorrect responses, and on two trials she failed to produce any codeable response. Following a period of free play, RH could not be encouraged to attend further and the session was abandoned.

In Session 2, RH was given six exposure trials. Her interest in these declined progressively, and on the final exposure trial she did not attend to the presentation of the novel auditory or visual stimulus. Further, RH failed to produce any codeable responses on the subsequent B-A test trials, and she was consistently distracted and uncooperative. She took no further part in the study.

Appendix F

Participant HD

Phase 2. A-B Exposures and B-A Testing

Participant HD progressed through Phases 2.1, 2.2, and 2.3 of the study, thus receiving non-ostensive, ostensive, and exclusion exposure trials. Table F1 shows the number of exposure trials HD had in each sub-phase, and her accuracy scores on B-A test trials.

Table F1

Participant HD: Number of exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	Exposure trials		B-A test trials	
Phase-Session	A1-B1	A2-B2	B1-A1	B2-A2
2.1 - 1	1	1	1/4	3/5
2.1 - 2	1	1	0/6	4/5
2.1 - 3	3	3	0/6	6/6
2.1 - 4	3	3	1/6	6/6
Total	8	8	2/22	19/22
2.2 - 1	1	1	0/6	6/6
2.2 - 2	3	3	0/6	6/6
Total	4	4	0/12	12/12
	B1-A1	B2-A2	B1-A1	B2-A2
2.3 - 1	1/1	1/1	2/6	5/6
2.3 - 2	0/1	0/1	1/2	0/2
2.3 - 3	0/1	0/1	1/2	2/2
2.3 - 4	0/2	0/2	-	-
Total	1/5	1/5	4/10	7/10

Phase 2.1. A-B non-ostensive exposure trials and B-A testing. HD produced codeable responses on 9/12 B-A trials in Session 1 (see Table F1); this was because she did not appear to understand the response requirements on the initial three trials. As a result, the carrier phrase in which the auditory sample was presented was altered in subsequent sessions; in these later sessions she produced codeable responses on all 12 trials.

HD did not demonstrate acquisition of the symmetrical B-A relations following non-ostensive exposure trials; her responding in each session was below criterion level (44.4, 36.4, 50, and 58.3 percent overall, respectively, see Figure F1). HD demonstrated a preference for the A2 stimulus, which she selected on 39/44 trials.

Vocalisations. HD produced one instance of echoing of the novel word "Os" -- this was an echo of the auditory sample presented on a B-A trial. HD did not label the novel objects either spontaneously or in response to prompts.

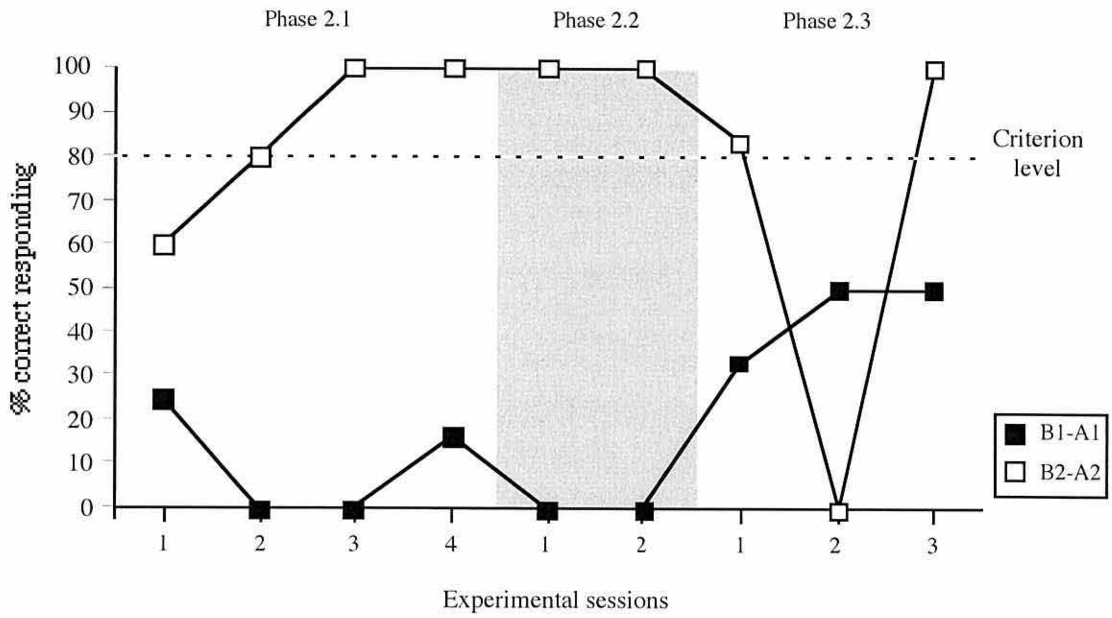


Figure F1. Participant HD: Percentage of correct responding on B-A trials throughout Phase 2. In Phase 2.1, percentage of correct responding was over nine trials (four B1-A1 and five B2-A2) in Session 1, and over 11 trials (six B1-A1 and five B2-A2) in Session 2. In the remaining Phase 2.1 and Phase 2.2 sessions, percentage of correct responding was over 12 trials. In Phase 2.3, percentage of correct responding was over 12 trials in Session 1, and over four trials in each of Sessions 2 and 3.

Phase 2.2. A-B ostensive exposure trials and B-A testing. HD did not demonstrate acquisition of the B-A relations following ostensive exposure trials; her responding was below criterion level in each experimental session (see Figure F1). In each session she responded with 100 percent accuracy on B2-A2 trials and zero percent accuracy on B1-

A1 trials. Thus her stimulus preference had increased in intensity from Phase 2.1 to Phase 2.2; she selected A2 on all 24 trials.

Phase 2.3. B-A exclusion exposure trials and B-A testing. It was intended to present four exclusion exposure trials and four control trials in each session. However, this number was reduced in Sessions 1 to 3 as a result of HD's increasing lack of interest in the procedure. Thus she was given a total of 10 exclusion exposure trials and 10 control trials. Overall, HD responded with 20 percent accuracy on exclusion exposure trials (see Table F1) and 70 percent accuracy on control trials.

Not surprisingly, HD did not demonstrate acquisition of the B-A relations as a result of the exclusion exposure trials (see Figure F1). Her responding in each session was below criterion level (58.3, 25, and 75 percent overall, respectively). She no longer had an exclusive preference for the A2 stimulus, selecting it on 13/20 trials.

Vocalisations. HD did not produce the novel word "Os" in this phase. She produced one instance of echoing of the novel word "Tak" on an exclusion exposure trial; this was accompanied by her selection of the familiar object.

HD labelled each of the novel objects a "Tak" in response to prompts in one instance, and also produced one instance of spontaneous labelling -- following an exclusion exposure trial, as HD was playing with the objects present, she incorrectly labelled the A2 stimulus a "Tak".

Phase 4. Follow-up Testing, A-B Non-Ostensive Exposures and B-A Testing

HD had one experimental session in which she received two A-B non-ostensive exposure trials (one each of A3-B3 and A4-B4). Only six B-A trials (three of each relation) were conducted as a result of HD's increasing inattentiveness during experimental sessions. On these trials HD responded with 16.6 percent accuracy overall; on B3-A3 trials she produced 1/3 correct responses, and on B4-A4 trials she did not produce any correct responses. HD took no further part in the study.

Participant GD

Phase 2. A-B Exposures and B-A Testing

GD progressed through Phases 2.1, 2.2, and 2.3 of the study. The number of exposure trials presented, and his accuracy scores on B-A trials, are presented in Table F2.

Table F2

Participant GD: Number of exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	Exposure trials		B-A test trials	
Phase-Session	A1-B1	A2-B2	B1-A1	B2-A2
2.1 - 1	1	1	1/6	4/6
2.1 - 2	1	1	1/6	4/6
2.1 - 3	3	3	1/6	5/6
2.1 - 4	3	3	0/6	6/6
Total	8	8	3/24	19/24
2.2 - 1	1	1	0/6	5/6
2.2 - 2	3	3	0/6	5/6
2.2 - 3	3	3	0/6	6/6
Total	7	7	0/18	16/18
	B1-A1	B2-A2	B1-A1	B2-A2
2.3 - 1	2/2	2/2	0/4	4/4
2.3 - 2	2/2	2/2	0/4	4/4
2.3 - 3	2/2	2/2	0/4	4/4
Total	6/6	6/6	0/12	12/12

Phase 2.1. A-B non-ostensive exposure trials and B-A testing. Initially, GD failed to produce responses on test trials in which the basic "Where is X?" (where X was the auditory sample) requests were employed. As a result, all the test trials were conducted

using the box that was employed in the A-B non-ostensive exposure trials. This was placed at the side of the table, and GD was requested: "Put X in the box." Responses were therefore coded by recording which of the novel objects was placed in the box.

GD did not pass the B-A symmetry tests; he responded below criterion level in each session (see Figure F2). He had a preference for the A2 stimulus, which he selected on 38/48 trials. This stimulus preference increased in intensity throughout the phase (see Table F2).

Vocalisations. GD echoed the novel words presented on seven B-A test trials; in 4/7 instances he simultaneously selected the incorrect object, and in the remaining 3/7 instances he selected both of the objects.

GD did not produce the novel word "Os" either spontaneously or in response to prompts. He did, however, spontaneously use the novel word "Tak" five times, each time while being shown a novel object on an exposure trial. In only three of these instances did his utterance correspond with the presentation of the A1 (Tak) stimulus.

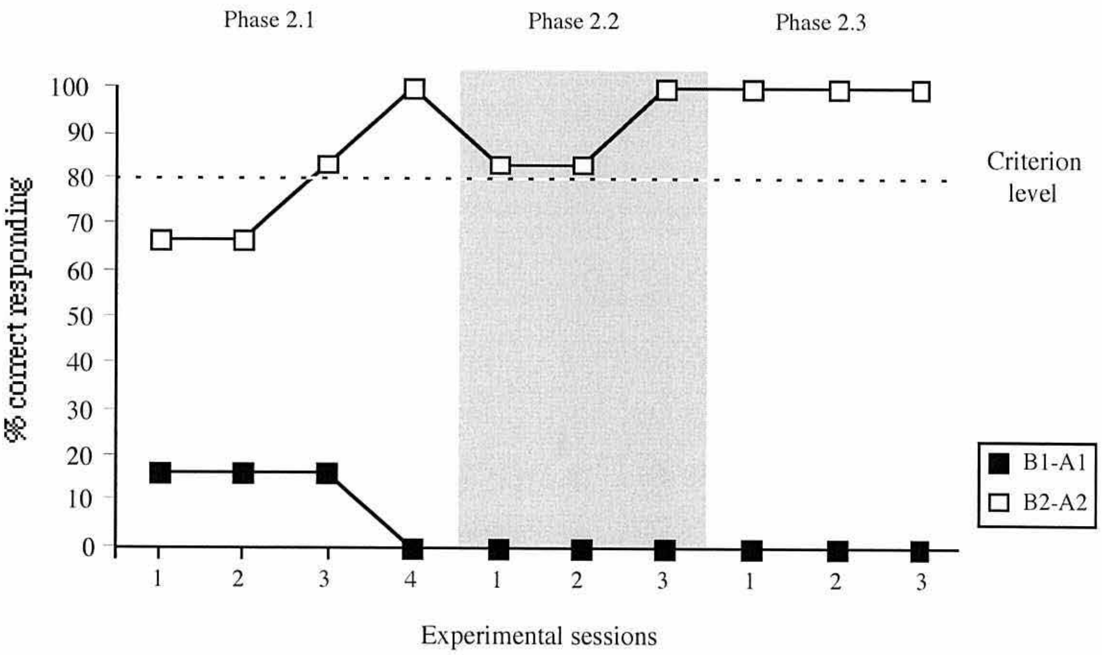


Figure F2. Participant GD: Percentage of correct responding on B-A trials throughout Phase 2. In Phases 2.1 and 2.2, percentage of correct responding was over 12 trials per session. In Phase 2.3, percentage of correct responding was over eight trials per session.

Phase 2.2. A-B ostensive exposure trials and B-A testing. GD did not demonstrate acquisition of the B-A relations following 14 ostensive exposure trials (see Table F2); his responding was below criterion level in each experimental session (see Figure F2). His stimulus preference increased in intensity from Phase 2.1 to Phase 2.2; he now selected A2 on every test trial.

Vocalisations. GD did not echo the novel words throughout this sub-phase. He did, however, spontaneously label the novel objects. This labelling became more accurate as the phase progressed.

In Session 1, GD was presented with both of the novel objects on a B-A trial. Before the auditory sample was presented, he pointed to A2 and incorrectly said, "Tak, that's Tak," and then immediately pointed to A1 and said, "That's Tak too, that's Tak."

In Session 2, the novel objects were presented on the first B-A trial. Before the auditory sample was presented, GD pointed to A1 and correctly said, "That's Tak," then he immediately pointed to A2 and said, "That's Os," and finally, he pointed to A1 again and said, "That one's Tak". On the same B-A trial, as he correctly placed A2 in the box, he said, "That's not Tak."

Phase 2.3. B-A exclusion exposure trials and B-A testing. GD responded with 100 percent accuracy on both exclusion exposure trials (see Table F2) and control trials, and was thus responding conditionally upon the auditory samples presented. However, his responding on B-A test trials was again below criterion level, and was identical to the previous sub-phase (see Figure F2). That is, he responded with 50 percent accuracy overall (100 percent correct on B2-A2 trials, and zero percent correct on B1-A1 trials). Thus his exclusive stimulus preference for A2 was maintained.

Vocalisations. As in the previous sub-phases, GD produced B1 more often than B2. He echoed the auditory sample presented on five exclusion exposure trials as he selected the corresponding novel object; in four of these instances this was an echo of the novel word "Tak".

GD produced only one instance of spontaneous labelling in this sub-phase: he incorrectly labelled A2 with the novel word "Tak".

Phase 4. Follow-up Testing, A-B Non-Ostensive Exposures and B-A Testing.

GD had one experimental session in which he received two A-B exposure trials (one each of A3-B3 and A4-B4). Following these he received 12 B-A test trials (six of each relation). On these trials he did not produce any correct responses; on each of the B3-A3 trials he selected A4, and on each of the B4-A4 trials he selected A3. Although GD responded conditionally upon the auditory samples presented, he appeared to have formed the incorrect B-A relations.

Vocalisations. GD produced only the novel word "Kiekie" which he echoed on five occasions.

Participant LS

Phase 2. A-B Exposures and B-A Testing

Participant LS received only Phase 2.1 experimental sessions before progressing to Phase 3. The number of exposure trials presented, and her accuracy scores on B-A test trials, are presented in Table F3.

Phase 2.1. A-B non-ostensive exposure trials and B-A testing. In the initial two sessions, LS was extremely inattentive and became increasingly reluctant to accompany the experimenter to the research room; as a result, only a small number of test trials were conducted in these sessions (see Table F3). However, following a break in testing (41 days), LS showed renewed interest in the study and experimental sessions were resumed; thus in Sessions 3 and 4, 12 test trials were conducted.

Table F3

Participant LS: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2. (Bold text denotes sessions in which criterion level was achieved.)

Phase-Session	A-B exposure trials		B-A test trials	
	A1-B1	A2-B2	B1-A1	B2-A1
2.1 - 1	1	1	1/4	2/4
2.1 - 2	1	1	0/3	2/3
2.1 - 3	3	3	**5/6**	**5/6**
2.1 - 4	3	3	**6/6**	**5/6**
Total	8	8	12/19	14/19

In Sessions 1 and 2, LS failed the B-A tests (see Figure F3). She had a stimulus preference for A2, which she selected on 10/14 trials.

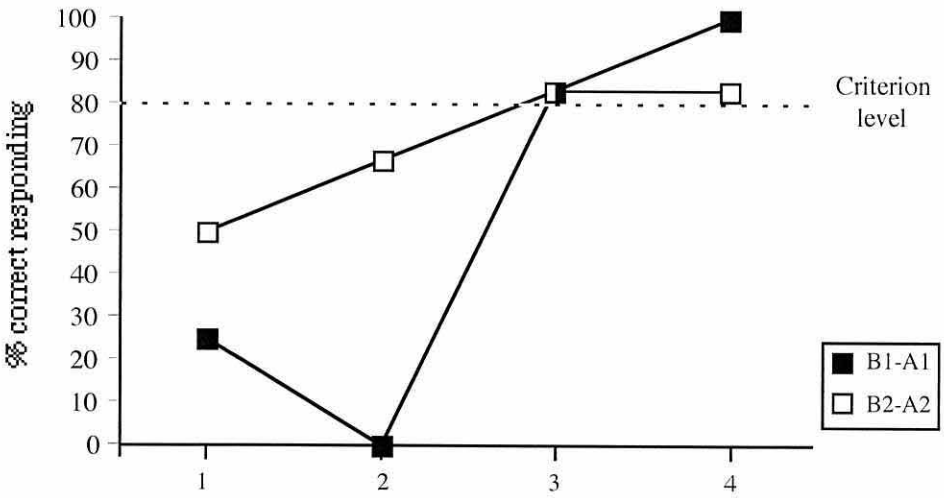


Figure F3. Participant LS: Percentage of correct responding on B-A trials throughout Phase 2.1. In Session 1 percentage of correct responding was over eight trials, and in Session 2 over six trials. In each of Sessions 3 and 4, percentage of correct responding was over 12 trials.

However, in Session 3, LS's preference was no longer evident and she demonstrated acquisition of the symmetrical B-A relations, responding with 83.3 percent accuracy on both B1-A1 and B2-A2 trials (see Figure F3). She was aged 31 months and 10 days when she passed this test. Her criterion level performance was maintained in Session 4 (100 percent correct on B1-A1 trials, and 83.3 percent correct on B2-A2 trials, see Figure F3).

Vocalisations. There was a marked difference in LS' productions of the novel words in the initial two sessions, in which she failed to respond above criterion level, and the final two sessions, in which she demonstrated acquisition of the B-A relations.

In Sessions 1 and 2, LS did not label the novel objects either spontaneously or in response to prompts, and she did not echo the novel words presented on exposure trials. She did, however, typically echo the novel words presented on B-A trials; on 13/14 trials she echoed the auditory sample presented as she selected one of the novel objects. There was no relationship between her echoic utterances and her comparison selections; she selected the novel object that corresponded with her echoic utterance on only 5/13 trials.

In Sessions 3 and 4, LS echoed the novel words presented on B-A trials with less frequency, she began to echo the novel words presented on exposure trials, and she also began to label the novel objects both spontaneously and in response to prompts.

LS echoed the novel words on B-A test trials with less frequency than in Sessions 1 and 2; she echoed the auditory sample presented on only 1/24 trials conducted. In this instance, LS said, "There's Tak," as she tentatively selected the incorrect A2 comparison. However, she then corrected herself by immediately selecting A1 and saying, "There's Tak."

LS also echoed the novel word presented on an exposure trial. In this instance (following the presentation of the novel word), LS removed A1 from the box and said, "Tak's heavy."

In addition, LS produced spontaneous vocalisations of the novel words during the exposure trials. In Session 3, on an A2-B2 trial, as A2 (Os) was being presented, LS repeatedly asked, "Where's Tak? Where's Tak gone?" This was prior to any presentation of the novel word "Tak" during that session.

On the third exposure trial presented in this session, an A2-B2 trial, E1 erred on the presentation of the novel word: after A2 was dropped into the box, E1 incorrectly said, "That was Tak." LS corrected E1 by saying, "That's not Tak." E1 then produced the correct novel word.

During a period of play with the novel objects, E2 asked LS which object she would like to play with. LS requested to play with "Os" and in response was given the incorrect "Tak" object. Upon presentation of this object LS said, "No, that's not Os," and when the correct object was subsequently presented she said, "That one's Os."

A-B naming test. Following Session 4, LS had a naming test comprising six free recall trials (three of each relation). On each of the A1-B1 trials, LS correctly produced the novel word "Tak". On the three A2-B2 trials, LS produced the correct novel word "Os" on one trial; on the remaining two trials she replied, "I don't know." Note that she did not incorrectly label A2 with the novel word "Tak".

Phase 3. C-A Exposures and B-C Testing

LS had three experimental sessions in Phase 3 (see Table F4); these comprised B-A test trials, C-A non-ostensive exposure trials, and B-C test trials. The number of exposure trials presented, and accuracy scores on test trials, are shown in Table F4.

B-A test trials. LS had two B-A test trials at the beginning of each experimental session. She responded with 100 percent accuracy overall on both B1-A1 and B2-A2 trials.

Table F4

Participant LS: Number of C-A exposure trials presented, and accuracy scores on B-C test trials, throughout Phase 3. (Bold text denotes sessions in which criterion level was achieved.)

	C-A exposure trials		B-C test trials	
Session	C1-A1	C2-A2	B1-C1	B2-C2
1	1	1	**6/6**	**6/6**
2	3	3	**6/6**	**6/6**
3	3	3	**6/6**	**6/6**
Total	7	7	18/18	18/18

B-C test trials. LS demonstrated immediate derivation of the B-C equivalence relations following only one non-ostensive exposure trial of each novel relation; she responded with 100 percent accuracy in Session 1 (see Figure F4). LS was aged 31 months and 18 days at this point in the study. LS maintained her criterion level performance in Sessions 2 and 3 (see Figure F4).

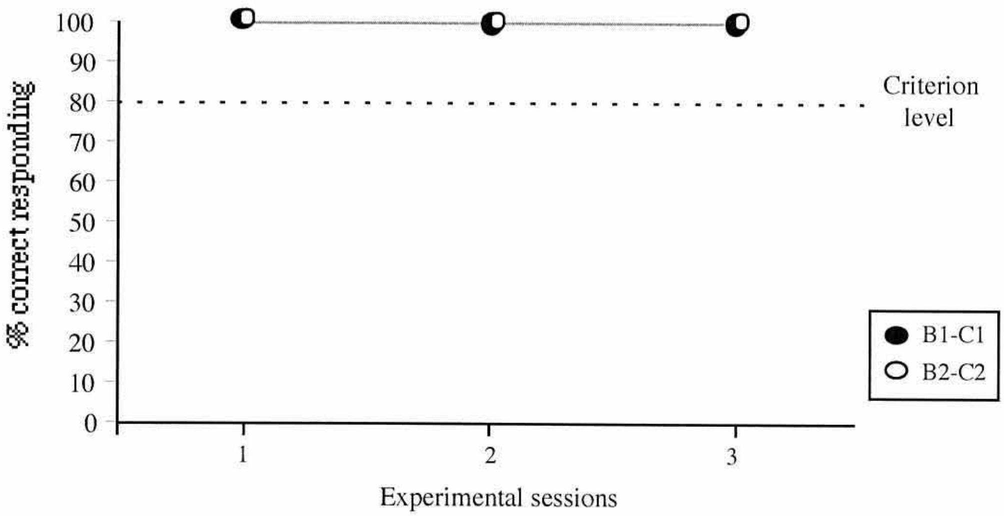


Figure F4. Participant LS: Percentage of correct responding on B-C trials throughout Phase 3. Correct responding was over 12 trials in each session.

Phase 4. Follow-up Testing, A-B Non-Ostensive Exposures and B-A Testing

LS had three experimental sessions, in Phase 4, comprising two, six, and four A-B non-ostensive exposure trials, respectively. LS received 12 B-A trials in each of the first two sessions. In both of these sessions she responded with 50 percent accuracy overall (zero percent correct on B3-A3 trials, and 100 percent correct on B4-A4 trials). Thus LS exhibited an exclusive preference for the A4 stimulus, which she selected on all of the trials.

Vocalisations. LS's vocalisations of the novel words were similar to those of the initial two sessions in Phase 2.1. She echoed the auditory sample presented on 23/24 B-A trials. These utterances were invariably accompanied by her selection of the A4 stimulus.

LS also echoed the novel word presented on one A3-B3 exposure trial. In this instance she said, "I get Kiekie out," as she removed the object from the box.

APPENDIX G

FAMILIAR AND NOVEL VISUAL STIMULI EMPLOYED IN STUDY 3

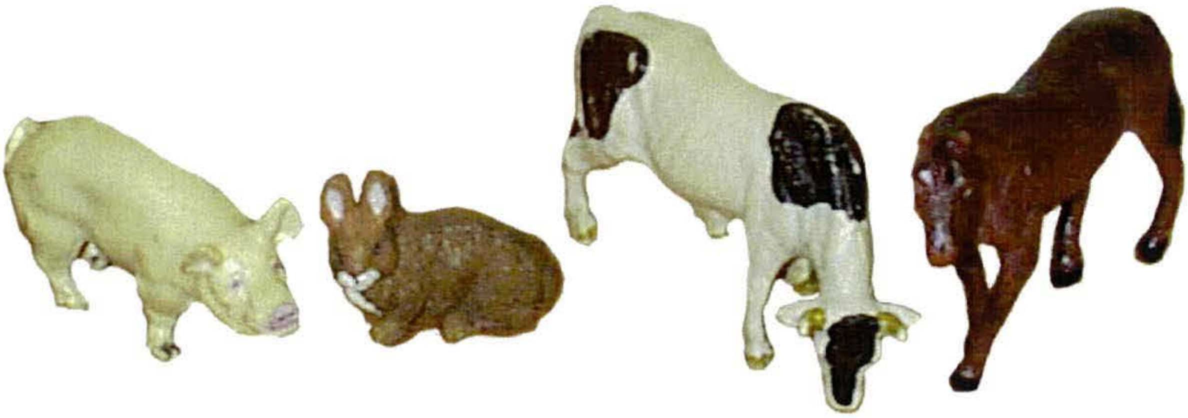


Figure G.1. Familiar visual stimuli employed in Study 3.

Figure G.2. Set A stimuli -- novel objects -- employed in Study 3.

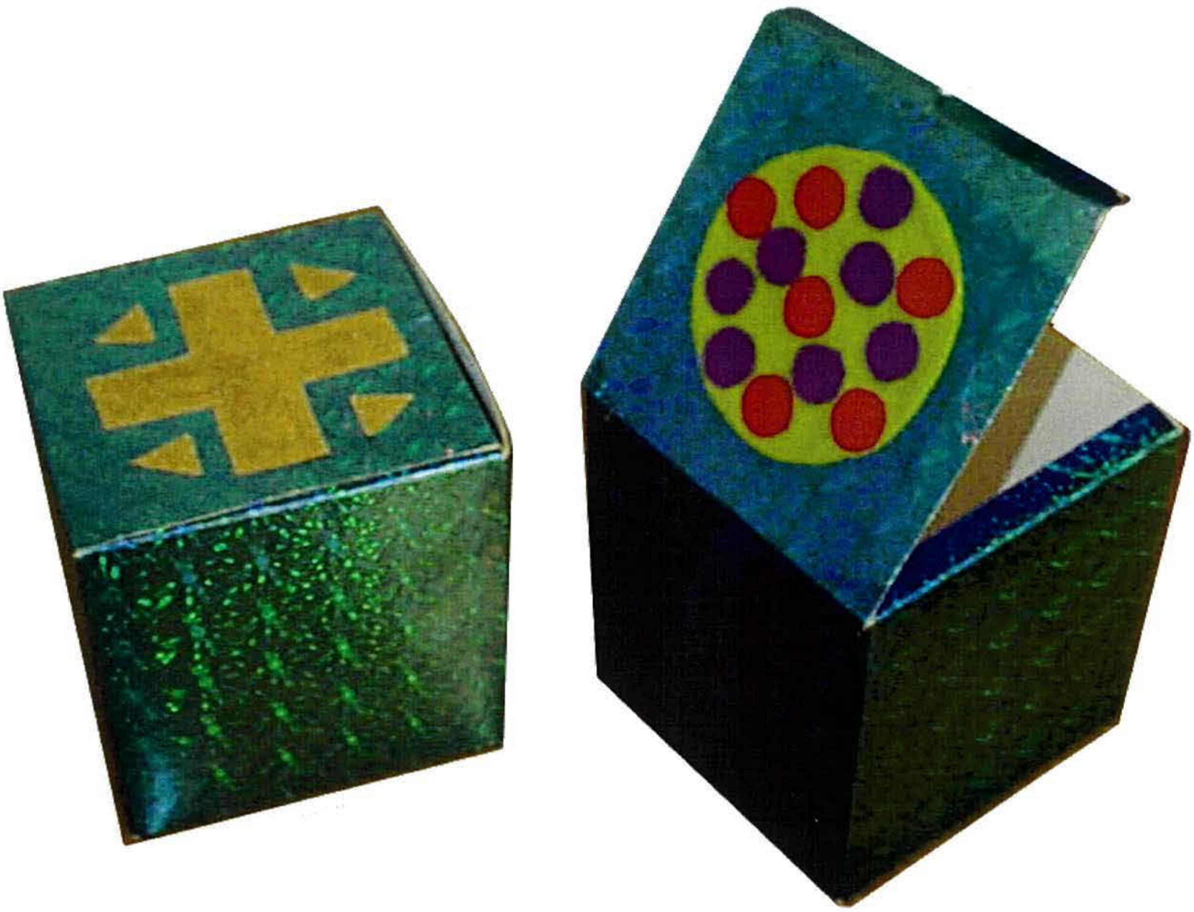


Figure G.3. Set C stimuli -- novel shapes -- employed in Study 3.

APPENDIX H

STUDY 3 DATA

Participant DN

Phase 2. A-B Exposures and B-A Testing

DN progressed through Phases 2.1 and 2.2, thus having A-B non-ostensive and ostensive exposure trials. The number of exposure trials presented, and his responses on the subsequent B-A tests, are presented in Table H1.

Table H1

Participant DN: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	A-B exposure trials		B-A test trials	
Phase - session	A1-B1	A2-B2	B1-A1	B2-A2
2.1 - 1	1	1	2/6	5/6
2.1 - 2	3	3	1/6	6/6
2.1 - 3	3	3	0/6	5/6
Total	7	7	3/18	16/18
2.2 - 1	1	1	1/6	3/6
2.2 - 2	3	3	3/6	4/6
2.2 - 3	3	3	4/6	4/6
Total	7	7	8/18	11/18

Phase 2.1. A-B non-ostensive exposure trials and B-A testing. DN did not demonstrate acquisition of the symmetrical B-A relations following non-ostensive exposure trials; he responded below criterion level in each session (58.3, 58.3, and 41.6 percent accuracy overall, in Sessions 1 to 3 respectively, see Figure H1). DN demonstrated a preference for the A2 stimulus, which he selected on 31/36 B-A trials.

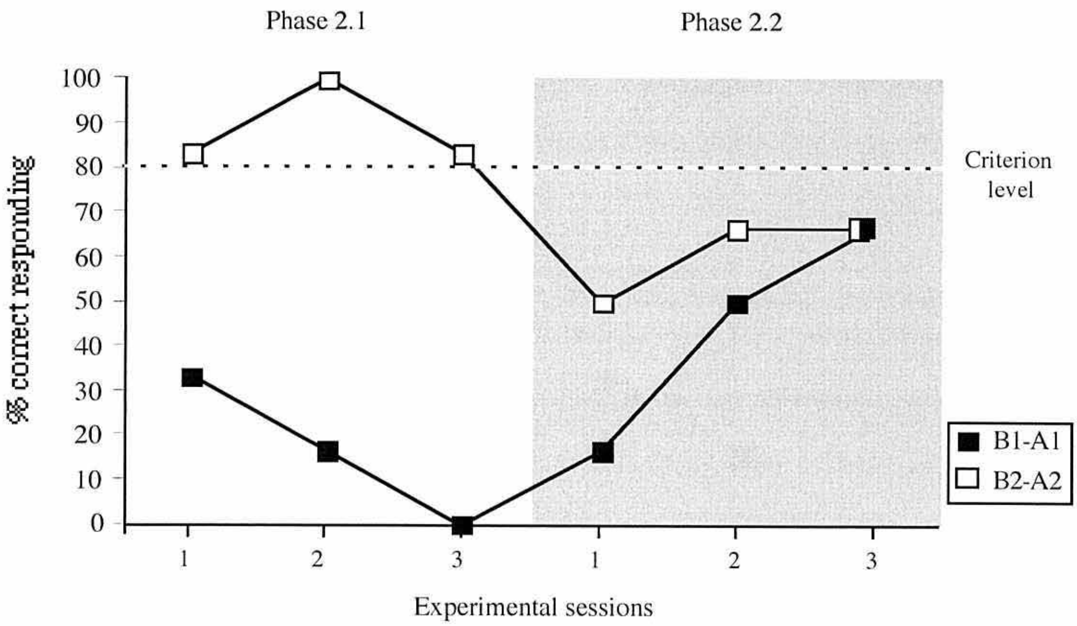


Figure H1. Participant DN: Percentage of correct responding on B-A trials throughout Phase 2. Percentage of correct responding was over 12 trials in each session.

Phase 2.2. A-B ostensive exposure trials and B-A testing. DN did not pass the B-A tests following ostensive exposure trials; his responding in each session was below criterion level (33.3, 58.3, and 66.6 percent overall, respectively, see Figure H1). His stimulus preference declined in intensity from Phase 2.1 to Phase 2.2; he now selected A2 on 21/36 trials.

DN's performance in experimental sessions declined progressively. His attention was increasingly distracted and sessions became progressively longer in duration. As a result he took no further part in the study.

Participant RP

Phase 2. A-B Exposures and B-A Testing

RP progressed through Phases 2.1 and 2.2, thus receiving A-B non-ostensive and ostensive exposure trials. The number of exposure trials presented, and his performance on the B-A tests, is shown in Table H2.

Table H2

Participant RP: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	A-B exposure trials		B-A test trials	
Phase - session	A1-B1	A2-B2	B1-A1	B2-A2
2.1 - 1	1	1	1/4	5/6
2.1 - 2	3	3	2/6	5/6
2.1 - 3	3	3	2/6	5/6
Total	7	7	5/16	15/18
2.2 - 1	1	1	0/6	6/6
2.2 - 2	1	1	1/6	6/6
2.2 - 3	3	3	1/6	6/6
Total	5	5	2/18	18/18

Phase 2.1. A-B non-ostensive exposure trials and B-A testing. RP did not demonstrate derivation of the symmetrical B-A relations following non-ostensive exposure trials; his performance was below criterion level in each session (50, 58.3, and 58.3 percent accuracy overall, respectively, see Figure H2). RP had a preference for the A2 stimulus, which he selected on 26/34 trials.

A-B naming test. At the end of Phase 2.1, RP had a naming test which comprised six free recall, prompted recall, and recognition trials, on which he responded with 50 percent accuracy overall (33.3, 66.6, and 50 percent correct on each trial type, respectively). On free recall and prompted recall trials he produced the B1 stimulus on 5/6 trials, and on the recognition trials he replied "Yes" on 5/6 trials.

Vocalisations. RP's vocalisations confirmed that he had not acquired the novel relations. He echoed the auditory sample presented on 12 B-A trials; these were not consistent with his selection of the correct comparison stimulus. In three of these instances, he selected both of the novel objects and said: "Two Taks," or "Two Bosch."

RP labelled a novel object "Tak", either spontaneously or in response to a prompt, on five occasions throughout Phase 2.1; only two of these instances corresponded with the presentation of the A1 (Tak) stimulus. RP did not label the objects a "Bosch" in any instance.

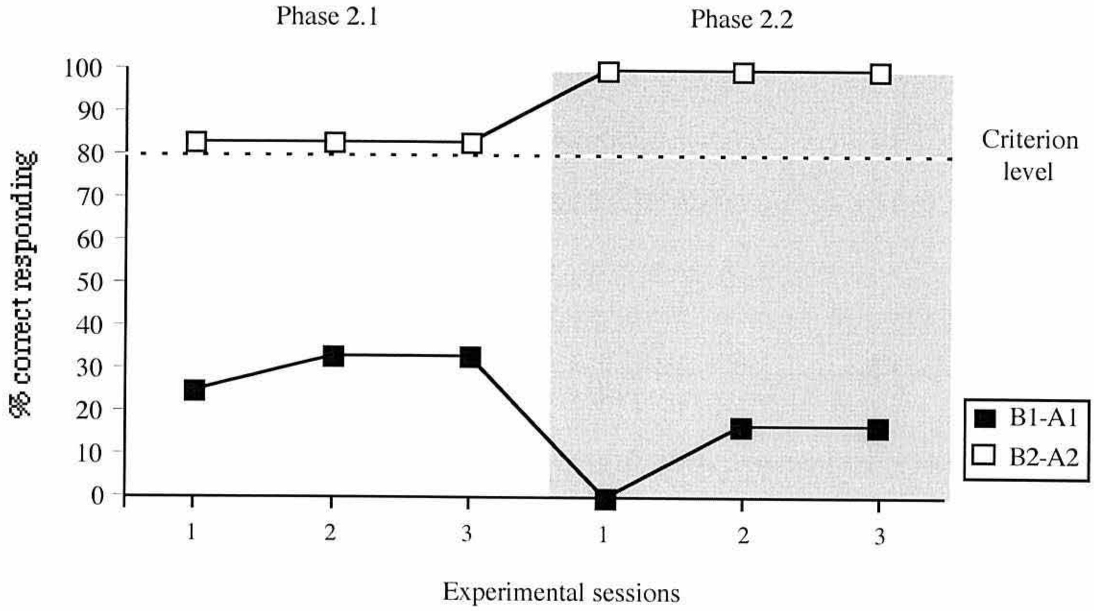


Figure H2. Participant RP: Percentage of correct responding on B-A trials throughout Phase 2. In Phase 2.1, percentage of correct responding was over 10 trials in Session 1 (four B1-A1 trials and six B2-A2 trials), and over 12 trials in Sessions 2 and 3. In Phase 2.2, percentage of correct responding was over 12 trials in each session.

Phase 2.2. A-B ostensive exposure trials and B-A testing. RP did not pass the B-A tests following 14 ostensive exposure trials; his responding was below criterion level in each session (50, 58.3, and 58.3 percent overall, respectively, see Figure H2). RP's stimulus preference increased in intensity from Phase 2.1 to Phase 2.2; he now selected A2 on 34/36 B-A trials.

A-B naming test. RP had a naming test, at the end of Phase 2.2, which comprised 11 free recall trials (five A1-B1 and six A2-B2 trials). Overall, he responded with 72.2 percent accuracy (100 percent on A1-B1 trials, and 50 percent on A2-B2 trials). He produced the B1 stimulus ("Tak") on 8/11 trials.

Vocalisations. RP echoed the novel word presented on two A2-B2 exposure trials. He also correctly labelled each of the novel objects once in response to prompts. However, he also produced two instances of incorrect spontaneous labelling; in both instances he labelled the A2 (Bosch) stimulus a "Tak".

Participant CE

Phase 2. A-B Exposures and B-A Testing

CE progressed through Phases 2.1 and 2.2, thus receiving both A-B non-ostensive and ostensive exposure trials. The number of exposure trials presented, and CE's accuracy scores on the subsequent B-A tests, are presented in Table H3.

Table H3

Participant CE: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	A-B exposure trials		B-A test trials	
Phase - session	A1-B1	A2-B2	B1-A1	B2-A2
2.1 - 1	1	1	4/6	3/6
2.1 - 2	3	3	0/6	6/6
2.1 - 3	3	3	0/6	5/6
Total	7	7	4/18	14/18
2.2 - 1	1	1	0/6	6/6
2.2 - 2	3	3	0/6	6/6
2.2 - 3	3	3	0/6	5/6
Total	7	7	0/18	17/18

Phase 2.1. A-B non-ostensive exposure trials and B-A testing. CE did not demonstrate acquisition of the symmetrical B-A relations following non-ostensive exposure trials; his responding was below criterion level in each session (see Table H3, Figure H3). CE had a preference for the A2 stimulus, which he selected on 28/36 trials.

A-B naming test. CE had a naming test session, at the end of Phase 2.1, which comprised six free recall, prompted recall, and recognition trials. CE responded with 44.4 percent accuracy overall (50, 16.6, and 66.6 percent correct on each trial type, respectively).

Patterns were evident in CE's responses. On free recall trials, whilst he produced the correct name on all A2-B2 (Bosch) trials, he did not make any response on A1-B1 (Tak) trials. It is important to note that he did not label the A1 stimulus a "Bosch", but rather, did not produce a response. This suggests that CE may have learned the A2-B2 (Bosch) relation. However, this pattern of responses was not evident on the remaining trial types. On the subsequent recognition trials he replied "Yes" on 5/6 trials, and named the A1 stimulus -- the pocket alarm -- a "Telephone" on the remaining trial.

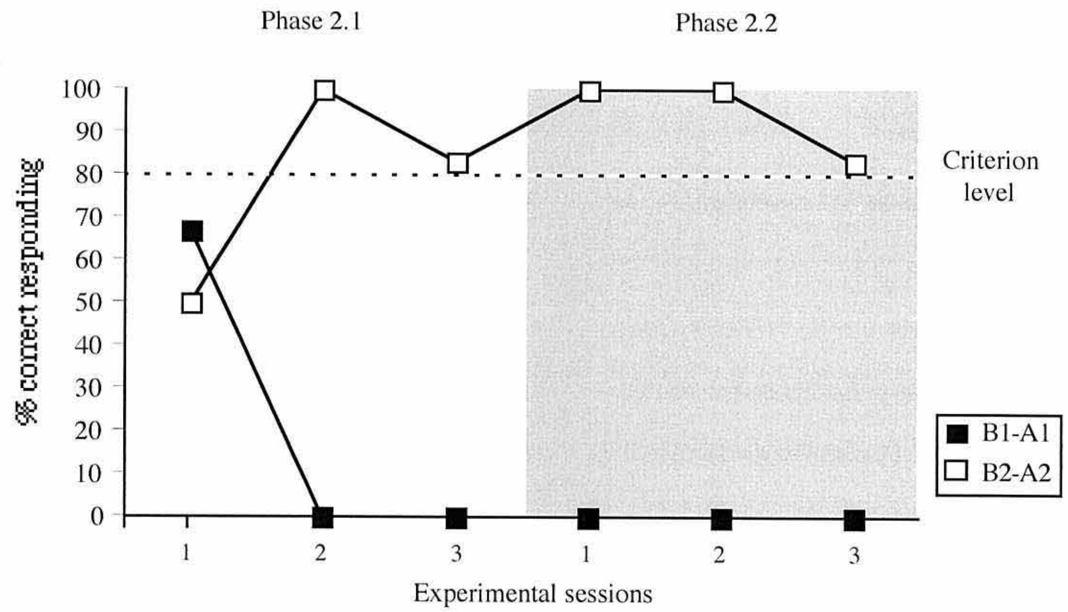


Figure H3. Participant CE: Percentage of correct responding on B-A trials throughout Phase 2. Percentage of correct responding was over 12 trials in each session.

Vocalisations. CE echoed the novel words on two occasions throughout this phase, and on one occasion he incorrectly labelled the A2 stimulus a "Tak" in response to a prompt. However, CE correctly and spontaneously labelled the A2 stimulus on three occasions; in contrast, he did not label the A1 stimulus in any instance. These vocalisations corresponded with his performance on the free recall trials conducted in the naming test.

Phase 2.2. A-B ostensive exposure trials and B-A testing. As depicted in Figure H3, CE did not pass the B-A tests following ostensive exposure trials (50, 50, and 41.6 percent accuracy in each session, respectively). His stimulus preference increased in intensity from Phase 2.1 to 2.2; he selected A2 on 35/36 trials.

A-B naming test. CE had a naming test which comprised six free recall, prompted recall, and recognition trials. He responded with 33.3 percent accuracy overall (50, 33.3, and 16.6 percent correct on each trial type, respectively).

A pattern was observed in CE's responses on free recall trials. On each A2-B2 trial, CE correctly produced the novel word "Bosch"; on one A1-B1 trial, he produced a familiar word, and on the remaining two trials he labelled A1: "Telephone."

A similar pattern of responses was observed on prompted recall trials. On A2-B2 trials CE produced 2/3 correct responses; on the incorrect response he corrected himself: "A tak, a bosch, a bosch." On all the A1-B1 trials, CE labelled the A1 stimulus: "Telephone." On the recognition trials, CE replied "Yes" on 5/6 trials. In one of these instances, when shown A1 (Tak) and asked "Is this a Bosch?" he replied, "Er, yes. No, telephone." On the remaining two A1-B1 recognition trials he responded with "Telephone".

Thus it appeared that CE may have learned the A2-B2 relation, and in addition had associated the A1 stimulus with the word "Telephone". (See vocalisations section for further evidence.) It is likely that this pattern of responses was not sustained fully over the prompted recall and recognition trials because CE found these confusing: whilst his responses on the familiar free recall trials were above criterion level, his responses were below criterion on both familiar prompted recall trials (50 percent) and familiar recognition trials (44.4 percent).

Vocalisations. CE's vocalisations, towards the end of the phase, corresponded with his performance on the naming test. In Session 1, CE spontaneously, yet incorrectly, labelled both of the novel objects once each on an exposure trial.

However, in Session 3, CE correctly and spontaneously labelled A2 a "Bosch". In addition, on two occasions he labelled the A1 stimulus: "Telephone." In one of these instances, E presented the A1 stimulus on an exposure trial; when she then presented the corresponding novel word ("Tak"), CE corrected her by saying, "No, telephone."

It appeared, from the naming test sessions and his informal vocalisations, that CE had learned something of the novel relations. Specifically, it appeared that he had learned the A2-B2 relation: he consistently labelled A2 correctly on free recall trials, and frequently labelled it spontaneously during experimental sessions. Further, it appeared that although CE had not learned the A1-B1 relation, he had associated "Telephone" with the A1 stimulus: he consistently labelled A1 with this name, or provided no response, on A1-B1 free recall trials, and, in addition, labelled A1 "Telephone" during experimental sessions. Note also that at no point in Phase 2 did CE label A2 "Telephone", and very rarely did he label A1 "Bosch". This was especially the case for the final two sessions of Phase 2.2.

As a result, CE progressed to Phase 3 of the study, despite not having passed the B-A test at this point.

Phase 3. C-A Exposures and B-C Testing

In each of the first three sessions, CE was given C-A non-ostensive exposure trials and B-C equivalence tests (B-A test trials were not conducted in these sessions because CE had not previously demonstrated derivation of these relations in Phase 2). The number of exposure trials presented, and his accuracy scores on the B-C test trials, are presented in Table H4. In the final session -- Session 4 -- CE had a C-A test.

Table H4

Participant CE: Number of C-A exposure trials presented, and accuracy scores on B-C test trials, throughout Phase 3.

	C-A exposure trials		B-C test trials	
Session	C1-A1	C2-A2	B1-C1	B2-C2
1	1	1	0/4	1/5
2	3	3	0/6	5/6
3	3	3	0/6	6/6
Total	7	7	0/16	12/17

B-C test trials. CE did not pass the B-C equivalence tests following C-A non-ostensive exposure trials; his responding was below criterion level in each experimental session (see Table H4 and Figure H4). CE had a preference for the C2 stimulus, which he selected on 28/33 trials.

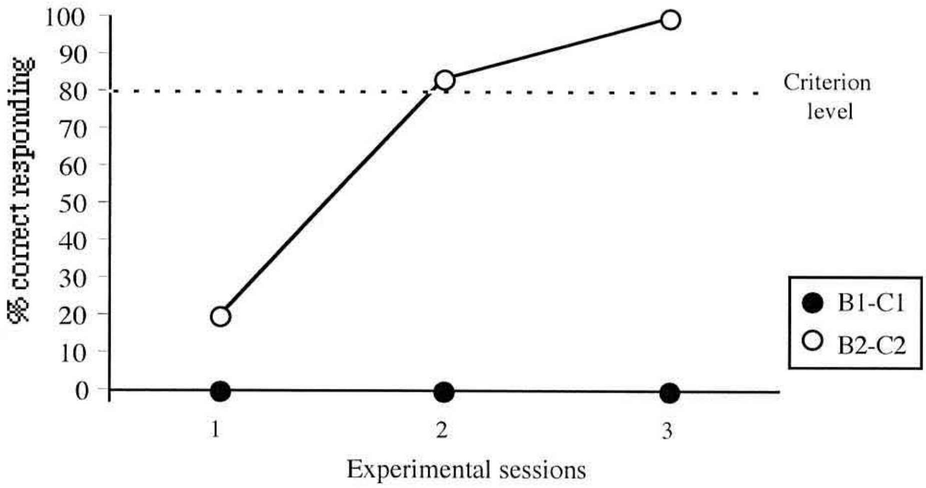


Figure H4. Participant CE: Percentage of correct responding on B-C trials throughout Phase 3. Percentage of correct responding was over nine trials (four B1-C1 and five B2-C2) in Session 1, and over 12 trials in Sessions 2 and 3.

C-A test trials. CE had one 12 trial C-A test (six trials each of C1-A1 and C2-A2) in Session 4. He did not demonstrate that he had acquired the C-A relations; his responding in this session was below criterion (33.3 percent correct on C1-A1 trials, and 83.3 percent correct on C2-A2 trials).

Vocalisations. CE produced one instance of prompted labelling throughout the C-A exposure trials: when he shown the C2 stimulus and was asked "What hides in here?" he correctly replied, "A bosch in there."

Throughout the C-A test session, on nine trials when asked "What hides in here?" as one of the novel shapes was presented, CE replied with the novel word "Bosch"; in only 3/9 of these instances was this the correct novel word.

Participant SR

Phase 2. A-B Exposures and B-A Testing

SR received only Phase 2.1 experimental sessions. The number of non-ostensive exposure trials presented, and his performance on the subsequent B-A tests, are shown in Table H5.

Table H5

Participant SR: Number of non-ostensive A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.1. (Bold text denotes sessions in which criterion level was achieved.)

	A-B exposure trials		B-A test trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	**6/6**	**6/6**
2	-	-	**5/6**	**6/6**
Total	1	1	11/12	12/12

Note. These sessions were not presented consecutively, but were interspersed with one Phase 3 experimental session.

Phase 2.1. A-B non-ostensive exposure trials and B-A testing. SR had only two non-ostensive exposure trials (one of each relation) before passing the B-A test; in Session 1 he responded with 100 per cent accuracy on both B1-A1 and B2-A2 trials. SR was aged 25 months and 18 days when he passed this test.

Following this, SR was given a Phase 3 test session. As his responding in this session was below criterion level (see Table H6), he was given a further B-A test (A-B exposure trials were not presented in this session, see Table H5). SR again responded above criterion level on this second B-A test (83.3 percent on B1-A1 trials and 100 percent on B2-A2 trials, see Table H5). Thus SR's criterion level performance was sustained over two B-A test sessions, even where no further exposure trials were presented.

Vocalisations. SR echoed the novel word presented on all 12 B-A test trials in Session 1, and 11 B-A trials in Session 2; in 22/23 of these instances this corresponded with his selection of the correct comparison stimulus. In Session 2, SR also produced one instance of correct prompted labelling of the A1 stimulus.

Phase 3. C-A Exposures and B-C Testing

Following only one B-A test, SR progressed to Phase 3. The number of C-A non-ostensive exposure trials presented, and his response accuracies on the subsequent B-C test trials, are shown in Table H6. Following these sessions, SR was also given an A-B, a C-A, and an A-C test.

Table H6

Participant SR: Number of C-A exposure trials presented, and accuracy scores on B-C test trials, throughout Phase 3. (Bold text denotes sessions in which criterion level was achieved.)

	C-A exposure trials		B-C test trials	
Session	C1-A1	C2-A2	B1-C1	B2-C2
1	1	1	1/6	3/6
2	1	1	**6/6**	**5/6**
3	-	-	**5/6**	**5/6**
Total	2	2	12/18	13/18

Note. These sessions were not presented consecutively, a B-A test session was conducted between Sessions 1 and 2.

B-A test trials. At the beginning of each session, SR was given B-A test trials (two in Sessions 1 and 3, and four in Session 2). He responded with 100 percent accuracy on these trials.

B-C test trials. SR did not pass the first B-C test (see Figure H5). However, following a total of four non-ostensive exposure trials, he demonstrated derivation of the B-C equivalence relations in Session 2 (100 percent on B1-C1 trials, and 83.3 percent on B2-C2 trials, see Figure H5). SR was aged 26 months when he passed this test. His criterion level performance was also sustained in Session 3 (83.3 percent correct responding on both B1-C1 and B2-C2 trials, see Figure H5), even where no further exposure trials were given.

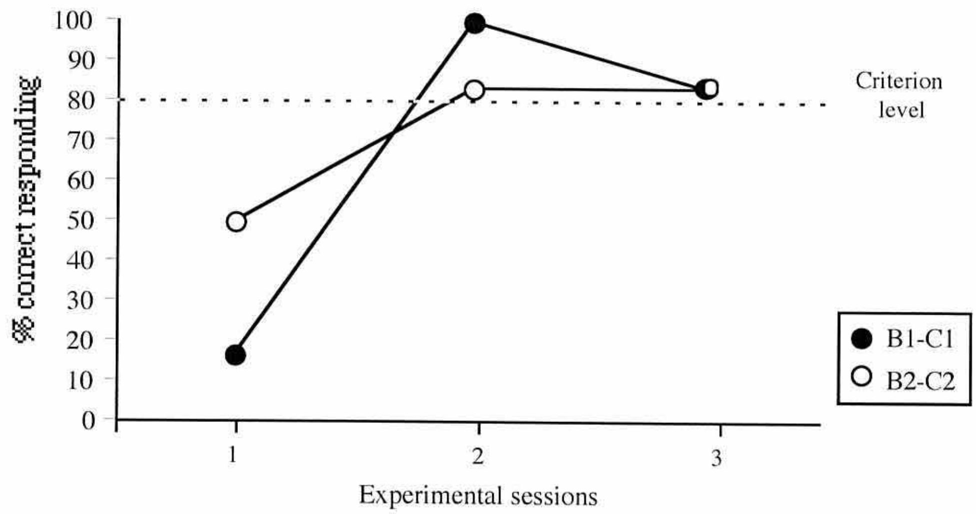


Figure H5. Participant SR: Percentage of correct responding on B-C trials throughout Phase 3. Percentage of correct responding was over 12 trials in each session.

A-B naming test. SR was given six free recall, prompted recall, and recognition trials, on which he responded above criterion level with 83.3 percent accuracy overall (50, 100, and 100 percent on each trial type, respectively). On free recall trials, although he responded with 100 percent accuracy on A1-B1 trials, he did not produce any correct responses on A2-B2 trials; on each of these trials , when asked to label A2 -- the multi-coloured slinky spring -- his vocalisations appeared to approximate "Rainbow".

C-A test trials. SR had one session which comprised 12 C-A test trials (six of each relation). He did not perform at criterion level on this test, responding with 66.6 percent accuracy on both C1-A1 and C2-A2 trials. However, it is noted that SR responded correctly on the first 7/8 test trials; this is at criterion level. Following this, his performance declined. This was likely to have been a result of his boredom with the test procedure -- his attention visibly declined towards the end of the session.

A-C test trials. SR had one session which comprised 12 A-C symmetry test trials (six of each relation). He did not perform above criterion level overall (100 percent correct on A1-C1 trials and 50 percent on A2-C2 trials). However, it is noted that SR responded correctly on the first 7/8 trials in this session. Again, his performance following these trials declined with his responses shifting to a stimulus preference for C1, which he selected on 9/12 test trials. This was again likely to have been a result of his boredom with the test procedure.

Vocalisations. SR correctly and spontaneously labelled A1, on one occasion, as it was revealed on a C-A exposure trial. Further, when shown the two novel shapes on a B-C test trial, SR pointed to C1 and correctly said, "The Tak's in there."

Participant SB

Phase 2. A-B Exposures and B-A Testing

SB progressed through Phases 2.1 and 2.2; the number of A-B exposure trials presented, and his performance on subsequent B-A test trials, are shown in Table H7.

Table H7

Participant SB: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2. (Bold text denotes sessions in which criterion level was achieved.)

	A-B exposure trials		B-A test trials	
Phase-session	A1-B1	A2-B2	B1-A1	B2-A2
2.1b - 1	1	1	4/6	1/6
2.1b - 2	3	3	3/6	4/6
2.1b - 3	3	3	3/6	3/6
Total	7	7	10/18	8/18
2.2 - 1	1	1	4/6	5/6
2.2 - 2	1	1	4/6	4/6
2.2 - 3	3	3	5/6	2/6
2.2 - 4	3	3	5/6	3/6
2.2 - 5	3	3	5/6	3/6
2.2 - 6	3	3	3/6	3/6
2.2 - 7	3	3	4/6	3/6
2.2 - 8	1	1	**6/6**	**6/6**
2.2 - 9	1	1	**6/6**	**6/6**
Total	19	19	42/54	35/54

Phase 2.1b. A-B non-ostensive exposure trials and B-A testing. A-B non-ostensive exposure trials were interspersed with non-ostensive exposure trials of familiar auditory-visual relations. SB did not respond at criterion level on B-A test trials (see Figure H6); although he demonstrated a stimulus preference for A1 in Session 1 (selected on 9/12 trials), this was not evident in Sessions 2 and 3.

Vocalisations. SB labelled each of the novel objects a "Tak"; in both of these instances this was following a prompt from the E.

Phase 2.2. A-B ostensive exposure trials and B-A testing. SB passed the B-A test in Session 8 following 36 ostensive exposure trials; in this session he responded with 100 percent accuracy on B-A trials of both novel relations (see Figure H6). SB was aged

30 months and 1 day when he passed this test. Further, his criterion level performance was maintained in Session 9, following two further exposure trials.

Note that following Session 7 there was a break in testing of three months and six days in which SB did not attend the nursery. In Session 8, conducted on his return to the nursery, SB achieved criterion level in this, and the subsequent, session.

Vocalisations. Throughout Phase 2.2, SB echoed the novel word presented on one exposure trial. He also echoed the auditory sample presented on six B-A test trials; in four of these instances this corresponded with his selection of the correct comparison stimulus.

On each exposure trial, E asked SB to label the novel object as it was first presented; on 27 trials SB labelled the novel object in response to these prompts, in 26 of these instances he produced the correct corresponding novel word.

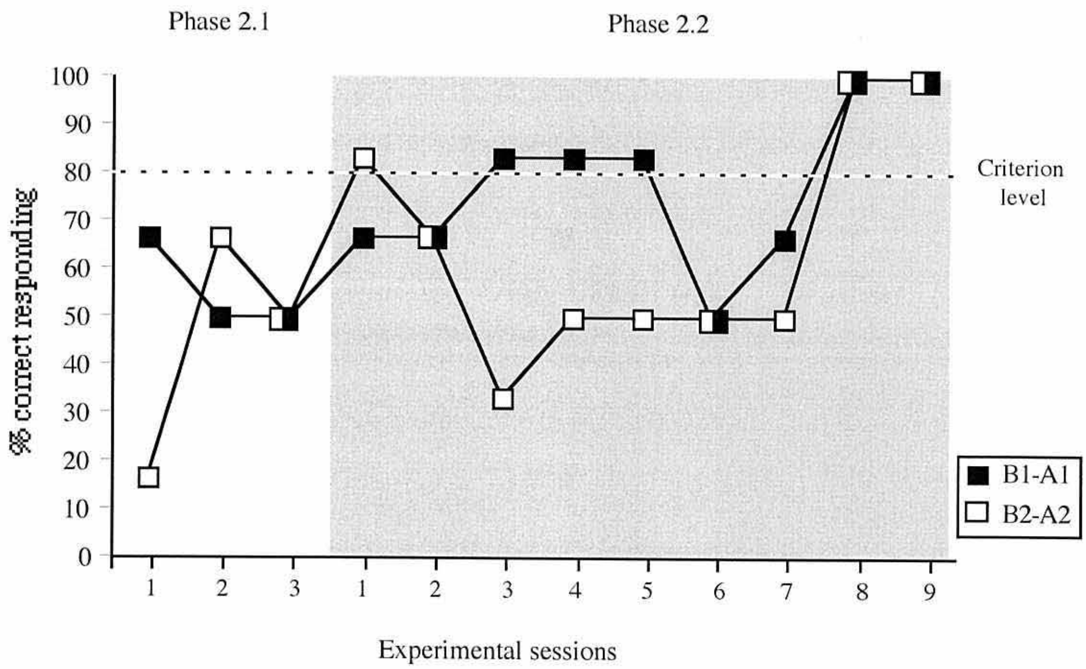


Figure H6. Participant SB: Percentage of correct responding on B-A trials throughout Phase 2. Percentage of correct responding was over 12 trials in each session.

Phase 3. C-A Exposures and B-C Testing

In Phase 3, SB had two sessions; the number of non-ostensive C-A exposure trials presented, and his performance on the B-C tests, are shown in Table H8.

Table H8

Participant SB: Number of C-A exposure trials presented, and accuracy scores on B-C test trials, throughout Phase 3. (Bold text denotes sessions in which criterion level was achieved.)

	C-A exposure trials		B-C test trials	
Session	C1-A1	C2-A2	B1-C1	B2-C2
1	1	1	**5/6**	**5/6**
2	1	1	3/6	6/6
Total	2	2	8/12	11/12

B-A test trials. In each session, SB was given six B-A test trials prior to the exposures. He responded with 100 percent accuracy on trials of both novel relations.

B-C test trials. SB derived the B-C equivalence relations, aged 30 months and 4 days, following only 2 non-ostensive C-A exposure trials; his responding in Session 1 was above criterion level (83.3 percent correct on trials of both novel relations, see Table H8). Criterion level performance was not, however, maintained in Session 2 (50 percent and 100 percent accuracy on B1-C1 and B2-C2 trials, respectively, see Table H8); in this session he exhibited a stimulus preference for C2, which he selected on 9/12 trials.

Participant TS

Phase 2. A-B Exposures and B-A Testing

TS progressed through the majority of sub-phases of Phase 2; thus he had A-B non-ostensive, ostensive, and B-A exclusion exposure trials. The number of exposure trials presented, and his accuracy scores on B-A test trials, are presented in Table H9.

Phase 2.1b. A-B non-ostensive exposure trials and B-A testing. A-B non-ostensive exposure trials were interspersed with non-ostensive exposure trials of familiar auditory-visual relations. TS did not demonstrate acquisition of the symmetrical B-A relations following non-ostensive exposure trials; his performance on the B-A test trials was below criterion level in each session (see Figure H7). In Session 1, TS had a stimulus preference for A1, which he selected on 11/12 B-A trials; this preference was not evident in subsequent experimental sessions.

A-B naming test. TS had a naming test session at the end of Phase 2.1; this comprised six free recall trials and four prompted recall trials. On free recall trials, TS responded with 50 percent accuracy overall, producing the B2 stimulus on every trial.

On the first three prompted recall trials, TS repeated the last name presented by E, and on the remaining trial TS repeatedly echoed the novel words *and* the carrier phrase presented. Thus the session was abandoned.

Vocalisations. TS echoed the novel word presented on one A-B exposure trial and one B-A test trial. On exposure trials, TS was requested to label the novel object as it was presented by E. On the three occasions that he did so, he produced the novel word "Tak"; this was consistent with the presentation of the corresponding A1 stimulus in one instance.

Table H9

Participant TS: Number of exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2. (Bold text denotes sessions in which criterion level was achieved.)

	Exposure trials		B-A test trials	
Phase-session	A1-B1	A2-B2	B1-A1	B2-A2
2.1b - 1	1	1	6/6	1/6
2.1b - 2	3	3	1/3	3/4
2.1b - 3	3	3	4/6	3/6
2.1b - 4	3	3	4/6	4/6
2.1b - 5	3	3	2/4	3/3
2.1b - 6	3	3	0/2	3/3
Total	16	16	17/27	17/28
2.2 - 1	1	1	3/3	0/1
2.2 - 2	1	1	4/6	4/6
2.2 - 3	1	1	1/3	3/4
2.2 - 4	1	1	3/6	5/6
2.2 - 5	3	3	4/5	2/4
2.2 - 6	1	1	1/6	1/6
2.2 - 7	3	3	3/6	3/6
2.2 - 8	3	3	4/6	6/6
2.2 - 9	1	1	4/6	6/6
2.2 - 10	1	1	3/6	3/6
2.2 - 11	3	3	4/6	2/6
2.2 - 12	3	3	2/6	4/6
2.2 - 13	3	3	3/6	3/6
Total	25	25	39/71	42/69
	B1-A1	B2-A2	B1-A1	B2-A2
2.3.3 - 1	1/1	1/1	4/6	3/6
2.3.3 - 2	3/3	3/3	**5/6**	**6/6**
2.3.3 - 3	3/3	3/3	4/6	3/6
Total	7/7	7/7	13/18	12/18

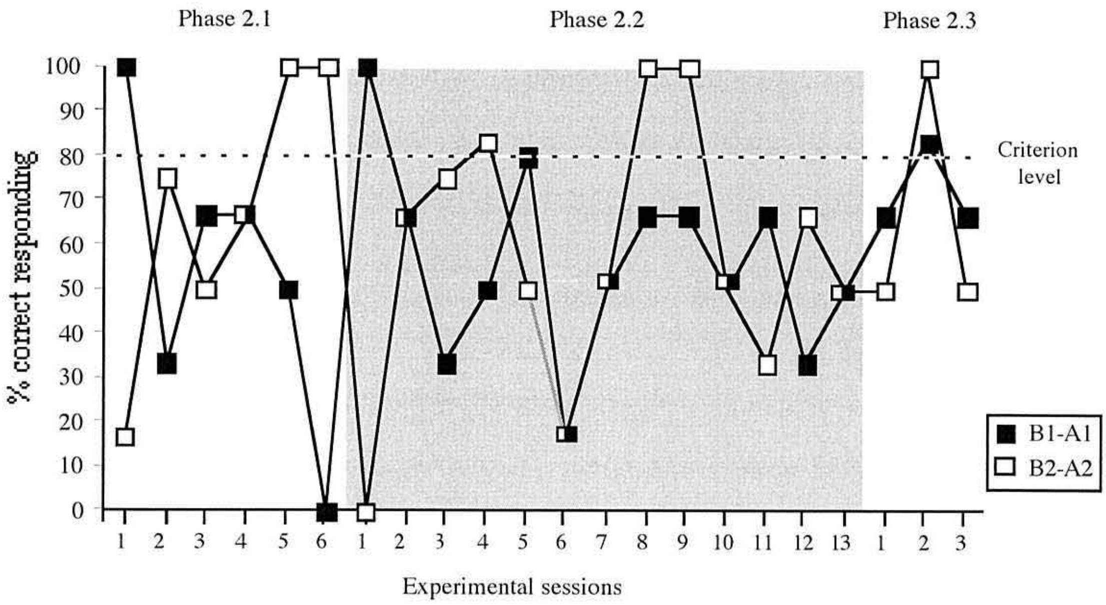


Figure H7. Participant TS: Percentage of correct responding on B-A trials throughout Phase 2. In Phase 2.1, percentage of correct responding was over 12 trials in Sessions 1, 3, and 4; over seven trials (three B1-A1 and four B2-A2) in Session 2; seven trials (four B1-A1 and three B2-A2) in Session 5; and five trials (two B1-A1 and three B2-A2) in Session 6. In Phase 2.2, percentage of correct responding was over 12 trials in all sessions except Session 1, which was over four trials (three B1-A1 and one B2-A2); Session 3, which was over seven trials (three B1-A1 and four B2-A2); and Session 5, which was over nine trials (five B1-A1 and four B2-A2). In Phase 2.3, percentage of correct responding was over 12 trials in each session.

Phase 2.2. A-B ostensive exposure trials and B-A testing. A-B ostensive exposure trials were interspersed with ostensive exposure trials of familiar auditory-visual relations. Again, TS did not demonstrate acquisition of the B-A relations; his responding on B-A tests was below criterion level in each session (see Figure H7). No stimulus preferences were identified in this phase.

In Sessions 6, 7, 8, and 9, TS was not presented with familiar exposure trials; this did not affect his performance in the subsequent B-A tests.

A-B naming test. TS had a naming test session at the end of Phase 2.2; this comprised 12 free recall trials (six of each novel relation). He responded with 75 percent accuracy on these trials (83.3 percent on A1-B1 trials and 66.6 percent on A2-B2 trials).

Vocalisations. TS echoed the novel word presented on 12 A1-B1 trials and 19 A2-B2 trials. He also echoed the auditory sample presented on two B-A trials.

TS's responses to E's prompts to label the novel objects on exposure trials confirmed that he had not acquired the novel relations. On 42 trials, TS produced one of the novel words in response to these prompts; in 15/42 of these instances he produced the incorrect corresponding novel word.

TS produced one instance of correct spontaneous labelling. On this occasion he was requested to select the "Tak" on a B-A trial; in response, he selected the A2 (Bosch) stimulus and said, "No, the bosch." The objects were replaced, the trial was reconducted, and again TS selected the A2 stimulus and said, "Bosch."

Phase 2.3.3. B-A exclusion exposure trials and B-A testing. B-A exclusion exposure trials were interspersed with equal numbers of control trials. TS responded with 100 percent accuracy on both exclusion trials (see Table H9) and control trials. Although he did not pass the B-A test in Session 1, he achieved criterion level in Session 2 (responding with 83.3 percent accuracy on B1-A1 trials and 100 percent accuracy on B2-A2 trials, see Figure H7), thus demonstrating acquisition of the B-A relations. TS was aged 32 months and 2 days when he passed this test. His criterion level performance was not maintained in the subsequent session (58.3 percent overall, see Figure H7).

A-B naming test. Prior to the exposure trials in Session 3, TS was given six free recall trials on which he responded with 100 percent accuracy.

Participant SJ

Phase 2. A-B Exposures and B-A Testing

SJ progressed through all sub-phases of Phase 2, thus receiving A-B non-ostensive, ostensive, and B-A exclusion exposure trials. The number of exposure trials presented, and his accuracy scores on B-A test trials, are shown in Table H10.

Table H10

Participant SJ: Number of exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2. (Bold text denotes sessions in which criterion level was achieved.)

	Exposure trials		B-A test trials	
Phase-session	A1-B1	A2-B2	B1-A1	B2-A2
2.1 - 1	1	1	4/6	4/6
2.1 - 2	1	1	2/6	4/6
2.1 - 3	3	3	2/6	3/6
2.1 - 4	3	3	2/6	5/6
Total	8	8	10/24	16/24
2.2 - 1	1	1	2/6	2/6
2.2 - 2	3	3	3/6	4/6
2.2 - 3	3	3	5/6	4/6
Total	7	7	10/18	10/18
	B1-A1	B2-A2	B1-A1	B2-A2
2.3.1 - 1	1/1	1/1	5/6	4/6
2.3.1 - 2	3/3	3/3	3/6	3/6
2.3.1 - 3	3/3	3/3	2/6	4/6
Total	7/7	7/7	10/18	11/18
2.3.2 - 1	1/1	1/1	1/6	6/6
2.3.2 - 2	3/3	3/3	0/6	6/6
2.3.2 - 3	3/3	3/3	1/6	5/6
Total	7/7	7/7	2/18	17/18
2.3.3 - 1	1/1	1/1	**5/6**	**6/6**
2.3.3 - 2	3/3	3/3	**6/6**	**6/6**
2.3.3 - 3	3/3	3/3	**6/6**	**6/6**
2.3.3 - 4	3/3	3/3	**6/6**	**6/6**
Total	10/10	10/10	23/24	24/24

Phase 2.1. A-B non-ostensive exposure trials and B-A testing. SJ did not demonstrate acquisition of the symmetrical B-A relations following non-ostensive exposure trials. His responding in each session was below criterion level (see Figure H8). SJ exhibited location preferences: in Session 2, for the right hand position (10/12 trials), and in

Session 3, for the left hand position (9/12 trials). In Session 4, he exhibited a stimulus preference for A2, which he selected on 9/12 trials.

A-B naming test. SJ had a naming test session at the end of Phase 2.1 which comprised six free recall, prompted recall, and recognition trials. Overall, he responded with 44.4 percent accuracy (50, 33.3, and 33.3 percent correct responding on each trial type, respectively). There was no pattern to his incorrect responses.

Vocalisations. On 14/16 exposure trials SJ echoed the novel word presented.

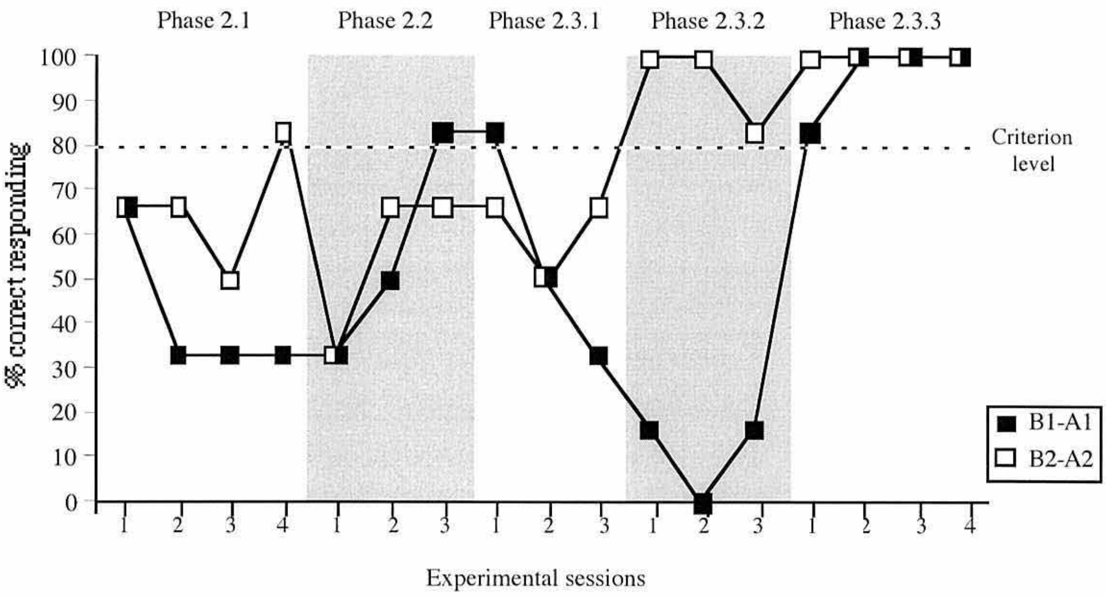


Figure H8. Participant SJ: Percentage of correct responding on B-A trials throughout Phase 2. Percentage of correct responding was over 12 trials per session.

Phase 2.2. A-B ostensive exposure trials and B-A testing. SJ did not demonstrate acquisition of the B-A relations following ostensive exposure trials. His responding in each session was below criterion level (see Table H10 and Figure H8). Patterns of preferential responding were not identified in this phase.

A-B naming test. At the end of Phase 2.2, SJ was given a naming test comprising six free recall, prompted recall, and recognition trials, on which he responded with 61.1 percent accuracy overall. He responded at criterion level on free recall trials (83.3 percent correct responding). However, on prompted recall and recognition trials, he responded at chance level (50 percent on each trial type); on prompted recall trials he repeated the last novel word presented by the E, and on recognition trials he replied "Yes" to every trial.

Vocalisations. SJ echoed the novel word presented on 11 exposure trials. On each exposure trial, SJ was asked to label the novel object as it was presented, which he did so on six trials; in 4/6 of these instances he produced the correct novel word.

Phase 2.3.1. B-A exclusion exposure trials and B-A testing. In each session SJ was given B-A exclusion exposure trials and subsequent B-A test trials. On exclusion trials, SJ responded with 100 percent accuracy (see Table H10). However, he did not demonstrate acquisition of the B-A relations (see Figure H8); his responding in each session was below criterion level (75, 50, and 50 percent overall, respectively). No patterns of preferential responding were identified in this phase.

A-B naming test. SJ had a naming test at the end of this phase; this comprised six free recall, prompted recall, and recognition trials, on which he responded with 66.6 percent accuracy overall. On both free recall and recognition trials his responding was below criterion level (66.6 and 50 percent, respectively). However, he achieved criterion level on prompted recall trials (83.3 percent accuracy).

Phase 2.3.2. B-A exclusion exposure trials and B-A testing. In each session SJ had exclusion exposure trials, and an equal number of baseline trials. He responded with 100 percent accuracy on both exclusion exposure trials (see Table H10) and baseline trials. However, he did not demonstrate acquisition of the novel relations as a result of these exposures (see Figure H8); his responding in each session was below criterion level (58.3, 50, and 58.3 percent accuracy overall, respectively). SJ exhibited a preference for the A2 stimulus, which he selected on 33/36 trials.

A-B naming test. SJ had a naming test comprising six free recall, prompted recall, and recognition trials, on which he responded with 77.7 percent accuracy overall. Although he responded at chance level on free recall trials (50 percent correct), producing the B1 stimulus on every trial, he responded above criterion on both prompted recall and recognition trials (83.3 percent and 100 percent correct respectively).

Phase 2.3.3. B-A exclusion exposure trials and B-A testing. In each session SJ had exclusion exposure trials, which were interspersed with an equal number of control trials. On both of these trial types SJ responded with 100 percent accuracy (see Table H10). In Session 1, SJ demonstrated acquisition of the B-A relations responding with 83.3 percent and 100 percent accuracy on B1-A1 and B2-A2 trials, respectively (see Figure H8). SJ was aged 30 months and 6 days at this point in the study. Criterion level performance was maintained in Sessions 2, 3, and 4; his performance was errorless in each of these sessions (see Figure H8).

A-B naming test. In the naming test, at the end of Phase 2.3.3, SJ had 12 free recall trials, six prompted recall trials, and six recognition trials. His responding overall was above criterion level at 87.5 percent (83.3, 83.3, and 100 percent correct on each trial type, respectively).

Vocalisations. SJ echoed the auditory sample presented on three exclusion exposure trials and eight B-A trials; in each instance his utterance corresponded with his selection of the correct corresponding object. On two further exclusion trials, SJ echoed the auditory sample presented as he selected the corresponding object, and then said, "And there's the X," (where X was the other novel word) as he pointed to the corresponding object on the floor. SJ also correctly labelled the novel objects, on three occasions, in response to prompts from E.

SJ produced four instances of spontaneous labelling; on three occasions he correctly labelled the A1 stimulus, and on the remaining occasion he correctly labelled the A2 stimulus. In addition, he produced three intraverbal utterances. In each instance he was requested to select one of the novel objects on a B-A test trial or a B-A exclusion trial; in response, he repeatedly produced the novel words (e.g., when "Bosch" was the auditory sample he said, "Tak, tak, tak," when "Tak" was the sample he said, "Tak, tak, tak, bosch, bosch, bosch,").

Phase 3. C-A Exposures and B-C Testing

SJ had four experimental sessions in Phase 3. Sessions 1 to 3 comprised B-A test trials, C-A exposure trials, and B-C test trials. The number of exposure trials presented in these sessions, and SJ's responses on the B-C test trials, are presented in Table H11. The final session comprised a C-B test.

Table H11

Participant SJ: Number of C-A exposure trials presented, and accuracy scores on B-C test trials, throughout Phase 3. (Bold text denotes sessions in which criterion level was achieved.)

	C-A exposure trials		B-C test trials	
Session	C1-A1	C2-A2	B1-C1	B2-C2
1	1	1	**5/6**	**5/6**
2	1	1	**6/6**	**6/6**
3	1	1	**6/6**	**6/6**
Total	3	3	17/18	17/18

B-A test trials. SJ had four B-A test trials at the beginning of Sessions 1 to 3, on which he responded with 100 percent accuracy.

B-C test trials. SJ demonstrated immediate derivation of the B-C equivalence relations following two C-A non-ostensive exposure trials (see Figure H9); he responded above criterion level in Session 1 (83.3 percent correct on both B1-C1 and B2-C2 trials) and was aged 30 months and 23 days at this point in the study. Criterion level performance was maintained in Sessions 2 and 3 (see Figure H9).

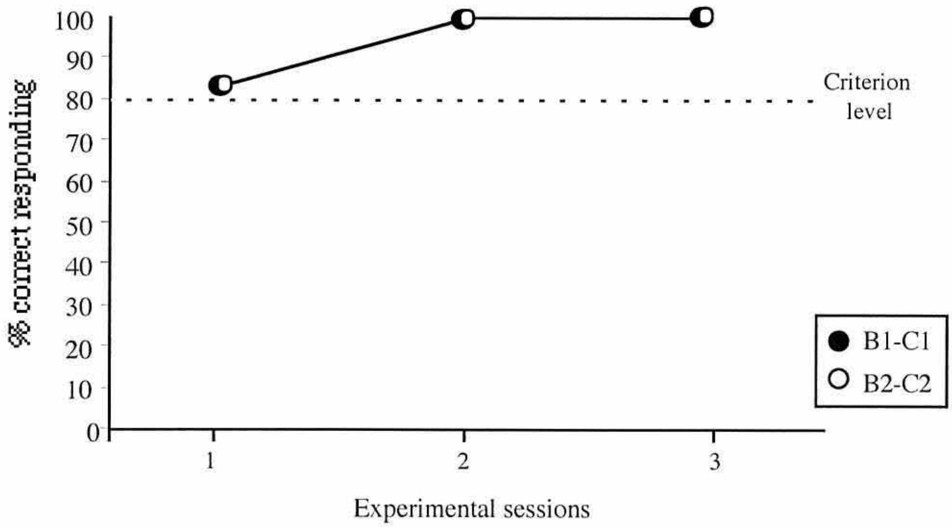


Figure H9. Participant SJ: Percentage of correct responding on B-C trials throughout Phase 3. Percentage of correct responding was over 12 trials in each session.

C-B test trials. SJ had one session in which 12 free recall, six prompted recall, and six recognition C-B trials were presented. SJ responded above criterion level with 95.8 percent accuracy overall (100, 83.3, and 100 percent correct on each trial type, respectively). As was stated in the method section (see also introduction to Study 2, Chapter 5), as SJ achieved criterion level on B-A tests following exclusion exposure trials, C-B tests constitute tests of equivalence, and thus this provides further evidence of SJ's derivation of the equivalence relations.

Vocalisations. SJ correctly and spontaneously labelled the novel objects as they appeared on six C-A exposure trials, and, in addition, correctly labelled each of the objects once in response to prompts from E. Further, on four C-A exposure trials, when SJ was asked, "What's hiding in here?" as E pointed to the novel shape present, he produced the correct corresponding novel word, thus providing further evidence of emergent C-B matching.

Participant KN

Phase 2. A-B Exposures and B-A Testing

Participant KN progressed through all sub-phases of Phase 2. The number of exposure trials presented, and her performance on the subsequent B-A test trials, is shown in Table H12. KN had two repetitions of Phase 2.1: at the commencement of Phase 2, she had Phase 2.1a, in which non-ostensive A-B exposure trials were presented alone; at the end of Phase 2, she was given Phase 2.1b, in which the A-B exposure trials were interspersed with non-ostensive exposure trials of familiar auditory-visual relations.

Phase 2.1a. A-B non-ostensive exposure trials and B-A testing. KN did not demonstrate acquisition of the symmetrical B-A relations following A-B non-ostensive exposure trials alone (see Figure H10); her responding in each experimental session was below criterion level (50, 58.3, 33.3, and 41.6 percent correct responding overall). No patterns of preferential responding were identified.

A-B naming test. KN was given a naming test at the end of Phase 2.1; this comprised six free recall, prompted recall, and recognition trials, on which she responded with 44.4 percent accuracy overall (50, 33.3, and 50 percent correct responding on each trial type, respectively).

Vocalisations. KN echoed the novel word presented on one A1-B1 and one A2-B2 exposure trial.

Table H12

Participant KN: Number of exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	Exposure trials		B-A test trials	
Phase-session	A1-B1	A2-B2	B1-A1	B2-A2
2.1a - 1	1	1	2/6	4/6
2.1a - 2	3	3	3/6	4/6
2.1a - 3	3	3	3/6	1/6
2.1a - 4	3	3	3/6	2/6
Total	10	10	11/24	11/24
2.2 - 1	1	1	6/6	0/6
2.2 - 2	3	3	6/6	0/6
2.2 - 3	3	3	5/6	1/6
Total	7	7	17/18	1/18
	B1-A1	B2-A2	B1-A1	B2-A2
2.3.1 - 1	1/1	1/1	4/6	0/6
2.3.1 - 2	3/3	3/3	4/6	0/6
2.3.1 - 3	3/3	3/3	2/6	4/6
Total	7/7	7/7	10/18	4/18
2.3.2 - 1	1/1	1/1	0/6	6/6
2.3.2 - 2	3/3	3/3	2/6	3/6
2.3.2 - 3	3/3	3/3	1/6	6/6
Total	7/7	7/7	3/18	15/18
2.3.3 - 1	1/1	1/1	1/6	5/6
2.3.3 - 2	3/3	3/3	1/6	4/6
2.3.3 - 3	3/3	3/3	4/6	0/6
2.3.3 - 4	3/3	3/3	3/6	1/6
Total	10/10	10/10	9/24	10/24
	A1-B1	A2-B2	B1-A1	B2-A2
2.1b - 1	1	1	2/6	2/6
2.1b - 2	3	3	3/6	3/6
2.1b - 3	3	3	1/6	4/6
Total	7	7	6/18	9/18

Phase 2.2. A-B ostensive exposure trials and B-A testing. KN did not demonstrate acquisition of the B-A relations following ostensive exposure trials (see Figure H10); her responding was at chance level (50 percent correct) in each experimental session. KN had a preference for the A1 stimulus, which she selected on 34/36 B-A trials.

A-B naming test. KN had a naming test at the end of Phase 2.2; this comprised six free recall, prompted recall, and recognition trials, on which she responded with 33.3 percent accuracy overall (33.3, 16.6, and 50 percent correct responding on each trial type, respectively). There was no pattern to KN's responses on free recall and prompted recall trials, but on recognition trials she responded with "Yes" on every trial.

Vocalisations. KN echoed the novel word presented on one A1-B1 and one A2-B2 exposure trial. She also echoed the auditory sample presented on one B-A trial; this did not correspond with her comparison selection.

On each exposure trial, KN was prompted to label the novel object as it was presented to her, which she did on six trials; she produced the correct novel word in 3/6 of these instances.

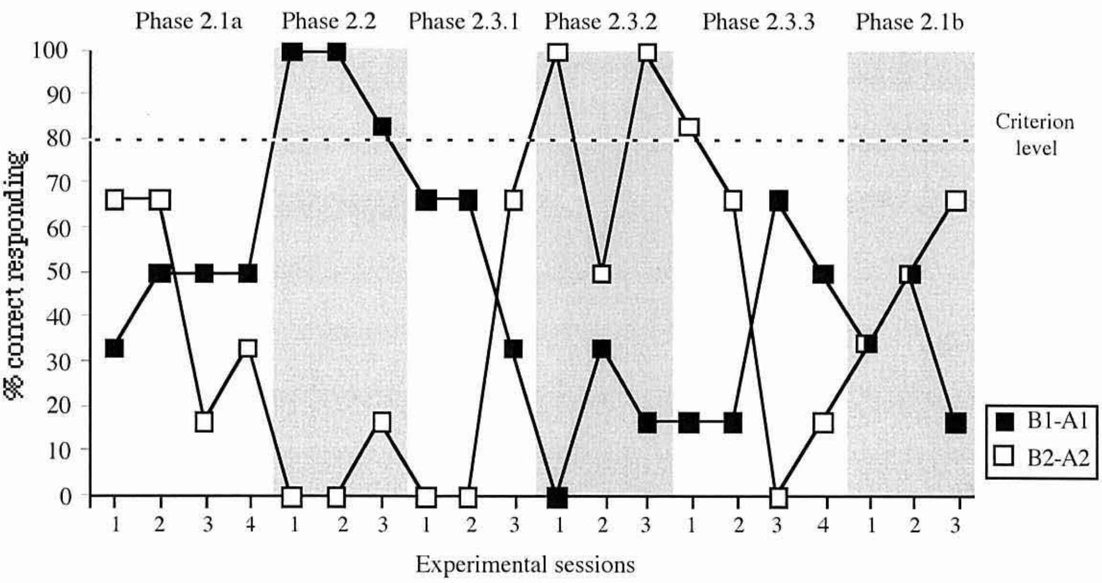


Figure H10. Participant KN: Percentage of correct responding on B-A trials throughout Phase 2. Percentage of correct responding was over 12 trials in each session.

Phase 2.3.1. B-A exclusion exposure trials and B-A testing. Each session comprised the presentation of B-A exclusion exposure trials and B-A test trials. KN responded with 100 percent accuracy on exclusion exposure trials (see Table H12); despite this she did not demonstrate acquisition of the B-A relations (see Figure H10). Her performance on B-A trials in each session was at, or below, chance level (33.3, 33.3, and 50 percent correct overall, respectively). KN had a preference for A1, which she selected on 24/36 trials.

A-B naming test. At the end of Phase 2.3.1, KN had a naming test comprising six free recall, prompted recall, and recognition trials. On these trials she responded with 55.5 percent accuracy overall (66.6, 33.3, and 66.6 percent correct on each trial type, respectively). No patterns of responding were identified.

Phase 2.3.2. B-A exclusion exposure trials and B-A testing. In each session, KN had exclusion exposure trials which were interspersed with an equal number of baseline trials. She responded with 100 percent accuracy on exclusion exposure trials (see Table H12), and 92.8 percent accuracy (13/14 correct responses) on baseline trials. However, her responding on the subsequent B-A trials was again below criterion level (50, 41.6, and 58.3 percent correct overall in each session respectively, see Figure H10). KN's preference switched to A2 in this phase; she selected this stimulus on 32/36 trials.

A-B naming test. KN had a naming test comprising six free recall, five prompted recall, and six recognition trials, at the end of Phase 2.3.2; she responded with 47.1 percent accuracy overall. Her responding was below criterion level on each trial type (50, 60, and 33.3 percent correct respectively). On all of the free recall trials she responded with the novel word "Tak"; there was no pattern to her responses on prompted recall and recognition trials.

Vocalisations. It appeared from her informal vocalisations that KN may have formed the incorrect relations. On two B2-A2 exclusion exposure trials, when asked to give the "Bosch", KN selected the A2 stimulus and said, "No, it's a tak." Similarly, when asked to give the "Tak" on four B1-A1 exclusion trials, she selected the A1 stimulus and said, "No, it's bosch silly."

Phase 2.3.3. B-A exclusion exposure trials and B-A testing. In each session KN was given B-A exclusion exposure trials, which were interspersed with an equal number of control trials. She responded without error on both exclusion exposure trials (see Table H12) and control trials. Despite this, KN did not demonstrate acquisition of the B-A relations; her responding was below criterion level in each session (see Figure H10); she had a preference for A2, which she selected on 37/48 trials.

A-B naming test. KN had a naming test session comprising six free recall, prompted recall, and recognition trials, on which she responded at chance level overall (50 percent correct on each trial type). Two patterns in her responding were identified: on free recall trials she produced the novel word "Tak" on every trial, and on every recognition trial she responded with "Yes".

Vocalisations. KN produced the novel word "Bosch" once throughout Phase 2.3.3. In this instance she incorrectly said "That's not the bosch" as she selected the A2 (Bosch) stimulus on a B-A trial.

Phase 2.1b. A-B non-ostensive exposure trials and B-A testing. During this phase KN had non-ostensive A-B exposure trials interspersed with non-ostensive exposure trials of familiar auditory-visual relations. The inclusion of these trials did not improve KN's performance on the subsequent B-A tests: again she responded below criterion level in each experimental session (33.3, 50, and 41.6 percent correct respectively, see Figure H10). No stimulus preferences were identified in Sessions 1 and 2; however, in Session 3, KN had a preference for the A2 stimulus, which she selected on 9/12 trials.

A-B naming test. KN had a naming test, at the end of Phase 2.1b, which comprised six free recall, prompted recall, and recognition trials; on these trials she responded with 50 percent accuracy overall (66.6, 33.3, and 50 percent accuracy on each trial type, respectively). No patterns of responding were evident on free recall and prompted recall trials, but on recognition trials she responded with "Yes" on every trial.

Vocalisations. KN echoed the novel word presented on five A1-B1 and two A2-B2 exposure trials; in each instance this was slightly after E had begun the presentation of the novel word. On four occasions KN labelled a novel object in response to prompts from E; in three of these instances KN produced the correct novel word.

Training Phase

As KN did not demonstrate acquisition of the B-A relations at the end of Phase 2.1b, and showed sustained interest in the study, she progressed to the training phase. She received 21 sessions in total; in Sessions 1 to 19 she was given A-B non-ostensive exposure trials and B-A training trials, and in Sessions 20 and 21 she had A-B non-ostensive exposure trials and B-A testing trials (i.e., the rewards for correct responding were removed). The number of exposure trials presented, and KN's responses on the B-A training and testing trials, are presented in Table H13.

KN produced criterion level responding in Sessions 18 and 19, in which she produced overall response accuracies of 83.3 percent and 100 percent (see Table H13 and Figure H11). KN was aged 34 months and 4 days at this point in the study. In Sessions 20 and 21, the rewards were removed, and thus B-A testing trials were presented. KN maintained her criterion level performance in both of these sessions (100 percent and 91.6 percent correct overall respectively, see Figure H11) in the absence of feedback or rewards.

Table H13

Participant KN: Number of non-ostensive A-B exposure trials presented, and accuracy scores on B-A training and testing trials. (Bold text denotes sessions in which criterion level was achieved and shaded areas denote sessions in which testing trials were presented.)

	A-B exposure trials		B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	2/6	6/6
2	3	3	1/6	5/6
3	3	3	3/6	4/6
4	3	3	3/6	6/6
5	3	3	2/6	5/6
6	3	3	1/6	5/6
7	3	3	1/6	4/6
8	1	1	3/6	3/6
9	3	3	4/6	3/6
10	3	3	2/6	4/6
11	3	3	0/6	4/6
12	3	3	3/6	3/5
13	3	3	0/6	4/6
14	3	3	3/6	3/6
15	3	3	0/6	5/6
16	3	3	3/6	4/6
17	3	3	5/6	3/6
18	-	-	**5/6**	**5/6**
19	3	3	**6/6**	**6/6**
20	-	-	**6/6**	**6/6**
21	3	3	**5/6**	**6/6**
Total	53	53	58/126	94/125

Appendix H

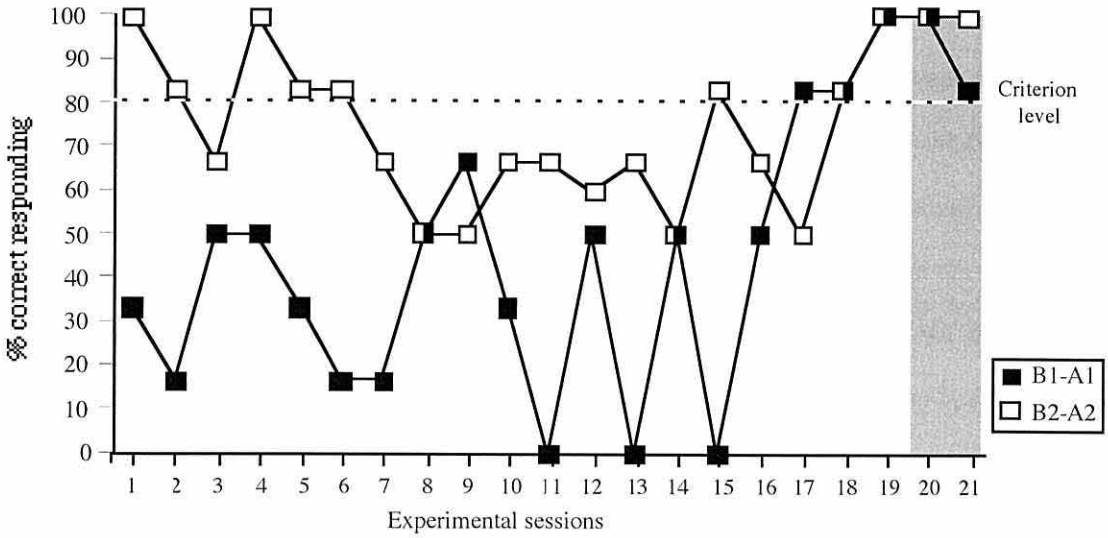


Figure H11. Participant KN: Percentage of correct responding on B-A trials in the training phase. Percentage of correct responding was over 11 trials in Session 12 (six B1-A1 and five B2-A2) and was over 12 trials in all other sessions. (Shading denotes sessions in which rewards were removed, and thus testing trials were presented.)

Vocalisations. There was a difference in KN's vocalisations between the sessions in which she did and did not perform at criterion level. In Sessions 1 to 17, KN rarely echoed the auditory stimulus presented on B-A trials, doing so on only two trials; on both of these she selected the correct corresponding comparison. She frequently echoed the novel word presented on exposure trials, doing so on 37 trials (19 A1-B1 trials and 18 A2-B2 trials) throughout these sessions. On each exposure trial, KN was asked "What's this?" as the novel object was presented. On 42 exposure trials she produced a novel word in response to these prompts; on A1-B1 trials she produced 18 responses of which 17 were correct, and on A2-B2 trials she produced 24 responses of which 11 were correct. KN also produced one instance of correct spontaneous labelling of the A2 stimulus.

In Sessions 18 to 21, KN also echoed the novel word presented on 11 exposure trials (six A1-B1 trials and five A2-B2 trials). She did not echo the auditory sample presented on any B-A trial. In contrast to Sessions 1 to 17, KN's productions of the novel words in response to prompts from E were more accurate. On seven A1-B1 trials she correctly labelled the A1 stimulus: "Tak." On A2-B2 trials, KN produced eight responses of which six were correct productions of the novel word "Bosch". On both of the incorrect responses, KN corrected herself by saying, "A tak, a bosch, bosch, bosch."

Phase 3. C-A Exposures and B-C Testing

KN had four sessions in Phase 3. In Sessions 1 to 3, she had B-A test trials, C-A non-ostensive exposure trials, and B-C equivalence test trials; the number of exposure trials presented, and her performance on the B-C tests, is shown in Table H14. In Session 4 KN had a C-B test.

Table H14

Participant KN: Number of non-ostensive C-A exposure trials presented, and accuracy scores on B-C test trials, throughout Phase 3. (Bold text denotes sessions in which criterion level was achieved.)

	C-A exposure trials		B-C test trials	
Session	C1-A1	C2-A2	B1-C1	B2-C2
1	1	1	**6/6**	**5/6**
2	1	1	**6/6**	**6/6**
3	-	-	**5/6**	**6/6**
Total	2	2	17/18	17/18

B-A test trials. KN had 6 B-A test trials at the beginning of Sessions 1 to 3. She responded with 94.4 percent accuracy (100 percent on B1-A1 trials and 88.8 percent on B2-A2 trials) on these trials.

B-C test trials. In Session 1, KN demonstrated immediate derivation of the B-C equivalence relations following only one non-ostensive exposure trial of each novel relation (see Figure H12); she responded with 100 percent accuracy on B1-C1 trials, and 83.3 percent accuracy on B2-C2 trials. KN was aged 34 months and 14 days when she passed this test. Her criterion level performance was maintained in the following two sessions (see Figure H12).

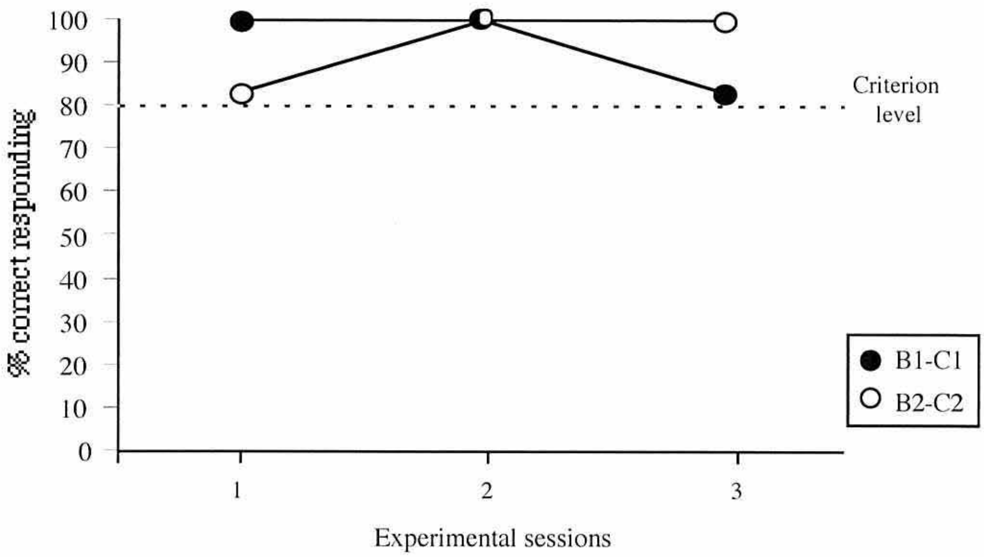


Figure H12. Participant KN: Percentage of correct responding on B-C trials throughout Phase 3. Percentage of correct responding was over 12 trials per session.

C-B test trials. KN had one session which comprised 12 C-B test trials. She demonstrated acquisition of these transitive relations by performing above criterion level on C-B trials of both novel relations (100 percent on C1-B1 trials and 83.3 percent on C2-B2 trials).

Vocalisations. KN produced one vocalisation of the B1 stimulus ("Tak") in this phase; when shown the C1 stimulus and asked, "What's hiding in here?" KN produced the correct corresponding novel word.

Participant CL

Phase 2. A-B Exposures and B-A Testing

CL progressed through Phases 2.1a, 2.1b, 2.2, and 2.3.3, thus receiving non-ostensive, ostensive, and exclusion exposure trials. The number of exposure trials presented, and his responses on the B-A tests, are shown in Table H15.

Table H15

Participant CL: Number of exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	Exposure trials		B-A test trials	
Phase-Session	A1-B1	A2-B2	B1-A1	B2-A2
2.1a - 1	1	1	4/6	1/6
2.1a - 2	1	1	3/6	4/6
2.1a - 3	3	3	3/6	3/6
2.1a - 4	3	3	0/6	5/6
Total	8	8	10/24	13/24
2.1b - 1	1	1	0/6	3/6
2.1b - 2	1	1	1/6	0/6
2.1b - 3	3	3	3/6	4/6
2.1b - 4	3	3	6/6	1/6
Total	8	8	10/24	8/24
2.2 - 1	1	1	2/6	1/6
2.2 - 2	3	3	5/6	2/6
2.2 - 3	3	3	3/6	1/6
Total	7	7	10/18	4/18
	B1-A1	B2-A2	B1-A1	B2-A2
2.3.3 - 1	1/1	1/1	3/6	2/6
2.3.3 - 2	2/3	3/3	4/6	1/6
2.3.3 - 3	3/3	3/3	4/6	1/6
Total	6/7	7/7	11/18	4/18

Phase 2.1a. A-B non-ostensive exposure trials and B-A testing. CL did not demonstrate acquisition of the symmetrical B-A relations following non-ostensive

exposure trials; his responding was below criterion level in each session (see Table H15 and Figure H13). Both stimulus and location preferences were identified: in Session 1, CL had a preference for the A1 stimulus (9/12 trials); in Sessions 2 and 3, for the left hand location (23/24 trials); and in Session 4, for the A2 stimulus (11/12 trials).

A-B naming test. CL had a naming test, at the end of Phase 2.1a, which comprised six free recall, prompted recall, and recognition trials. Overall he responded with 38.8 percent accuracy (33.3, 33.3, and 50 percent accuracy on each trial type, respectively). No patterns were observed in his responses.

Vocalisations. CL echoed the novel word presented on seven A1-B1 trials and three A2-B2 trials. He also correctly labelled A1 in response to a prompt from E.

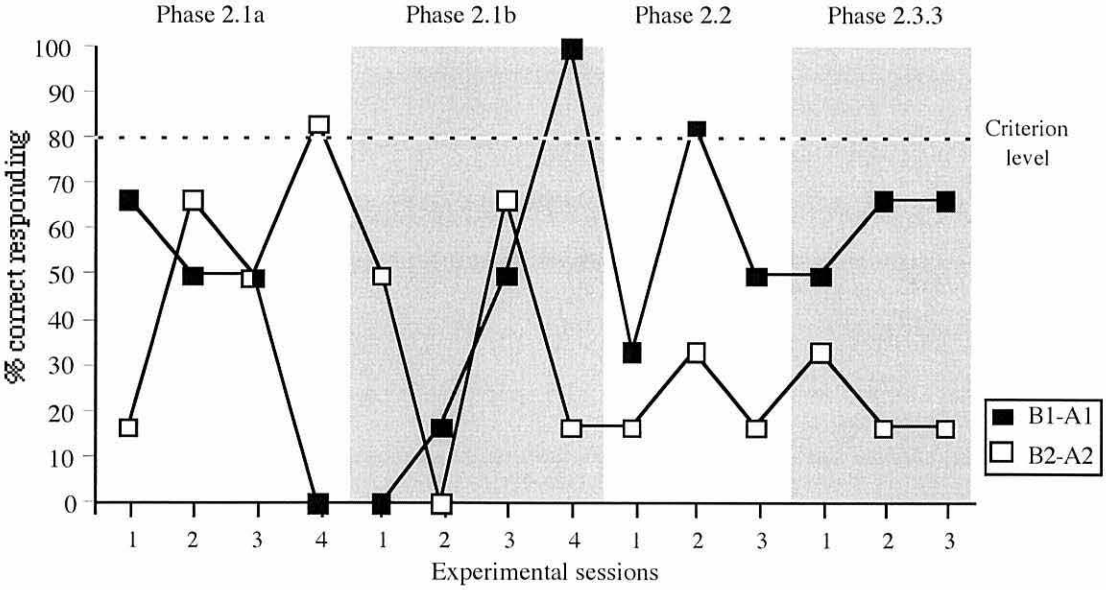


Figure H13. Participant CL: Percentage of correct responding on B-A trials throughout Phase 2. Percentage of correct responding was over 12 trials in each session.

Phase 2.1b. A-B non-ostensive exposure trials and B-A testing. In Phase 2.1b, A-B exposure trials were interspersed with non-ostensive exposure trials of familiar auditory-visual relations. These did not serve to improve CL's performance on the subsequent B-A tests (see Figure H13). In each session he responded below criterion level (25, 16.6, 58.3, and 58.3 percent correct overall, respectively). In Sessions 1 and 4, stimulus preferences developed; in Session 1 for A2 (9/12 trials), and in Session 4 for A1 (10/12 trials).

A-B naming test. CL had a naming test at the end of this phase. This comprised six free recall, prompted recall, and recognition trials, on which he responded with 50 percent accuracy overall (this comprised 50 percent correct on each trial type). Patterns of responding were identified on each trial type: on both free recall and prompted recall trials CL produced the novel word "Tak" on every trial; on every recognition trial he replied "Yes".

Vocalisations. CL echoed the novel word "Tak" on two occasions.

Phase 2.2. A-B ostensive exposure trials and B-A testing. In each session, CL had A-B exposure trials which were interspersed with ostensive exposure trials of familiar auditory-visual relations. CL did not demonstrate acquisition of the B-A relations as a result of these trials; his responding on B-A tests in each session was below criterion level (see Figure H13). Location and stimulus preferences were again identified: in Session 1, for the left hand location (selected on 9/12 trials); and in Session 2, for the A1 stimulus (selected on 9/12 trials).

A-B naming test. CL had a further six exposure trials prior to the naming test at the end of this phase. The naming test comprised six free recall, prompted recall, and recognition trials, on which he responded with 50 percent accuracy overall (this comprised 50 percent correct on each trial type). On all free recall and prompted recall trials CL produced the novel word "Tak", and on recognition trials he produced this word on 5/6 trials. Thus it appeared that CL treated the novel word "Tak" as a name for both of the novel objects.

Vocalisations. This is further supported by CL's informal vocalisations. CL did not produce the novel word "Bosch" throughout this phase. On eight A1-B1 exposure trials, CL echoed the novel word presented, in each instance saying "Yeah, Tak". On seven A2-B2 exposure trials, when the novel word "Bosch" was presented, CL corrected E by saying either, "Tak," or, "No, it's tak." CL was prompted to label the A1 stimulus on one occasion and the A2 stimulus on two occasions; in each instance he produced the novel word "Tak".

Phase 2.3.3. B-A exclusion exposure trials and B-A testing. In each session CL had exclusion exposure trials which were interspersed with an equal number of control trials. He responded with 100 percent accuracy on control trials and 92.8 percent accuracy on exclusion exposure trials (85.7 percent on B1-A1 trials and 100 percent on B2-A2 trials, see Table H15). Despite this, his responding on subsequent B-A test trials was below criterion level in each session (see Figure H13). Again, both location and stimulus preferences were observed: in Session 1, for the right hand location (9/12 trials); and in Sessions 2 and 3, for the A1 stimulus (18/24 trials).

A-B naming test. CL had a naming test at the end of this phase. This comprised six free recall, prompted recall, and recognition trials, on which he responded with 33.3 percent accuracy overall (33.3, 16.6, and 50 percent correct on each trial type respectively). No patterns of responding were observed.

Vocalisations. CL echoed the novel word presented on one exclusion and one B-A test trial.

Training Phase

As CL did not demonstrate acquisition of the B-A relations in Phase 2, and continued to show interest in the study, he progressed to the training phase in which he had six experimental sessions. Each session comprised A-B non-ostensive exposure trials interspersed with non-ostensive exposure trials of familiar auditory relations, and B-A training trials. The number of exposure trials presented, and CL's accuracy scores on B-A trials, are presented in Table H16.

Table H16

Participant CL: Number of A-B non-ostensive exposure trials presented, and accuracy scores on B-A training and test trials. (Bold text denotes sessions in which criterion level was achieved.)

	A-B exposure trials		B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	2/6	2/6
2	3	3	3/6	4/6
3	3	3	**5/6**	**6/6**
4	3	3	5/6	4/6
5	3	3	**6/6**	**5/6**
6	3	3	**5/6**	**5/6**
Total	16	16	26/36	26/36

CL produced criterion level responding in Sessions 3, 5, and 6, in which he produced overall response accuracies of 91.6, 91.6, and 83.3 percent (see Table H16 and Figure H14). CL was aged 31 months and 11 days at this point in the study. The rewards for correct responding were not removed before CL progressed to Phase 3.

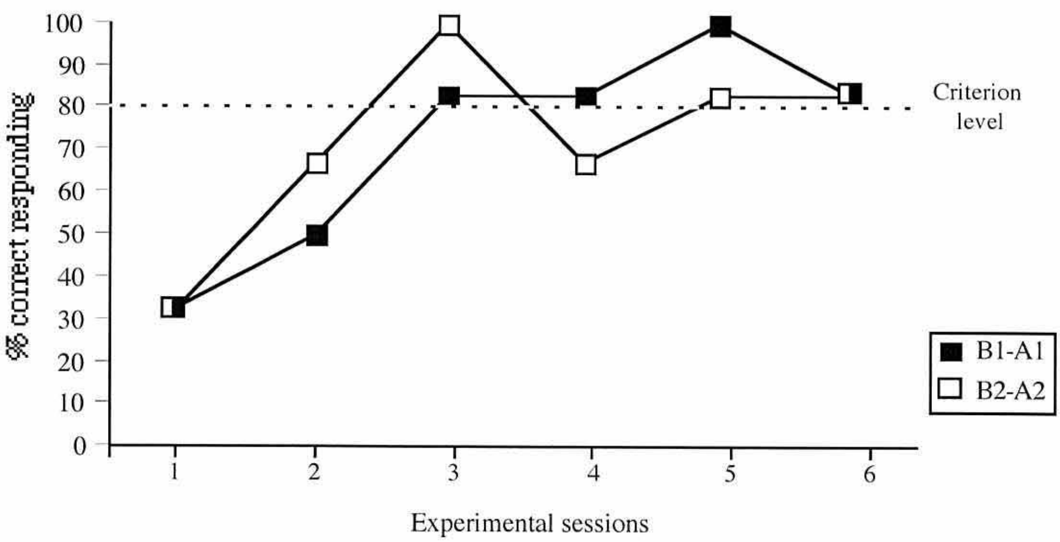


Figure H14. Participant CL: Percentage of correct responding on B-A trials in the training phase. Percentage of correct responding was over 12 trials in each session.

Vocalisations. CL echoed the name presented on one A2-B2 exposure trial. He also labelled one of the novel objects in response to prompts from E on four occasions; in 2/4 of these instances he produced the correct novel word.

Phase 3. C-A Exposures and B-C Testing

Each experimental session comprised the presentation of B-A test trials, C-A non-ostensive exposure trials, and B-C tests. The number of exposure trials presented, and CL's accuracy scores on B-C test trials, are presented in Table H17.

Table H17

Participant CL: Number of non-ostensive C-A exposure trials presented, and accuracy scores on B-C test trials, throughout Phase 3.

	C-A exposure trials		B-C test trials	
Session	C1-A1	C2-A2	B2-C2	B1-C1
1	1	1	5/6	3/6
2	1	1	4/6	3/6
3	1	1	5/6	4/6
4	3	3	3/6	6/6
Total	6	6	17/24	16/24

B-A test trials. CL had four B-A trials in Session 1, and six B-A trials in each of Sessions 2 to 4. Overall, he responded with 83.3 percent accuracy on these trials (83.3 percent correct on both novel relations).

B-C test trials. CL did not demonstrate acquisition of the B-C equivalence relations following a total of 12 C-A non-ostensive exposure trials (see Figure H15). His responding in each experimental session was below criterion level (66.6, 58.3, 75, and 73 percent correct overall, in each session, respectively). In Session 1, CL had a preference for the selection of comparisons in the right hand location (9/12 trials); in Session 4, he had a preference for the selection of the C1 stimulus (9/12 trials).

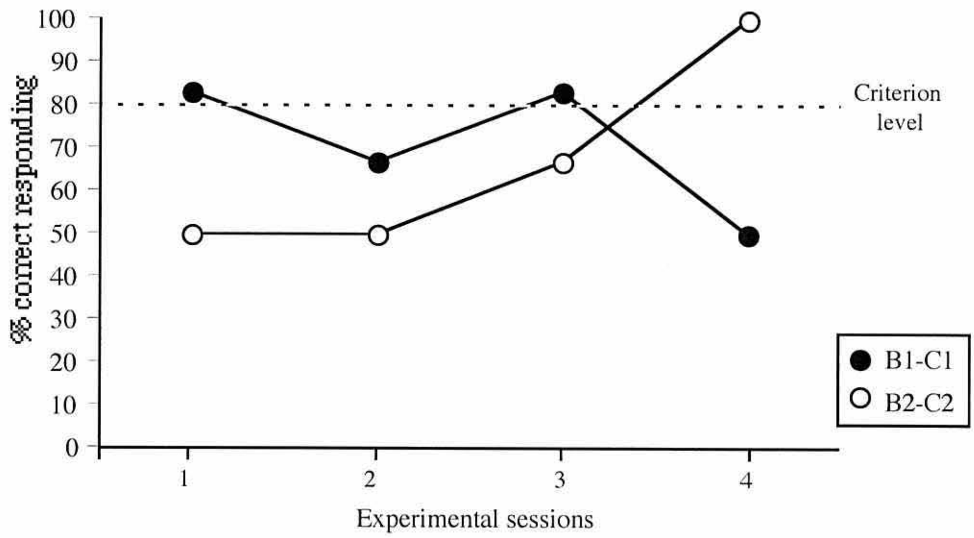


Figure H15. Participant CL: Percentage of correct responding on B-C trials throughout Phase 3. Percentage of correct responding was over 12 trials in each session.

Vocalisations. On seven C-A exposure trials, when asked, "What's hiding in here?" CL responded by producing one of the novel words; in 6/7 of these instances he produced the correct corresponding novel word (he also spontaneously produced the incorrect label for A2 on one occasion). These vocalisations were 85.7 percent correct and suggest the emergence of C-B transitive relations.

APPENDIX J

APPARATUS UTILISED FOR THE MAGIC CONTEXT, AND FAMILIAR AND NOVEL VISUAL STIMULI EMPLOYED IN STUDY 4

Figure J.1. Magic box, magic wand, and Sooty glove puppet utilised in the magic context in Study 4.

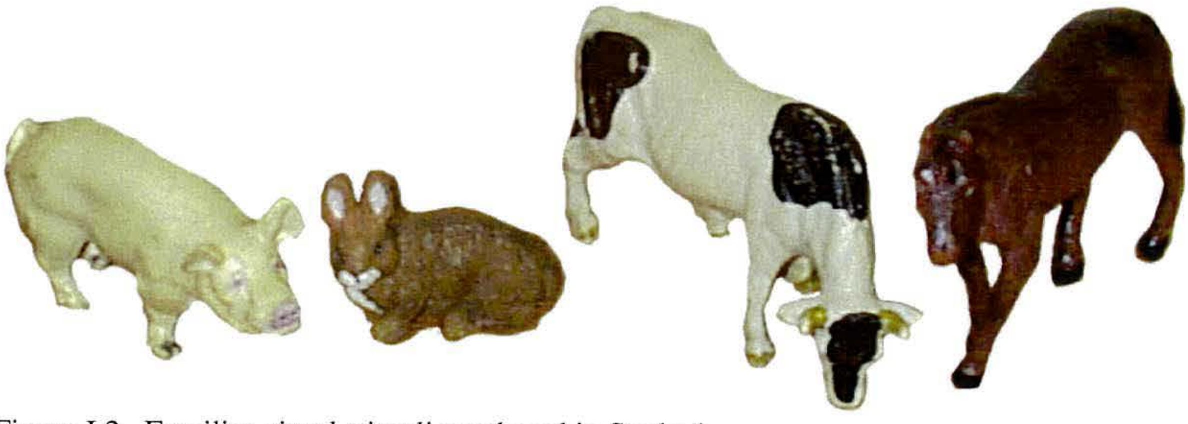


Figure J.2. Familiar visual stimuli employed in Study 4.

Figure J.3. Set A stimuli -- novel objects -- employed in Study 4.

Figure J.4. Set C stimuli -- novel shapes -- employed in Study 4.

APPENDIX K

STUDY 4 DATA

Participant ST

Participant ST was given only one repetition of the procedure with Stimulus Sets 1 and 2; she received only Phase 2 experimental sessions in this repetition.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing

ST received two experimental sessions in Phase 2 (see Table K1). She did not demonstrate acquisition of the symmetrical B-A relations following a total of eight A-B non-ostensive exposure trials; her responding in both experimental sessions was at chance level (50 percent correct overall). ST had an exclusive preference for the A2 stimulus, which she selected on all 24 B-A trials conducted.

Table K1

Participant ST: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	A-B exposure trials		B-A test trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	0/6	6/6
2	3	3	0/6	6/6
Total	4	4	0/12	12/12

Following these sessions ST's attendance at the nursery was infrequent, and thus she took no further part in the study.

Appendix K

Participant BS

Participant BS received two repetitions of the procedure; the first with Stimulus Sets 1 and 2, and the second with Sets 3 and 4.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing

BS had three experimental sessions in Phase 2 (see Table K2). He did not pass the B-A tests in this repetition; his responding in each experimental session was below criterion level (see Figure K1). In Session 1, although BS responded with 83.3 percent accuracy overall, he did not satisfy criterion level (he responded with 66.6 percent accuracy on B1-A1 trials, and 100 percent on B2-A2 trials, see Figure K1).

Table K2

Participant BS: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	A-B exposure trials		B-A test trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	4/6	6/6
2	3	3	4/6	4/6
3	1	1	3/6	5/6
Total	5	5	11/18	15/18

Despite failing to achieve criterion level, it is possible that BS may have derived the B-A relations. In Sessions 1 and 3, he produced correct responses on the initial 7/8 trials (thus responding with 87.5 percent accuracy on the first 8 trials in both of these sessions). In Session 2, he responded correctly on the first two B-A trials (and responded correctly on 6/8 initial trials); the lower level of correct responding on the initial trials in this session was likely to have been a result of the inclusion of six exposure trials (as opposed to only two in each of Sessions 1 and 3) -- BS's attention was already lost before the test trials were conducted. Thus it is possible that BS had derived the B-A relations, yet did not respond at criterion level as a result of his lack of interest in the procedure. It was noted that subsequent experimental sessions would further reduce his attention. As a result, BS proceeded straight to Phase 3.

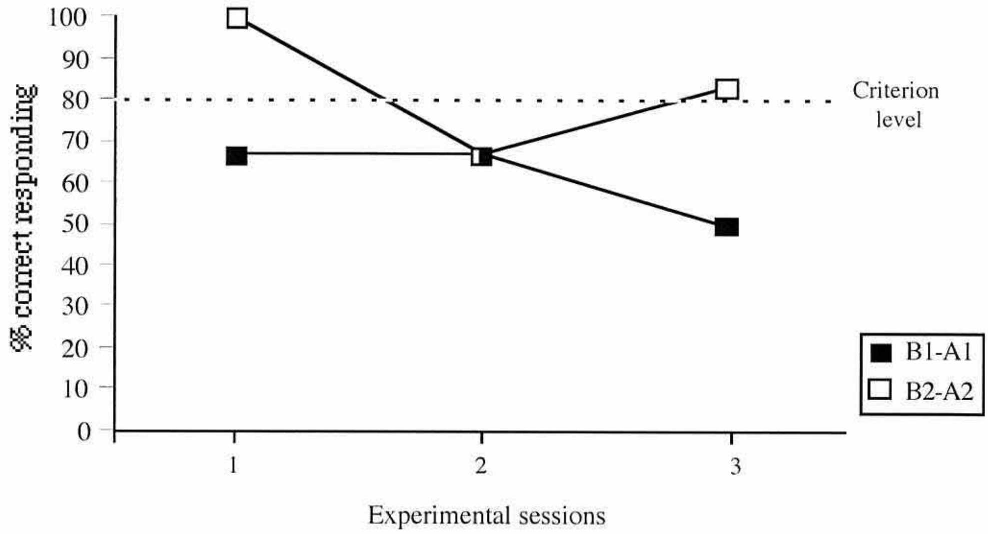


Figure K1. Participant BS: Percentage of correct responding on B-A trials throughout Phase 2. Percentage of correct responding was over 12 trials in each session.

Vocalisations. BS echoed the novel word presented on one A2-B2 exposure trial. He did not label the objects either spontaneously or in response to prompts.

Phase 3. C-A Non-Ostensive Exposures and B-C Testing

BS was given three sessions in Phase 3. It was intended to present B-A test trials, C-A exposure trials, and B-C tests in each session. However, as a result of BS's lack of interest in the procedure, B-C test trials were conducted in only one session; the remaining sessions comprised A-B exposures and B-A test trials (see Table K3).

Table K3

Participant BS: Number of A-B and C-A exposure trials presented, and accuracy scores on B-A and B-C test trials, throughout Phase 3.

	A-B exposures		B-A test trials		C-A exposures		B-C test trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2	C1-A1	C2-A2	B1-C1	B2-C2
1	-	-	1/2	2/2	1	1	3/5	2/4
2	-	-	0/2	2/2	-	-	-	-
3	1	1	2/5	3/5	-	-	-	-
Total	1	1	3/9	7/9	1	1	3/5	2/4

In Session 1, BS responded with 75 percent accuracy on the four B-A test trials (50 percent on B1-A1 and 100 percent on B2-A2). Following two C-A exposure trials, it was intended to present 12 B-C test trials; however, nine trials were conducted before BS refused to cooperate further. On these trials he responded with 55.5 percent accuracy overall (60 percent on B1-C1 trials, and 50 percent on B2-C2 trials, see Table K3).

In Session 2, BS selected the A2 stimulus on all four B-A trials presented, and was extremely inattentive. The session was abandoned following these trials.

In Session 3, BS was given A-B exposure trials and B-A test trials; 10 B-A trials were conducted before BS refused to cooperate further. Overall he responded with 50 percent accuracy on these trials (40 percent on B1-A1 trials, and 60 percent on B2-A2 trials). In contrast to Phase 2 sessions, BS responded correctly on only the first three trials in this session.

Vocalisations. BS echoed the novel word presented on one A1-B1 exposure trial. He also correctly, and spontaneously, labelled the A1 stimulus when it appeared on a C-A exposure trial.

By this point in the study BS had tired of the procedure and, specifically, appeared to be bored with the novel objects. He began to pay less attention on exposure trials, and each time the objects were presented on a test trial he requested to play with other familiar toys; thus BS proceeded to the second repetition of the procedure with new sets of stimuli.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing -- Repetition 1

BS was given a free play session with the remaining novel objects, two of which were selected as Set A stimuli and were paired with the novel words "Kiekie" (B3) and "Os" (B4). It was hoped that BS would show increased levels of interest with the new stimuli. Further, in order to sustain his interest, each session comprised no more than two A-B exposure trials and four B-A test trials. Thus criterion level responding was at least 80 percent accuracy on test trials of both novel relations over three experimental sessions.

BS was given three Phase 2 sessions (see Table K4) in which he did not demonstrate acquisition of the B-A relations. Despite responding correctly on all four trials in Session 2, on B-A trials overall he responded with 75 percent accuracy (83.3 percent on B3-A3 trials and 66.6 percent on B4-A4 trials, see Table K4), thus missing criterion level by one error on a B4-A4 trial. He exhibited a preference for the selection of objects in the left hand position, which he selected on 9/12 trials.

Table K4

Participant BS: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2 -- repetition 1.

	A-B exposure trials		B-A test trials	
Session	A3-B3	A4-B4	B3-A3	B4-A4
1	1	1	1/2	1/2
2	1	1	2/2	2/2
3	1	1	2/2	1/2
Total	3	3	5/6	4/6

Vocalisations. BS echoed the novel word on one A3-B3 exposure trial.

BS showed little interest in the procedure throughout these sessions, and tired of the test trials very quickly; he took no further part in the study.

Participant LB

Participant LB was given only one repetition of the procedure with Stimulus Sets 1 and 2; she proceeded through both Phase 2 and the training phase.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing

LB had three experimental sessions in Phase 2 (see Table K5). She did not demonstrate acquisition of the symmetrical B-A relations; she responded below criterion level in each experimental session (66.6, 50, and 75 percent correct responding overall, respectively; see Figure K2). LB demonstrated both stimulus and location preferences: in Session 1 for comparisons in the right hand location, which she selected on 10/12 trials; and in Sessions 2 and 3 for the A2 stimulus, which she selected on 14/16 trials. In Session 3, only four trials were conducted as a result of LB's increasing lack of interest in the procedure.

Table K5

Participant LB: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	A-B exposure trials		B-A test trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	4/6	4/6
2	3	3	1/6	5/6
3	3	3	0/1	3/3
Total	7	7	5/13	12/15

Note: Only four trials were presented in Session 3 as a result of LB's lack of cooperation.

Vocalisations. LB produced one instance of correct prompted labelling of the A2 stimulus. In addition, she labelled A2 "Phone" on one occasion, and A1 as "Heavy" on four occasions.

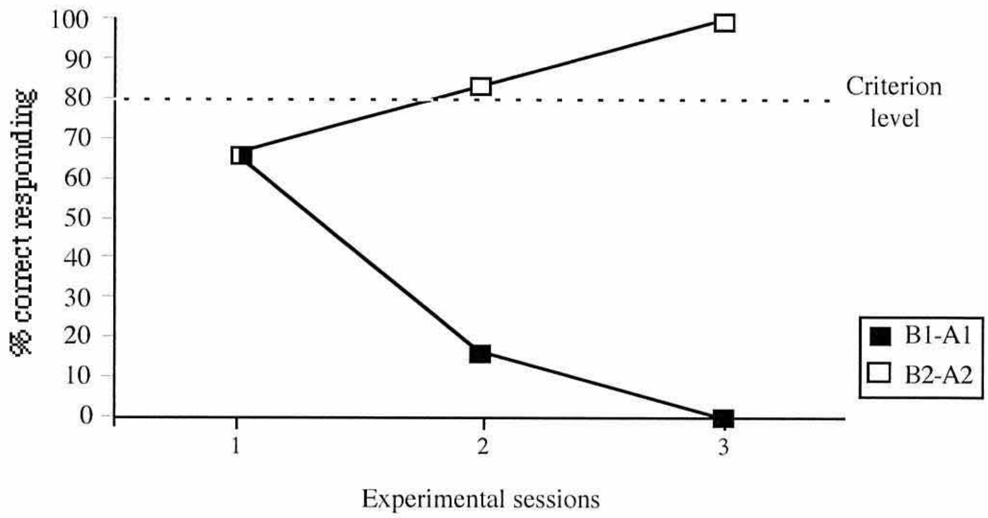


Figure K2. Participant LB: Percentage of correct responding on B-A trials throughout Phase 2. Percentage of correct responding in Sessions 1 and 2 was over 12 trials, and in Session 3 was over four trials (one A1-B1 and three A2-B2 trials).

LB became increasingly distracted in experimental sessions and appeared to tire of the magic-box following only a few exposure and test trials. As a result she proceeded to the training phase where it was hoped that the presentation of reinforcement for correct responding would sustain her interest in the procedure.

Training Phase

LB received eight training sessions. These comprised three training procedures, namely: generic training, training by exclusion, and training by descriptive samples.

Generic training (T1). LB was initially given one generic training session. In this session she was given two A-B exposure trials, and, although it was intended to conduct 12 B-A training trials, only five trials were conducted (three B1-A1 trials and two B2-A2 trials) before LB refused to cooperate further. LB responded with 66.6 percent accuracy on B1-A1 trials, and 100 percent accuracy on B2-A2 trials, thus failing to achieve criterion level.

Vocalisations. LB did not produce the novel words throughout this session, but rather, as in Phase 2, spontaneously labelled A1 as "Heavy" and A2 as a "Phone".

Context switch (CS). Although LB had tired of the magic-box she appeared willing to continue to play with the novel objects, thus she switched to the table-top context at this point in the study. She was given one generic training session in the table-top context in order to familiarise her with the new response requirements. LB showed renewed interest in the procedure and cooperated for two A-B exposure trials and 12 B-A training trials. She responded at chance level overall (33.3 percent on B1-A1 trials and 66.6 percent on B2-A2 trials). On correction trials conducted in this session, LB always selected the correct comparison by the third correction trial.

Vocalisations. When prompted to label the novel objects, LB correctly labelled A1 "Tak", and, as in generic training, labelled A2 a "Phone".

Training by exclusion (T3). LB was given two training by exclusion sessions. In Session 3, LB was given six exclusion and six control trials. She responded with 83.3 percent accuracy on exclusion trials, and 100 percent accuracy on control trials (see Table K6).

Table K6

Participant LB: Number of A-B exposure trials presented, and accuracy scores on exclusion, control, and B-A training trials, throughout training by exclusion.

	A-B exposure trials		Exclusion trials			B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2	Control	B1-A1	B2-A2
3	1	1	2/3	3/3	6/6	-	-
4	1	1	1/1	1/1	2/2	0/1	-
Total	2	2	3/4	4/4	8/8	0/1	-

As a result, it was intended to conduct four trials of each type in Session 4. However, only two control trials, two exclusion trials, and one B-A training trial were conducted before LB refused to cooperate further (see Table K6). Although she responded correctly on all the exclusion and control trials in this session, she responded incorrectly on the B1-A1 training trial conducted; on the five correction trials conducted subsequently, she selected A2 on two trials, and refused to respond on the remaining three. As a result the session was abandoned.

Vocalisations. LB echoed the auditory sample on one B2-A2 exclusion trial; this corresponded with her comparison selection.

Training by descriptive samples (T5). LB received four training by descriptive samples sessions (see Table K7).

Table K7

Participant LB: Number of A-B exposure trials presented, and accuracy scores on training trials, throughout training by descriptive samples.

	A-B exposure trials		Descriptive sample trials		Descriptive + novel sample trials		B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2	B1-A1	B2-A2	B1-A1	B2-A2
5	1	1	6/7	4/5	-	-	-	-
6	1	1	-	-	5/6	2/6	-	-
7	-	-	-	-	6/6	4/6	-	-
8	-	-	-	-	3/3	1/2	-	-
Total	2	2	6/7	4/5	14/15	7/14	-	-

In Session 5, 12 descriptive sample trials were presented, upon which LB responded at criterion level (83.3 percent correct responding overall). Thus Sessions 6, 7, and 8, comprised descriptive and novel sample trials. LB did not achieve criterion level in Sessions 6 and 7 (see Table K7), and Session 8 was abandoned as LB refused to cooperate following five trials. Following this session LB refused to accompany E1 to the room, and thus she took no further part in the study.

Participant KJ

KJ received one repetition of the procedure with Stimulus Sets 1 and 2; in this repetition she proceeded through Phase 2 and the training phase.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing

KJ received four experimental sessions in Phase 2 (see Table K8).

Table K8

Participant KJ: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	A-B exposure trials		B-A test trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	6/6	0/6
2	3	3	6/6	0/6
3	3	3	5/6	0/6
4	1	1	3/6	3/6
Total	8	8	20/24	3/24

KJ did not demonstrate acquisition of the symmetrical B-A relations following A-B non-ostensive exposure trials. Her responding in each experimental session was at, or below, chance level (50, 50, 41.6, and 50 percent accuracy overall, in each session, respectively, see Figure K3). In the first three sessions KJ had an exclusive preference for the A1 stimulus, which she selected on 35/36 trials; this was not evident in Session 4, in which she selected the comparisons with equal frequency. She did, however, select the A1 stimulus on the first six trials, and the A2 stimulus on the remaining six trials.

Vocalisations. KJ echoed the novel word presented on three A1-B1 and one A2-B2 exposure trials. She also echoed the auditory sample on two B2-A2 test trials: in both instances she selected the (incorrect) A1 stimulus.

KJ's labelling of the novel objects further confirmed that she had not learned the novel relations. In response to prompts, KJ correctly labelled the A1 stimulus "Tak" on one occasion, and incorrectly labelled it "Bosch" in another instance. KJ also produced instances of spontaneous labelling: she correctly labelled the A1 stimulus a "Tak", yet also labelled the A1 stimulus a "Bosch" in another instance; on a B1-A1 trial KJ selected the correct A1 stimulus, and when this was made to disappear KJ incorrectly said, "Where's the bosch gone?"

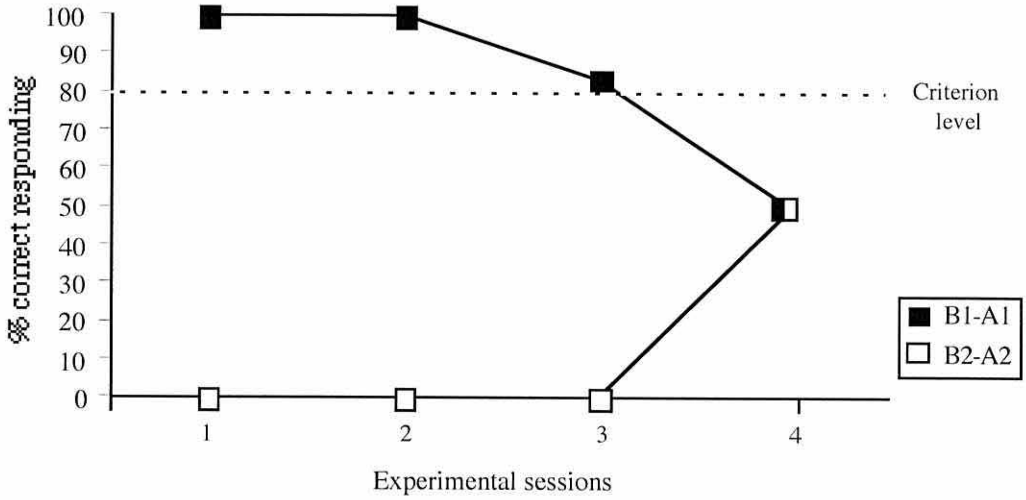


Figure K3. Participant KJ: Percentage of correct responding on B-A trials in Phase 2. Percentage of correct responding was over 12 trials per session.

Training Phase

As KJ did not demonstrate acquisition of the B-A relations, she proceeded to the training phase. In this phase she was given 14 experimental sessions throughout five training procedures, namely: generic training, training by exclusion, training by descriptive samples, training by increased rewards, and training by token rewards.

Generic training (T1). KJ received one generic training session. She was given two A-B exposure trials, and although it was intended to conduct 12 B-A training trials, only two (one each of B1-A1 and B2-A2) were conducted. On the first trial, a B1-A1 trial, KJ responded correctly. On the second trial, a B2-A2 trial, KJ again selected A1 (see Figure K4); this was in accordance with her stimulus preference identified in Phase 2. KJ then failed to respond correctly on four correction trials conducted; she could not be encouraged to select the A2 stimulus. As a result, the session was abandoned.

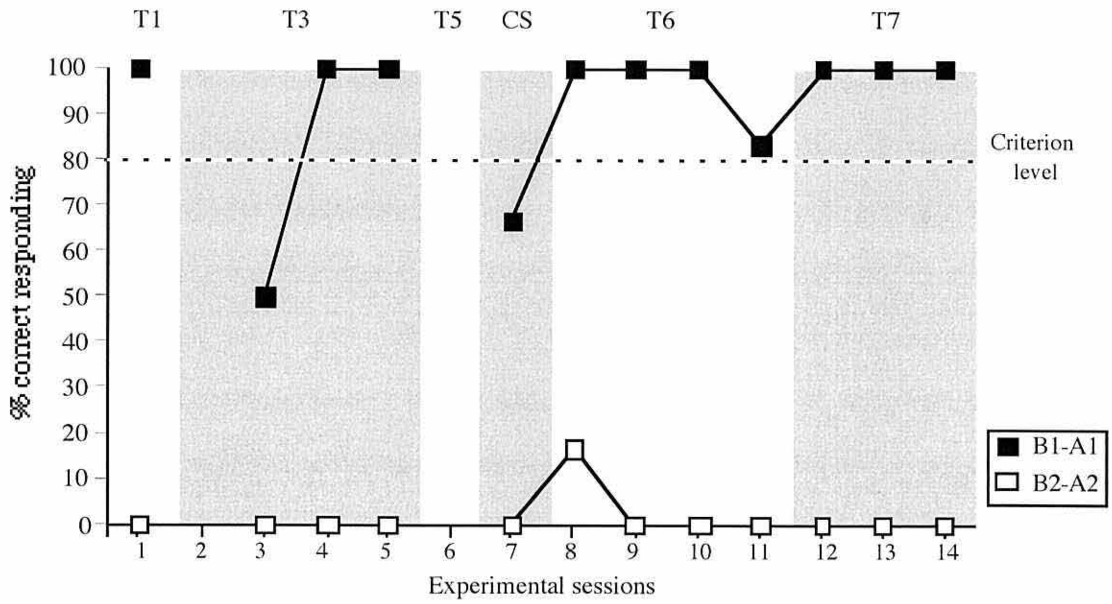


Figure K4. Participant KJ: Percentage of correct responding on B-A training trials (correct responding on other training trial types is not represented in this figure, but is shown in Tables 6.13, 6.14, and 6.15). In generic training (T1), percentage of correct responding was over two trials. Training by exclusion (T3) comprised Sessions 2 to 5; B-A training trials were not presented in Session 2; in Sessions 3, 4, and 5, percentage of correct responding was over four trials. In training by descriptive samples (T5), Session 6, B-A training trials were not presented. CS refers to the context switch, Session 7, which comprised one generic training session in the new table-top context, and thus percentage of correct responding was over 12 trials. Sessions 8 to 14 comprised training by increased rewards (T6) and training by token rewards (T7); in each session, percentage of correct responding was over 12 trials.

Vocalisations. KJ produced only the B1 stimulus; in response to prompts, she correctly labelled A1 a "Tak" on one occasion, and incorrectly labelled A2 a "Tak" on two occasions.

Training by exclusion (T3). KJ was given four training by exclusion sessions (Sessions 2 to 5 inclusive, see Table K9). In Session 2, KJ received six exclusion trials and six control trials; she responded with 83.3 percent accuracy on exclusion trials, and 100 percent accuracy on control trials (see Table K9). As a result, B-A training trials were introduced in the subsequent sessions.

Table K9

Participant KJ: Number of A-B exposure trials presented, and accuracy scores on exclusion, control, and B-A training trials, throughout training by exclusion.

	A-B exposure trials		Exclusion trials			B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2	Control	B1-A1	B2-A2
2	1	1	3/3	2/3	6/6	-	-
3	1	1	2/2	2/2	4/4	1/2	0/2
4	1	1	2/2	2/2	4/4	2/2	0/2
5	1	1	2/2	2/2	4/4	2/2	0/2
Total	4	4	9/9	8/9	18/18	5/6	0/6

Sessions 3, 4, and 5 each comprised four exclusion trials, four control trials, and four B-A training trials. In each of these sessions KJ responded with 100 percent accuracy on both exclusion trials and control trials (see Table K9). However, this did not serve to improve her responding on B-A trials: she responded with 41.6 percent accuracy overall (83.3 percent on B1-A1 trials, and zero percent on B2-A2 trials, see Figure K4). KJ continued to exhibit a preference for the A1 stimulus, which she selected on 11/12 B-A training trials conducted. Correction trials were conducted in Session 3; again these were ineffective in reducing KJ's stimulus preference (on the first B2-A2 trial KJ did not select the correct stimulus until the fourth repetition, and on the second B2-A2 trial until the seventh repetition).

Vocalisations. KJ correctly labelled the A1 stimulus in response to a prompt from E1. Again, she did not produce the novel word "Bosch" throughout these sessions.

Training by descriptive samples (T5). KJ received one session (Session 6) of training by descriptive samples, in which she was given two A-B exposure trials and 12 descriptive + novel sample trials. KJ responded at chance level (50 percent) overall: 100 percent on B1-A1 trials, and zero percent on B2-A2 trials. Her exclusive preference was maintained in this session: she selected A1 on all 12 trials. As the inclusion of the descriptive labels did not bring her responding under control of the auditory samples, in any part, and no training procedure had served to affect her pattern of preferential responding, it was deemed that the rewards for correct responses were not reinforcing. Thus KJ proceeded to training by increased rewards.

Vocalisations. KJ echoed the novel word presented on one B1-A1 and one B2-A2 trial; in both instances she selected the A1 stimulus.

Context switch (CS). At this point in the study KJ tired of the magic-box procedure, and was thus given the remainder of the study in the table-top context. In order to familiarise her with the new response requirements, she was given one generic training session (Session 7) in the table-top context. KJ responded with 33.3 percent accuracy overall on B-A training trials (66.6 percent on B1-A1 trials, and zero percent on B2-A2 trials, see Figure K4); she continued to exhibit a preference for A1, which she selected on 10/12 trials.

Training by increased rewards (T6). KJ was given four sessions in which the rewards for correct responses were increased (see Table K10). These did not serve to improve KJ's responses on B-A training trials; she performed below criterion level in each experimental session (see Figure K4), and her stimulus preference persisted; she selected the A1 stimulus on 46/48 trials.

Vocalisations. KJ echoed the auditory stimulus on one B1-A1 trial; this corresponded with her selection of A1.

Table K10

Participant KJ: Number of A-B exposure trials presented, and accuracy scores on B-A training trials, throughout training by increased rewards.

	A-B exposure trials		B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
8	-	-	6/6	1/6
9	-	-	6/6	0/6
10	1	1	6/6	0/6
11	1	1	5/6	0/6
Total	2	2	23/24	1/24

Training by token rewards (T7). KJ was given three sessions of training by token rewards, each of which comprised two A-B exposure trials and 12 B-A training trials (see Table K11). Again, KJ did not achieve criterion level on B-A training trials; she responded at chance level (50 percent correct responding) in each experimental session (see Figure K4). Her exclusive stimulus preference remained evident; she selected A1 on all 36 B-A training trials.

Table K11

Participant KJ: Number of A-B exposure trials presented, and accuracy scores on B-A training trials, throughout training by token rewards.

	A-B exposure trials		B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
12	1	1	6/6	0/6
13	1	1	6/6	0/6
14	1	1	6/6	0/6
Total	3	3	18/18	0/18

Vocalisations. In contrast to KJ's informal vocalisations in earlier sessions, she did not produce the novel word "Tak" throughout these sessions. Instead, she echoed the novel word presented on two A2-B2 exposure trials. She correctly labelled the A2 stimulus a "Bosch" on one occasion, and also incorrectly labelled the A1 stimulus a "Bosch" on three occasions.

As the training procedures failed to improve KJ's responding on B-A trials, she took no further part in the study.

Participant IB

Participant IB had one repetition of the procedure with Stimulus Sets 1 and 2; he received Phase 2 and training phase sessions in this repetition.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing

IB had five experimental sessions in Phase 2 (see Table K12).

Table K12

Participant IB: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	A-B exposure trials		B-A test trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	0/6	6/6
2	3	3	0/5	6/6
3	3	3	2/6	3/6
4	3	3	0/6	6/6
5	3	3	1/6	6/6
Total	13	13	3/29	27/30

Note. 11 B-A trials were conducted in Session 2 due to experimenter error.

IB did not pass the B-A symmetry tests following non-ostensive A-B exposure trials (see Table K12 and Figure K5); his responding in each experimental session was below criterion level. IB exhibited both stimulus and location preferences: in Sessions 1 and 2 for the A2 stimulus, which he selected on 23/23 trials; in Session 3 for comparisons in the right hand location, which he selected on 9/12 trials; and in Sessions 4 and 5 for the A2 stimulus again, which he selected on 23/24 trials. Note that there was a break in testing of 68 days between Sessions 4 and 5, during which IB did not attend the nursery; his stimulus preference was maintained over this break.

Vocalisations. IB echoed the novel word presented on 10 A1-B1 and 10 A2-B2 exposure trials. On one of these A2-B2 trials IB incorrectly said, "Tak's gone," before E1 presented the correct corresponding novel word "Bosch". IB also echoed the auditory sample on seven B-A test trials, but his utterance corresponded with his selection of correct object in only 3/7 of these instances.

Following the magic routine, on 13 test trials (six B1-A1 trials and seven B2-A2 trials) IB said, "Tak's gone,"; in 7/13 instances his utterance corresponded with the novel object selected. Thus it appeared that IB said "Tak's gone" irrespective of the auditory sample, and his comparison selections.

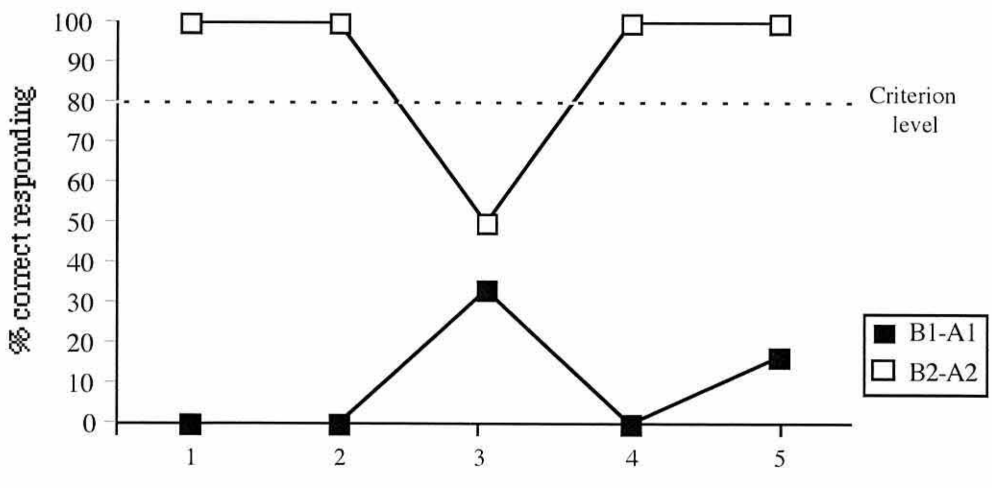


Figure K5. Participant IB: Percentage of correct responding on B-A trials throughout Phase 2. In Sessions 1, 3, 4, and 5, percentage of correct responding was over 12 trials. In Session 2, percentage of correct responding was over 11 trials (five B1-A1 trials and six B2-A2 trials).

Appendix K

Training Phase

IB received a total of 28 experimental sessions in six training procedures, namely: generic training, training by exclusion, training by descriptive samples, training by increased rewards, training by token rewards, and B-A training with ostensive A-B exposure trials.

Generic training (T1). IB was given two generic training sessions, in each of which he had two A-B exposure trials. In Session 1, he had 12 B-A training trials on which he responded with 66.6 percent accuracy overall (50 percent on B1-A1 trials and 83.3 percent on B2-A2 trials, see Figure K6).

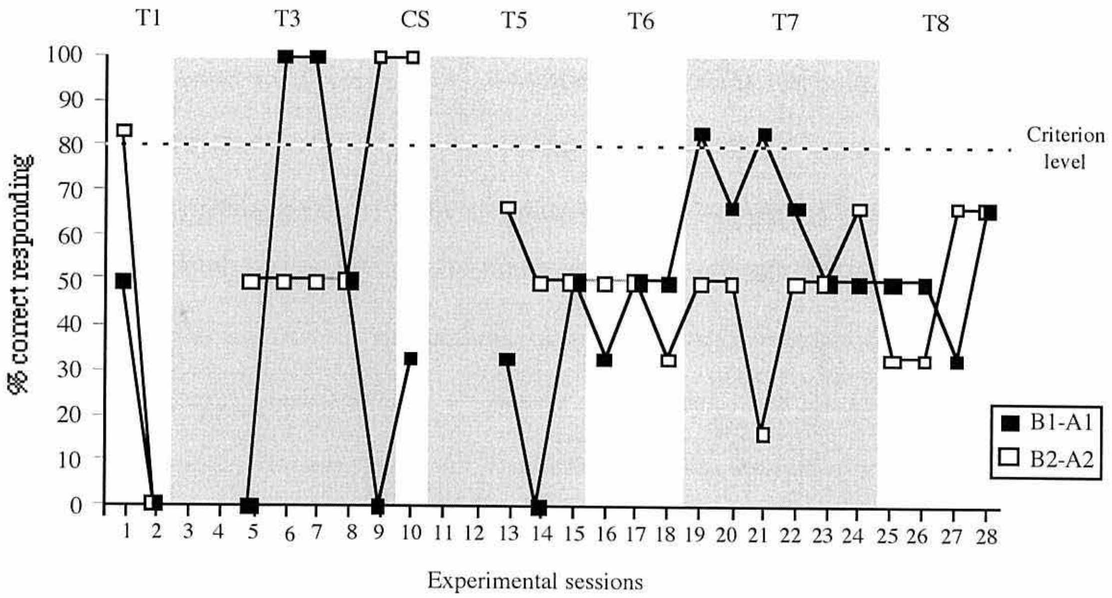


Figure K6. Participant IB: Percentage of correct responding on B-A training trials. Generic training (T1) was given in Sessions 1 and 2; percentage of correct responding was over 12 trials in Session 1, and two trials in Session 2. Training by exclusion (T3) comprised Sessions 3 - 9; in Sessions 3 and 4, B-A training trials were not presented; in Sessions 5 - 9, percentage of correct responding was over four trials. Session 10 (CS) comprised a context switch and percentage of correct responding was over 12 trials. Training by descriptive samples (T5) was given in Sessions 11 - 15; B-A training trials were not presented in Sessions 11 and 12; percentage of correct responding was over 12 trials in Session 13, and four trials in Sessions 14 and 15. Each session in training by increased rewards (T6), training by token rewards (T7), and training including ostensive exposures (T8) comprised 12 B-A training trials.

Where correction trials were given in Session 1, IB did not select the correct corresponding comparison until the fourth repetition of each trial; thus these were inefficient in producing a change in his responding. This was also the case for Session 2; IB was given only two B-A training trials (one of each relation) on both of which he responded incorrectly. On the first trial IB did not select the correct comparison until the third correction trial, and on the second trial he did not select the correct comparison even on the fourth correction trial. As a result the session was abandoned.

Vocalisations. IB echoed the novel word presented on one A1-B1 exposure trial. In addition, he correctly labelled the A2 stimulus in response to a prompt.

Training by exclusion (T3). IB received seven training by exclusion sessions (see Table K13). Sessions 3 and 4 comprised six exclusion trials and six control trials. In Session 3, IB responded with 83.3 percent accuracy on exclusion trials and 100 percent accuracy on control trials; in Session 4 he responded without error on both trial types (see Table K13). As a result, each of the subsequent sessions comprised four exclusion trials, four control trials, and four B-A training trials. Despite responding with 100 percent accuracy on exclusion and control trials, IB failed to respond above criterion level on B-A training trials; overall he responded with 50 percent accuracy on B1-A1 trials, and 60 percent accuracy on B2-A2 trials. On correction trials presented in these sessions IB now selected the correct comparison by the third repetition of each trial.

Context switch (CS). At this point in the study IB switched to the table-top context. He was given one generic training session in the new context (Session 10) in order to familiarise him with the new response requirements. He responded with 66.6 percent accuracy on these trials (33.3 percent on B1-A1 trials, and 100 percent on B2-A2 trials, see Figure K6); he selected the A2 stimulus on 10/12 trials.

Table K13

Participant IB: Number of A-B exposure trials presented, and accuracy scores on exclusion, control, and B-A training trials, throughout training by exclusion.

	A-B exposure trials		Exclusion trials			B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2	Control	B1-A1	B2-A2
3	1	1	2/3	3/3	6/6	-	-
4	1	1	3/3	3/3	6/6	-	-
5	1	1	1/2	2/2	4/4	0/2	1/2
6	1	1	1/2	2/2	4/4	2/2	1/2
7	1	1	2/2	2/2	4/4	2/2	1/2
8	1	1	2/2	2/2	4/4	1/2	1/2
9	1	1	2/2	2/2	4/4	0/2	2/2
Total	7	7	13/16	16/16	32/32	5/10	6/10

Training by descriptive samples (T5). IB received five sessions of training by descriptive samples (see Table K14). In Session 11, IB was given 12 descriptive + novel sample trials; he failed to achieve criterion level on these trials (50 percent correct responding overall, see Table K14). He selected his preferred stimulus on 10/12 trials. However, in Session 12, IB achieved criterion level on these trials (see Table K14).

As a result, IB was given 12 B-A training trials in Session 13, on which he responded with 50 percent accuracy overall (see Figure K6). As he failed to respond at criterion level, descriptive + novel sample trials were again conducted in Sessions 14 and 15; in both of these sessions IB was given eight of these trials, and four B-A training trials. Although IB performed above criterion level on descriptive + novel sample trials in these sessions (93.75 percent accuracy overall), he failed to respond at criterion level on B-A training trials: he responded with 37.5 percent accuracy overall (25 percent on B1-A1 trials and 50 percent on B2-A2 trials, see Figure K6).

Vocalisations. IB echoed the auditory sample on one B1-A1 trial. He did not label the objects either spontaneously or in response to prompts from the experimenter.

Table K14

Participant IB: Number of A-B exposure trials presented, and accuracy scores on training trials, throughout training by descriptive samples.

Session	A-B exposure trials		Descriptive + novel sample trials		B-A training trials	
	A1-B1	A2-B2	B1-A1	B2-A2	B1-A1	B2-A2
11	1	1	1/6	5/6	-	-
12	1	1	6/6	6/6	-	-
13	-	-	-	-	2/6	4/6
14	1	1	3/4	4/4	0/2	1/2
15	1	1	4/4	4/4	1/2	1/2
Total	4	4	14/20	19/20	3/10	6/10

Training by increased rewards (T6). IB received three experimental sessions in which the rewards for correct responses were increased (see Table K15). IB did not demonstrate acquisition of the B-A relations as a result of this training procedure. His responding was below criterion level in each experimental session (41.6, 50, and 41.6 percent overall, in each session respectively; see Figure K6). IB's stimulus preference was no longer evident; he selected the objects with equal frequency.

Vocalisations. IB echoed the novel word presented on one A1-B1 and one A2-B2 exposure trial. He also correctly labelled the A2 stimulus a "Bosch" in response to a prompt from E1.

Table K15

Participant IB: Number of A-B exposure trials presented, and accuracy scores on B-A training trials, throughout training by increased rewards.

Session	A-B exposure trials		B-A training trials	
	A1-B1	A2-B2	B1-A1	B2-A2
16	1	1	2/6	3/6
17	1	1	3/6	3/6
18	1	1	3/6	2/6
Total	3	3	8/18	8/18

Training by token rewards (T7). IB received six experimental sessions (Sessions 19 to 24 inclusive) in which correct responses were rewarded with the presentation of tokens (see Table K16). IB did not achieve criterion level responding on B-A training trials as a result of the inclusion of the token reward system. His responding in each experimental session was below criterion level (see Figure K6). He exhibited a stimulus preference for A1 in Session 21, which he selected on 10/12 trials. In Sessions 19, 20, 22, and 24, he demonstrated a location preference for objects in the right hand location, which he selected on 39/48 trials.

Table K16

Participant IB: Number of A-B exposure trials presented, and accuracy scores on B-A training trials, throughout training by token rewards.

	A-B exposure trials		B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
19	1	1	5/6	3/6
20	1	1	4/6	3/6
21	1	1	5/6	1/6
22	1	1	4/6	3/6
23	1	1	3/6	3/6
24	1	1	3/6	4/6
Total	6	6	24/36	17/36

Vocalisations. IB echoed the novel word presented on three A1-B1 and two A2-B2 exposure trials. He also echoed the auditory sample on three B1-A1 and one B2-A2 training trials; these utterances corresponded with his comparison selections in 2/4 instances.

IB's vocalisations confirmed that he had not learned the novel words: he correctly and spontaneously labelled A2 a "Bosch" on one occasion, and he correctly labelled A2 "Bosch" on four occasions in response to prompts. However, he also labelled A1 "Bosch" on one occasion spontaneously, and on three occasions in response to prompts. On one occasion, when requested to label A1, IB said, "Tak . . . bosch," and in another instance said, "A bosch . . tak."

Training by token rewards: ostensive A-B exposure trials (T8). The final training procedure was identical in nature to T7, with the exception that A-B ostensive exposure trials were now presented (see Table K17). IB did not achieve criterion level on B-A training trials, his responding in each session was below criterion level (see Figure K6). IB again demonstrated location preferences: in Sessions 25 and 26 for objects in the right hand location, which he selected on 20/24 trials; and in Sessions 27 and 28 for objects in the left hand location, which he selected on 20/24 trials.

Table K17

Participant IB: Number of A-B ostensive exposure trials presented, and accuracy scores on B-A training trials, throughout training procedure 8.

	A-B ostensive exposure trials		B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
25	1	1	3/6	2/6
26	3	3	3/6	2/6
27	3	3	2/6	4/6
28	3	3	4/6	4/6
Total	10	10	12/24	12/24

Vocalisations. IB echoed the novel word presented on two A1-B1 and six A2-B2 exposure trials. Further, on each exposure trial, IB was prompted to label the novel object as it was initially presented to him. On nine A1-B1 trials he responded with the correct novel word "Tak", on two further trials he produced the incorrect novel word "Bosch"; and on five A2-B2 trials IB responded with the correct novel word "Bosch", on two further trials he produced the incorrect novel word. In addition, IB also correctly and spontaneously labelled A2 a "Bosch". However, in one instance he also spontaneously, yet incorrectly, labelled A2 a "Tak".

By this point in the study IB had tired of the procedure, and his attention declined progressively. As a result he took no further part in the study.

Participant FR

FR had two repetitions of the procedure: the first repetition with Stimulus Sets 1 and 2, and the second with Stimulus Sets 3 and 4. In the first repetition she proceeded through Phase 2, the training phase, and Phase 3; in the second repetition she proceeded through Phases 2 and 3.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing

FR received four sessions in Phase 2 (see Table K18).

Table K18

Participant FR: Number of A-B exposure trials presented, and accuracy scores on B-A test trials throughout Phase 2.

	A-B exposure trials		B-A test trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	3/6	2/6
2	1	1	3/6	1/6
3	3	3	2/6	2/6
4	3	3	3/6	4/6
Total	8	8	12/24	9/24

FR did not demonstrate derivation of the symmetrical B-A relations; her responding in each session was below criterion level (see Figure K7). In Sessions 2, 3, and 4, she exhibited a preference for comparisons in the right hand location, which she selected on 30/36 B-A trials.

A-B naming test session. FR was given a naming test session which comprised free recall, prompted recall, and recognition trials. On free recall trials FR did not produce any vocal responses, despite responding correctly on four baseline free recall trials. On prompted recall trials it appeared that FR did not understand the responses required of her. On the five baseline trials of this type, FR responded with "No" rather than producing a familiar word. On the four target trials conducted, she produced one correct response and one incorrect response (both on an A1-B1 trial), responded with "No" on one trial, and failed to produce any response on the remaining trial. On recognition trials, FR responded with "No" on all four baseline trials and two target trials conducted. The naming test was abandoned following these trials.

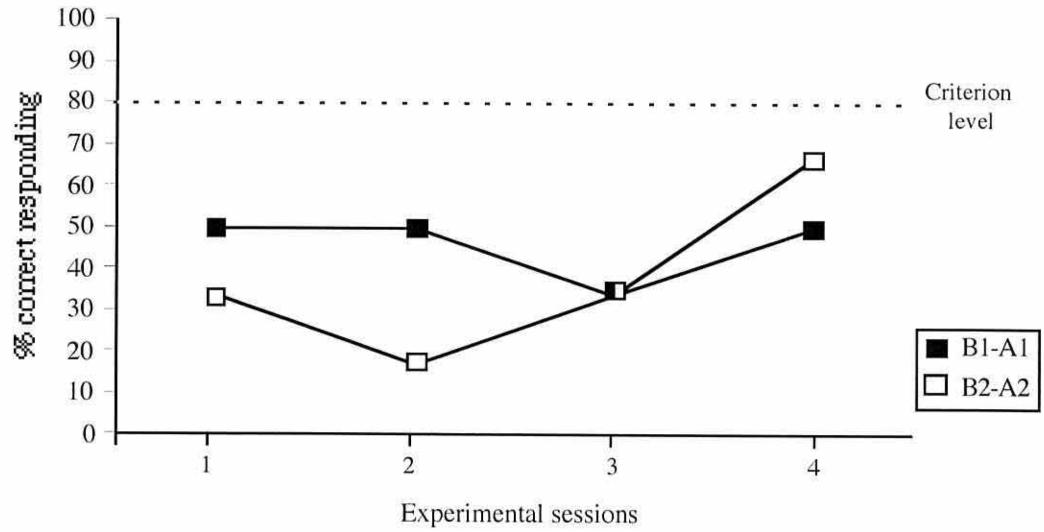


Figure K7. Participant FR: Percentage of correct responding on B-A trials throughout Phase 2. Percentage of correct responding was over 12 trials in each session.

Training Phase

FR was given 32 experimental sessions which comprised five training procedures, namely: generic training, training by proximity, training by exclusion, A-B training, and training by descriptive samples.

Generic training (T1). FR was given three generic training sessions (see Table K19). She did not respond at criterion level on B-A training trials in these sessions (see Figure K8). She demonstrated both stimulus and location preferences: in Session 1 for the A1 stimulus, which she selected on 9/12 trials; and in Sessions 2 and 3 for comparisons in the right hand location, which she selected on 22/24 trials. Correction trials included in Session 3 were inefficient in encouraging FR to select the correct comparison: she required between two and four repetitions of each trial in order to respond accurately.

Vocalisations. FR echoed the auditory stimulus on two B2-A2 training trials; in both instances she selected the correct corresponding novel object. On one B2-A2 trial after correctly selecting the A2 stimulus, she then picked up A1 and correctly labelled it "Tak".

Table K19

Participant FR: Number of A-B exposure trials presented, and accuracy scores on B-A training trials, throughout generic training.

Session	A-B exposure trials		B-A training trials	
	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	4/6	1/6
2	1	1	4/6	4/6
3	1	1	3/6	3/6
Total	3	3	11/18	8/18

Training by proximity (T2). In order to eliminate FR's location preference, she was given three sessions of training by proximity (see Table K20).

Table K20

Participant FR. Number of A-B exposure trials conducted, and accuracy scores on B-A training trials, throughout training by proximity.

	A-B exposure trials		B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
4	1	1	5/6	4/6
5	1	1	4/6	3/6
6	1	1	4/6	3/6
Total	3	3	13/18	10/18

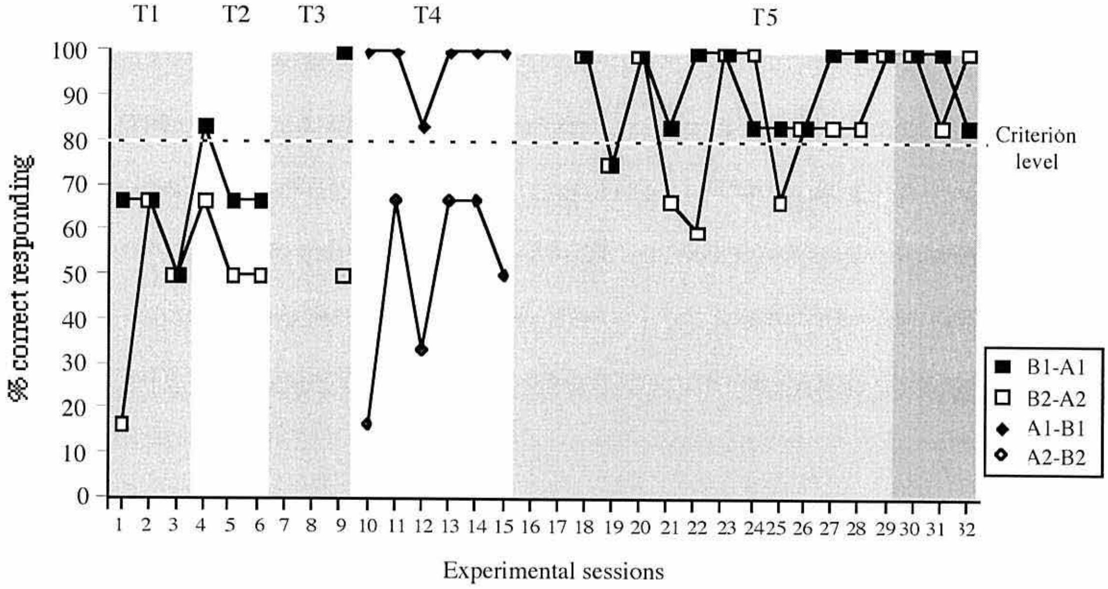


Figure K8. Participant FR: Percentage of correct responding on B-A and A-B training trials throughout the training phase. In each generic training (T1) and training by proximity (T2) session, percentage of correct responding was over 12 trials. Sessions 7 to 9 comprised training by exclusion (T3); in Sessions 7 and 8, only exclusion and control trials were conducted (these are not depicted in this figure), and in Session 9 percentage of correct responding was over four trials. Sessions 10 to 15 comprised A-B training (T4); percentage of correct responding was over 12 A-B training trials in each session. Sessions 16 to 32 comprised training by descriptive samples (T5). In Sessions 16 and 17, B-A training trials were not presented; in Session 18, percentage of correct responding was over four trials; in Sessions 19 and 20, over eight trials; in Session 21, over 12 trials; in Sessions 22 and 23, over 10 trials; and in the remaining sessions (Sessions 24 - 32), percentage of correct responding was over 12 trials. The area of darker shading within T5 denotes sessions in which feedback and rewards were not presented.

In each of these sessions the objects were presented so that the proximate object was always the correct comparison. Again, FR did not achieve criterion level on B-A training trials (see Figure K8). She continued to exhibit a location preference for the selection of objects in the right hand position (which she selected on 27/36 trials), despite the correct comparison being presented proximately. Correction trials were included in each session; FR now selected the correct comparison on the first correction trial presented following each incorrect response on a B-A training trial.

A-B naming test. FR was given one naming test session following training by proximity. On eight free recall trials conducted she responded with 50 percent accuracy overall; she produced the novel word "Tak" on each trial. FR did not produce any responses on both target and baseline prompted recall trials; it again appeared that she did not understand the nature of the responses required. Finally, FR was given 10 target recognition trials and four baseline recognition trials; she did not respond at criterion level on these trials. On the first nine trials FR responded with "No", and on the remaining five trials she responded with "Yes".

Vocalisations. FR's informal vocalisations were similar to those in the naming test, in that she produced only the B1 stimulus ("Tak"). She echoed the novel word presented on one A1-B1 exposure trial. In addition, on each exposure trial, FR was requested to label the novel object as it was presented; on every exposure trial she produced the novel word "Tak" in response to these requests.

Training by exclusion (T3). FR was given three training by exclusion sessions (see Table K21). Sessions 7 and 8 comprised six exclusion trials and six control trials; She responded with 100 percent accuracy on exclusion trials and 83.3 percent accuracy on control trials. As a result, B-A training trials were introduced in Session 9; FR responded at 100 percent on both exclusion and control trials, but on B-A training trials she continued to exhibit a preference for the selection of objects in the right hand location (which she selected on 3/4 trials).

Vocalisations. FR correctly labelled the A1 stimulus "Tak" on three occasions in response to prompts; however, she also labelled the A2 stimulus "Tak" in two instances. FR also echoed the novel word "Bosch" on a B2-A2 training trial; her utterance corresponded with her comparison selection in this instance.

Table K21

Participant FR: Number of A-B exposure trials presented, and accuracy scores on exclusion, control, and B-A training trials, throughout training by exclusion.

Session	A-B exposure trials A1-B1	A-B exposure trials A2-B2	Exclusion trials B1-A1	Exclusion trials B2-A2	Control	B-A training trials B1-A1	B-A training trials B2-A2
7	1	1	3/3	3/3	5/6	-	-
8	-	-	3/3	3/3	5/6	-	-
9	1	1	2/2	2/2	4/4	2/2	1/2
Total	2	2	8/8	8/8	14/16	2/2	1/2

A-B training (T4). In Sessions 10 to 15, FR was given A-B training. Each session comprised A-B exposure trials and 12 A-B training trials (see Table K22).

Table K22

Participant FR: Number of A-B exposure trials presented, and accuracy scores on A-B training trials, throughout A-B training sessions.

Session	A-B exposure trials A1-B1	A-B exposure trials A2-B2	A-B training trials A1-B1	A-B training trials A2-B2
10	1	1	6/6	1/6
11	1	1	6/6	4/6
12	1	1	5/6	2/6
13	1	1	6/6	4/6
14	1	1	6/6	4/6
15	-	-	6/6	3/6
Total	5	5	35/36	18/36

FR did not demonstrate acquisition of the A-B relations; her responding in each session was below criterion level (see Figure K8). In comparison to her informal vocalisations, FR produced the B1 stimulus with a greater frequency than the B2 stimulus on A-B training trials: she produced the novel word "Tak" on 53/72 trials.

Vocalisations. FR echoed the novel word presented on one A2-B2 exposure trial.

Training by descriptive samples (T5)[1]. FR had 17 training by descriptive samples sessions (see Table K23). In Session 16, FR achieved criterion level on descriptive sample only trials (100 percent correct responding), and in Session 17 on descriptive + novel sample trials (91.6 percent correct responding; see Table K23). Thus B-A training trials were progressively introduced in Sessions 18 to 23, with descriptive + novel sample trials being phased out. FR responded at criterion level overall on B-A training trials in these sessions (92.3 percent accuracy on B1-A1 trials and 80.7 percent accuracy on B2-A2 trials).

As a result, Sessions 24 to 32 comprised 12 B-A training trials. FR achieved criterion level in Session 24 (see Figure K8); this performance was not maintained in Session 25. Nonetheless, she again responded above criterion level in Session 26, and this performance was maintained in each subsequent session (see Figure K8). In Sessions 30, 31, and 32, the feedback and rewards for correct responses were removed, and therefore FR responded at criterion level on B-A test trials, thus demonstrating acquisition of the B-A relations.

Vocalisations. FR echoed the novel word presented on one A2-B2 exposure trial. In response to prompts from the experimenter, FR correctly labelled the A1 stimulus on 13 occasions. In addition, FR correctly labelled the A2 stimulus, in response to prompts, on eight occasions; on three further occasions when FR incorrectly labelled it a "Tak" she corrected herself: "Tak . . . bosch," or, "Tak . . . no, bosch." Further, she also correctly and spontaneously labelled each of the novel objects on one occasion. Thus FR's informal vocalisations confirmed that she had acquired the novel relations.

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[1] Only one experimenter was available for participation at this point in the study, and thus she conducted both the exposure and test trials.

Table K23

Participant FR: Number of exposure trials presented, and accuracy scores on test trial types, throughout training by descriptive samples. (Bold text denotes sessions in which criterion level was achieved. Shading denotes sessions in which feedback and rewards were not presented.)

	A-B exposure trials		Descriptive sample trials		Descriptive + novel sample trials		B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2	B1-A1	B2-A2	B1-A1	B2-A2
16	1	1	6/6	6/6	-	-	-	-
17	1	1	-	-	6/6	5/6	-	-
18	1	1	-	-	4/4	4/4	2/2	2/2
19	1	1	-	-	2/2	2/2	3/4	3/4
20	1	1	-	-	2/2	2/2	4/4	4/4
21	1	1	-	-	-	-	5/6	4/6
22	1	1	-	-	1/1	0/1	5/5	3/5
23	1	1	-	-	1/1	1/1	5/5	5/5
24	1	1	-	-	-	-	**5/6**	**6/6**
25	1	1	-	-	-	-	5/6	4/6
26	1	1	-	-	-	-	**5/6**	**5/6**
27	1	1	-	-	-	-	**6/6**	**5/6**
28	1	1	-	-	-	-	**6/6**	**5/6**
29	1	1	-	-	-	-	**6/6**	**6/6**
30	-	-	-	-	-	-	**6/6**	**6/6**
31	1	1	-	-	-	-	**6/6**	**5/6**
32	-	-	-	-	-	-	**5/6**	**6/6**
Total	15	15	6/6	6/6	16/16	14/16	74/80	69/80

Phase 3. C-A Non-Ostensive Exposures and B-C Testing

FR had 17 sessions in Phase 3. Fifteen sessions comprised B-A test trials, C-A non-ostensive exposure trials, and B-C test trials (see Table K24), and the remaining two sessions comprised a C-A test and an A-C symmetry test.

B-A test trials. Four B-A test trials were conducted at the start of each session. FR responded correctly on these trials in each session, except Session 4 in which she responded correctly on 3/4 trials. This amounted to a total of 67/68 correct responses (98.5 percent accuracy overall) over the 17 experimental sessions.

B-C test trials: Sessions 1 to 12. Initially it appeared that FR had formed the incorrect relations, that is, had paired B1 with C2, and, similarly, had paired B2 with C1: in Sessions 1 to 5, FR responded with only 8.3, 16.6, 8.3, zero, and 16.6 percent accuracy in each session, respectively (see Figure K9). If the novel stimuli had been paired in this way (i.e., B1-C2 and B2-C1) then FR's performance in these sessions would have been at criterion level.

This pattern of responding was no longer evident in Sessions 6 to 12 in which FR produced response accuracies of between 33.3 and 75 percent (see Table K24 and Figure K9). Thus in these sessions there was no evidence that FR had either paired the novel stimuli incorrectly, or had derived the correct B-C equivalence relations.

Vocalisations. FR spontaneously labelled the novel objects as they were revealed on C-A exposure trials; in 17 instances she correctly labelled A1, and in 11 instances she correctly labelled A2. FR did not incorrectly spontaneously label either object in these sessions. In instances where FR did not spontaneously label the objects, she was prompted to do so by the experimenter; in nine instances she correctly labelled A1 in response to prompts, and in 7/8 instances she correctly labelled A2 in response to prompts -- in the one instance that she responded incorrectly, she corrected herself: "Tak . . .bosch."

On each C-A exposure trial, as the experimenter presented the shape to FR she was asked, "What's hiding in here?" On 24 C1-A1 exposure trials FR responded with a novel word; in 12/24 instances she produced the correct corresponding word. FR also produced a response on 30 C2-A2 exposure trials; in 20/30 instances she produced the correct corresponding word. The higher accuracy of C-B naming on C2-A2 trials was most likely a result of FR's greater tendency to produce the novel word "Bosch" in these sessions (e.g., in Session 9 she responded with this novel word on all six exposure trials, and in Sessions 8 and 10, she produced this word on 5/6 exposure trials). FR's vocalisations further suggest that she had not acquired the C-A relations: as her criterion level A-B labelling was maintained in this session, if she had acquired the C-A relations then C-B labelling should emerge via transitivity; however, as stated above, her C-B labelling was below criterion.

Table K24

Participant FR: Number of C-A exposure trials presented, and accuracy scores on B-C, C-A and A-C test trials, throughout Phase 3. (Bold text denotes sessions in which criterion level performance was achieved.)

	C-A exposures		B-C test trials		C-A test trials		A-C test trials	
Session	C1-A1	C2-A2	B1-C1	B2-C2	C1-A1	C2-A2	A1-C1	A2-C2
1	1	1	0/6	1/6	-	-	-	-
2	3	3	1/6	1/6	-	-	-	-
3	3	3	1/6	0/6	-	-	-	-
4	3	3	0/6	0/6	-	-	-	-
5	3	3	1/6	1/6	-	-	-	-
6	3	3	3/6	2/6	-	-	-	-
7	3	3	4/6	2/6	-	-	-	-
8	3	3	2/6	3/6	-	-	-	-
9	3	3	3/6	1/6	-	-	-	-
10	3	3	4/6	5/6	-	-	-	-
11	3	3	4/6	5/6	-	-	-	-
12	3	3	3/6	4/6	-	-	-	-
13	3	3	**-**	**-**	**6/6**	**6/6**	**-**	**-**
14	3	3	**-**	**-**	**-**	**-**	**6/6**	**6/6**
15	3	3	**6/6**	**6/6**	**-**	**-**	**-**	**-**
16	3	3	6/6	4/6	-	-	-	-
17	3	3	3/6	4/6	-	-	-	-

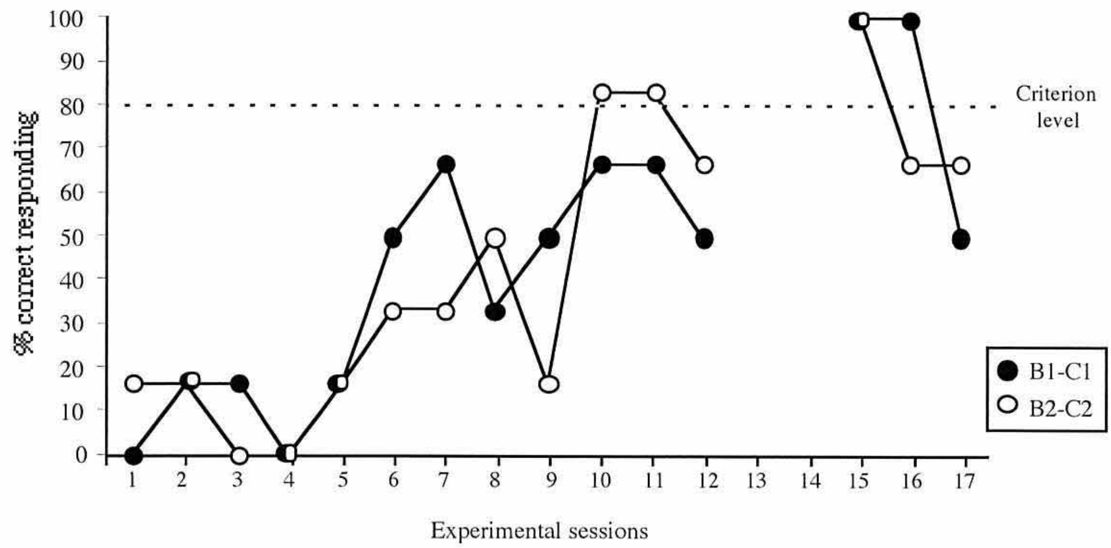

Figure K9. Participant FR: Percentage of correct responding on B-C trials throughout Phase 3. Percentage of correct responding was over 12 trials in each session. B-C trials were not presented in Sessions 13 and 14 (these sessions comprised C-A and A-C tests).

Session 13: C-A exposure trials. Throughout the C-A exposure trials, in Session 13, when prompted to label the novel objects as they appeared on exposure trials FR did so correctly on all six trials.

In addition, when she was shown the novel shapes and was asked, "What's hiding in here?" on C-A exposure trials, FR's responses were more accurate than in previous sessions: she produced the correct novel word "Tak" on 3/3 C1-A1 trials; on C2-A2 trials, she produced the correct novel word "Bosch" on two trials, and on the remaining trial she responded incorrectly but corrected herself: "Tak . . . bosch." FR's C-B matching throughout these trials suggested that, at this point, she had acquired the novel C-A relations. In order to confirm this, a C-A test was conducted subsequently.

Session 13: C-A test trials. FR was given a 12 trial C-A test on which it was confirmed that she had acquired the C-A relations; she responded with 100 percent accuracy on this test.

Vocalisations. In comparison to her vocalisations on exposure trials presented at the start of Session 13, on C-A test trials FR was asked, "What hides in here?" as she was shown the novel shapes. She responded on three C1-A1 trials producing the correct corresponding word; on the three C2-A2 trials that she responded on, she produced the correct novel word in two of these instances, and on the one incorrect response she corrected herself: "Tak . .. bosch." These vocalisations demonstrate the emergence of the transitive C-B (shape-word) relations.

Session 14: A-C test trials. In Session 14, FR was given 12 A-C test trials on which she demonstrated acquisition of the symmetrical A-C relations: she responded with 100 percent accuracy on these trials.

Vocalisations. FR's vocalisations on exposure trials were similar to the previous session, and further indicate that she may have learned the transitive shape-word relations: when prompted to label the objects as they were revealed on exposure trials she did so correctly on one C1-A1 and one C2-A2 trial. Further, when asked, "What's hiding in here?" she produced the correct novel word "Tak" on all three C1-A1 trials; on C2-A2 trials, she produced the correct novel word "Bosch" on 2/3 trials.

B-C test trials: Sessions 15 to 17. In the next session -- Session 15 -- B-C testing was resumed, and FR demonstrated that she had derived the B-C equivalence relations; she responded with 100 percent accuracy on B-C trials in this session (see Figure K9). FR was aged 28 months and 20 days when she passed this test, and had received 86 non-ostensive C-A exposure trials at this point in the study. Although her criterion level performance was not maintained in the two subsequent B-C testing sessions (see Figure K9), her performance overall in Sessions 15 to 17 marginally exceeded 80 percent accuracy.

Vocalisations. FR's vocalisations were similar to those in Sessions 13 and 14 (in which she responded at criterion level on C-A and A-C test trials), and further confirmed that she had derived the novel relations. When asked, "What's hiding in here?' on exposure trials, she produced the correct novel word "Tak" on 8/9 C1-A1 trials; she also produced the correct novel word "Bosch" on 8/9 C2-A2 trials, on the one C2-A2 trial on which she produced the incorrect novel word she corrected herself: "Tak . . . bosch," again demonstrating emergent transitive relations.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing -- Repetition 1

Phase 2 of the study was repeated with Stimulus Sets 3 and 4. FR was given four sessions, each of which comprised two A-B non-ostensive exposure trials and 12 B-A test trials (see Table K25).

Table K25

Participant FR: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2 -- repetition 1. (Bold text denotes sessions in which criterion level was achieved.)

	A-B exposure trials		B-A test trials	
Session	A3-B3	A4-B4	B3-A3	B4-A4
1	1	1	**6/6**	**6/6**
2	1	1	**5/6**	**6/6**
3	1	1	**5/6**	**5/6**
4	1	1	**6/6**	**5/6**
Total	4	4	22/24	22/24

FR demonstrated immediate acquisition of the symmetrical B-A relations following only one non-ostensive exposure to each of the novel A-B relations; she responded with 100 percent accuracy in Session 1. She was aged 29 months and 2 days when she passed this test. Her criterion level performance was maintained in Sessions 2, 3, and 4 (see Figure K10).

Vocalisations. FR echoed the novel word on one A3-B3 exposure trial.

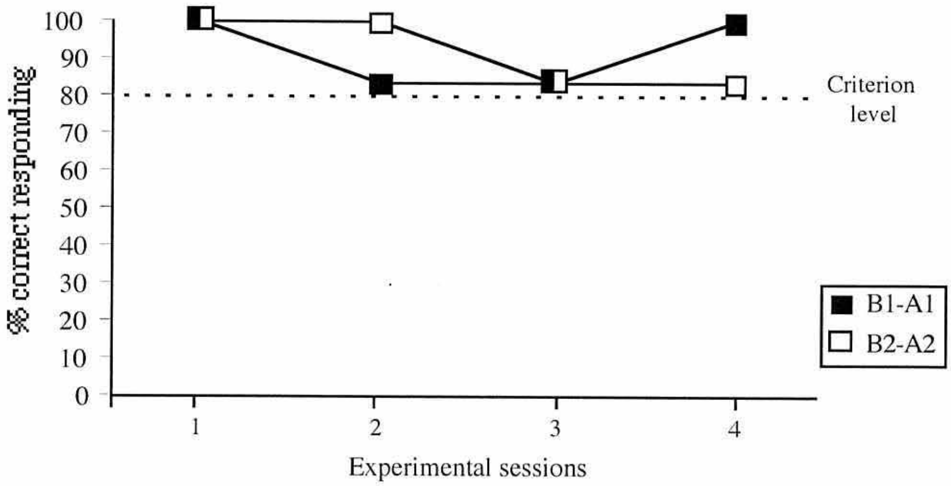

Figure K10. Participant FR: Percentage of correct responding on B-A trials throughout Phase 2 -- repetition 1. In each session the percentage of correct responding was over 12 trials.

Phase 3. C-A Non-Ostensive Exposures and B-C Testing -- Repetition 1

FR was given only one session in Phase 3 (following this was no longer available to participate in the study). In this session she was given two C-A exposure trials and 12 B-C test trials. Following only two non-ostensive exposure trials, FR demonstrated derivation of the B-C equivalence relations; she responded with 91.6 percent accuracy overall in this session (100 percent on B3-C3 trials and 83.3 percent on B4-C4 trials). FR was aged 29 months and 7 days when she passed this test.

Participant DE

Participant DE had two repetitions of the procedure, the first with Stimulus Sets 1 and 2, and the second with Sets 3 and 4.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing

DE received three sessions in Phase 2 (see Table K26). He did not pass the B-A symmetry tests following a total of 14 A-B non-ostensive exposure trials (see Figure K11).

Table K26

Participant DE: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

Session	A-B exposure trials		B-A test trials	
	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	1/6	6/6
2	3	3	2/6	3/6
3	3	3	1/6	5/6
Total	7	7	4/18	14/18

He responded below criterion level in each experimental session producing overall response accuracies of 58.3, 41.6, and 50 percent, respectively. In Sessions 1 and 3, DE exhibited a preference for the A2 stimulus, which he selected on 21/24 trials. Preferential responding was not evident in Session 2.

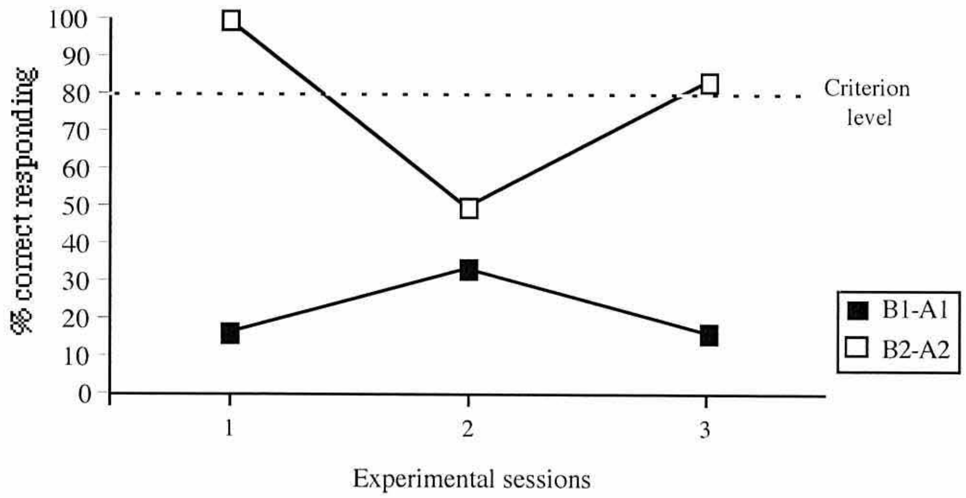

Figure K11. Participant DE: Percentage of correct responding on B-A trials throughout Phase 2. Percentage of correct responding was over 12 trials in each session.

Vocalisations. DE produced the novel word "Bosch" with a greater frequency than the novel word "Tak" throughout this phase: he echoed the novel word presented on two A1-B1 exposure trials and eight A2-B2 exposure trials. In addition, when the novel word "Tak" was presented on two exposure trials in Session 3, DE said, "Bosch," or, "Bosch gone," in response. Further, on two B2-A2 test trials DE also said, "Bosch gone," when the objects had been made to disappear; these were classified as instances of echoing as the novel word "Bosch" was presented as the auditory sample on both trials. He did not label the novel objects either spontaneously or in response to prompts.

Training Phase

Generic training. DE was given six generic training sessions (see Table K27). In Session 1, DE exhibited an exclusive preference for the A2 stimulus, which he selected on all eight trials conducted. However, in Session 2, his preference was no longer evident, and DE responded at criterion level on B-A training trials (100 percent on both novel relations, see Figure K12). His criterion level performance was maintained in Sessions 3, 4, 5, and 6. Further, as is shown in Figure K12, DE responded above criterion level in Sessions 4, 5, and 6, in which the feedback and reinforcement for correct responding were removed. As a result, he proceeded to Phase 3 of the study.

Vocalisations. DE's vocalisations in this phase were similar to those of Phase 2. He did not produce the novel word "Tak" throughout these sessions. He did, however, produce the novel word "Bosch" on several occasions. He echoed the word "Bosch" as it was presented on five A2-B2 exposure trials, and also echoed this word on two B2-A2 training trials. When the novel word "Tak" was presented on A1-B1 exposure trials, he did not echo this novel word, but rather, in five instances said, "Bosch gone." DE continued to do this even in sessions where he responded with 100 percent accuracy on B-A trials.

Table K27

Participant DE: Number of A-B exposure trials presented, and accuracy scores on B-A training trials throughout generic training. (Bold text denotes sessions in which criterion level was achieved. Shading denotes sessions in which feedback and rewards were not provided.)

	A-B exposure trials		B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	0/4	4/4
2	1	1	**6/6**	**6/6**
3	1	1	**6/6**	**6/6**
4	1	1	**6/6**	**6/6**
5	1	1	**6/6**	**6/6**
6	1	1	**6/6**	**6/6**
Total				

Note. Only eight B-A training trials were presented in Session 1 before DE refused to cooperate further.

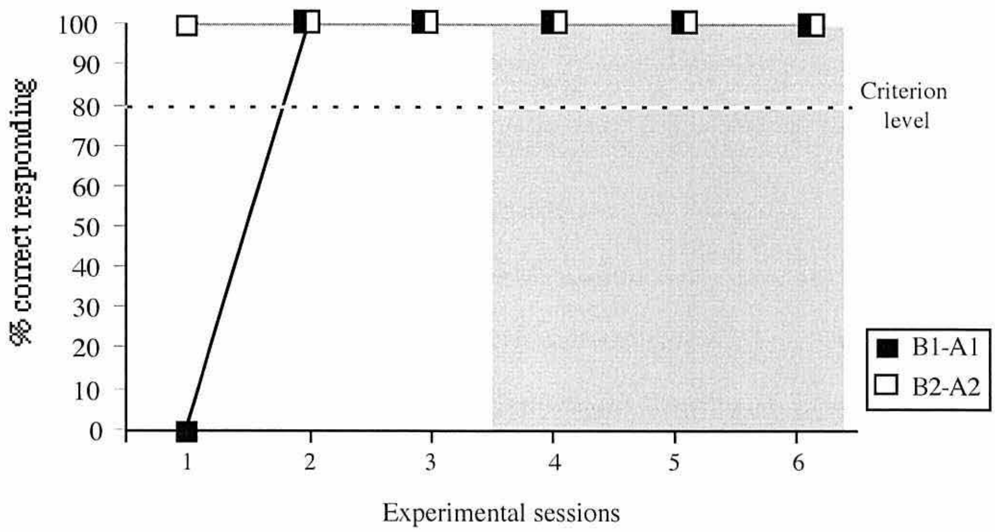

Figure K12. Participant DE: Percentage of correct responding on B-A training trials throughout generic training. Percentage of correct responding was over eight trials in Session 1. In the remaining sessions percentage was over 12 trials per session. Shaded areas denote sessions in which feedback and rewards were not presented.

Phase 3. C-A Non-Ostensive Exposures and B-C Testing

DE was given seven sessions in this phase. These comprised both Phase 2 and Phase 3 sessions, and thus DE received both B-A and B-C tests (see Table K28).

Table K28

Participant DE: Number of A-B and C-A exposure trials presented, and accuracy scores on B-A and B-C test trials throughout Phase 3. (Bold text denotes sessions in which criterion level was achieved.)

	Exposure trials		Test trials	
Session	C1-A1	C2-A2	B1-C1	B2-C2
1	1	1	0/3	1/1
2	1	1	0/1	2/2
	A1-B1	A2-B2	B1-A1	B2-A2
3	-	-	**6/6**	**5/6**
4	-	-	**6/6**	**6/6**
	C1-A1	C2-A2	B1-C1	B2-C2
5	1	1	**5/6**	**6/6**
6	1	1	**6/6**	**6/6**

Sessions 1 and 2. C-A exposures and B-C testing. C-A exposure trials and B-C test trials presented in Sessions 1 and 2 were conducted in the magic context. DE appeared confused throughout the exposure trials: he was reluctant to put both of the novel objects in the magic-box together, and when the objects were then revealed from the holographic boxes, he repeatedly requested to place them in the magic-box or said, "Put it back." DE's confusion was further noticeable on the B-C test trials in which the magic-box was not utilised. On each test trial he refused to respond, or repeatedly selected both of the novel shapes; he could not be encouraged to select only one comparison despite many repetitions of each trial. As a result, only four test trials were conducted in Session 1, and three trials in Session 2 (see Table K28). It was clear that DE did not understand the responses required of him on these trials: simple pointing responses were now required as opposed to the selection of an object which was then placed in a box and acted upon.

Sessions 3 and 4. B-A testing and context switch. Consequently, DE was given two B-A tests in the table-top context. On each trial he was requested to simply point to the correct comparison; this was in order to familiarise him with the responses required on the B-C test trials. In Session 3, DE again showed signs of confusion; he frequently selected both of the novel objects repeatedly, and test trials were repeated many times until a clear response was produced. Despite this, when DE finally produced a codeable response it was typically correct: he responded above criterion level in this session (100 percent on B1-A1 trials and 83.3 percent on B2-A2 trials). Likewise, he responded above criterion level in Session 4 (100 percent on both B1-A1 and B2-A2 trials, see Figure K13).

Vocalisations. Sessions 1 to 4. On test trials in Sessions 1, 2 and, 3, DE repeatedly echoed the auditory sample presented on each trial, or repeatedly said, "Bosch?", or, "Bosch gone,"; these utterances did not correspond with his comparison selections because DE consistently produced ambiguous responses. Further, his productions of the novel words in these sessions were not occasioned by the stimuli present, and thus appeared to be a result of his confusion.

In contrast, there was a marked difference in DE's productions of the novel words in Session 4, in which he produced clear responses on all 12 B-A trials. On test trials in this session he simply echoed the auditory stimulus, once only, as he selected the correct corresponding comparison on 10/12 trials. On the remaining two trials he did not make any vocalisations.

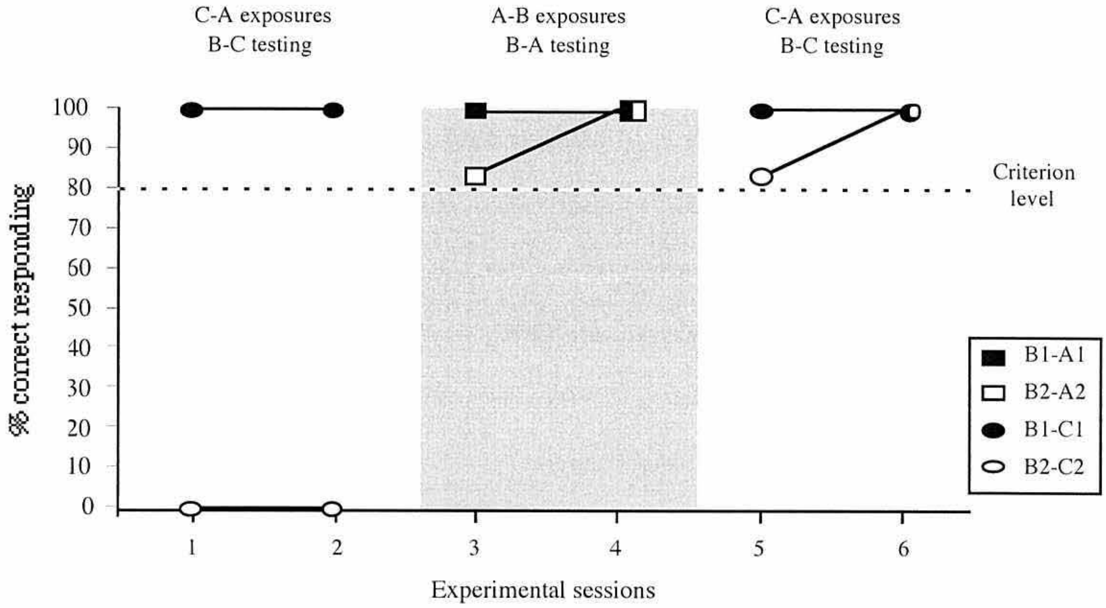

Figure K13. Participant DE: Percentage of correct responding on B-A and B-C test trials throughout Phase 3. In Session 1, percentage of correct responding was over four trials (three B1-C1 and one B2-C2), and in Session 2, correct responding was over three trials (one B1-C1 and two B2-C2). In the remaining sessions, percentage of correct responding was over 12 trials. Note that DE switched to the table-top context in Session 3.

Sessions 5 and 6. C-A exposures and B-C testing. As DE had demonstrated an understanding of the new matching-to-sample response requirements, B-C testing was resumed (see Table K28). In Sessions 5 and 6, he was given two C-A exposure trials and 12 B-C test trials in the table-top context. DE demonstrated derivation of the B-C relations in Session 5, in which he responded with 83.3 percent accuracy on B1-C1 trials, and 100 percent accuracy on B2-C2 trials (see Figure K13). DE had received six C-A non-ostensive exposure trials, and was aged 26 months and 23 days at this point in the study. His criterion level performance was maintained in the subsequent session, in which he responded with 100 percent accuracy on the B-C trials.

Vocalisations. On one C2-A2 exposure trial DE was asked, "What's hiding in here?" as he was shown the novel shape; he correctly responded with the novel word "Bosch." In addition, on this trial, he correctly spontaneously labelled the A2 stimulus as it was revealed from the box. On 23/24 B-C test trials presented DE echoed the auditory stimulus as he selected the corresponding comparison (on the remaining trials he did not make a vocal response).

Session 7. A-B naming test. In Session 7, DE was given an A-B naming test that comprised 11 free recall trials (six A1-B1 and five A2-B2 trials); he responded with 100 percent accuracy on these trials. This further clarifies that he had acquired the novel relations.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing -- Repetition 1

DE was given a free play session with the remaining novel objects, and two were selected as Set A stimuli for use in this repetition of the procedure: the multi-coloured koosh ball was selected as A3, and the giggle stick as A4. These were paired with the novel words "Kiekie" (B3) and "Os" (B4).

DE was given one session in Phase 2; this comprised two A-B exposure trials and 12 B-A test trials. Following only two non-ostensive A-B exposure trials DE responded above criterion level on the B-A test; he responded with 100 percent accuracy on trials of both novel relations, thus demonstrating acquisition of the symmetrical B-A relations. DE was aged 27 months when he passed this test.

Vocalisations. DE echoed the auditory sample presented on each B-A trial as he selected the correct corresponding comparison.

Phase 3. C-A Non-Ostensive Exposures and B-C Testing -- Repetition 1

DE was given a total of 14 experimental sessions in this phase. Initially he was given two sessions that comprised B-A test trials, C-A exposure trials, and B-C tests. There followed a break in testing of 58 days after which DE was again given A-B exposures and B-A testing sessions; this was in order to ensure the permanency of the

B-A relations, and to re-familiarise him with the procedure[2]. Following these sessions, C-A exposures and B-C testing were resumed. The final two sessions in this phase comprised a C-A and an A-C symmetry test (see Table K29).

Table K29

Participant DE: Number of A-B and C-A exposure trials presented, and accuracy scores on all test trial types throughout Phase 3 -- repetition 1. (Bold text denotes sessions in which criterion level was achieved.)

	Exposure trials				Test trials			
Session	A3-B3	A4-B4	C3-A3	C4-A4	B3-A3	B4-A4	B3-C3	B4-C4
1	-	-	1	1	2/2	2/2	4/6	5/6
2	-	-	1	1	2/2	2/2	0/6	0/6
3	1	1	-	-	**5/6**	**6/6**	-	-
4	-	-	-	-	**6/6**	**6/6**	-	-
5	-	-	-	-	**6/6**	**6/6**	-	-
6	-	-	-	-	**6/6**	**6/6**	-	-
7	-	-	1	1	2/2	2/2	4/6	5/6
8	-	-	1	1	2/2	2/2	**5/6**	**6/6**
9	-	-	1	1	2/2	2/2	**6/6**	**6/6**
10	-	-	1	1	2/2	2/2	**6/6**	**6/6**
11	-	-	1	1	2/2	2/2	**6/6**	**6/6**
12	-	-	1	1	2/2	2/2	**6/6**	**6/6**
Total	1	1	8	8	39/40	40/40	37/48	40/48
Session	C3-A3		C4-A4		C3-A3		C4-A4	
13	1		1		**6/6**		**6/6**	
	C3-A3		C4-A4		A3-C3		A4-C4	
14	1		1		**6/6**		**6/6**	

Sessions 1 and 2. C-A exposures and B-C testing. In Sessions 1 and 2, DE was given four B-A test trials, two C-A exposure trials, and 12 B-C test trials. In each session he responded with 100 percent accuracy on B-A test trials. However, he did not

[2] At this point only one experimenter was available for participation in the study. Thus she conducted both the exposure and test trials.

demonstrate acquisition of the B-C equivalence relations following the C-A exposure trials; his responding in each session was below criterion level (see Figure K14). In Session 2, DE did not produce any correct responses; this suggests that he had formed the incorrect relations: on B3-C3 trials he selected the C4 stimulus, and likewise, on B4-C4 trials he selected the C3 stimulus.

Vocalisations. On each B-A and B-C test trial DE echoed the auditory stimulus presented; this was irrespective of which comparison he selected. On one C3-A3 trial DE correctly and spontaneously labelled the A3 stimulus when it was revealed.

Sessions 3 to 6. A-B exposures and B-A testing. Following a break in testing DE was again given A-B exposures and B-A tests. In each session he responded above criterion level producing overall response accuracies of between 91.6 and 100 percent (see Figure K14).

Vocalisations. DE echoed the auditory stimulus presented on 26/48 test trials conducted. He did not label the novel objects in these sessions.

Sessions 7 to 12. C-A exposures and B-C testing. As DE responded above criterion level on B-A tests, B-C testing was resumed in Sessions 7 to 12. In each session he was given four B-A test trials, two C-A exposure trials, and 12 B-C test trials. DE responded with 100 percent accuracy on B-A test trials in each session (see Table K29). DE did not demonstrate acquisition of the B-C equivalence relations in Session 7, in which he responded with 75 percent accuracy overall; he no longer appeared to have formed the incorrect relations, as was evident in Session 2.

In Session 8, however, DE responded above criterion level demonstrating that he had derived the B-C relations; he responded with 92.6 percent accuracy overall (see Figure K14). DE was aged 29 months and 18 days when he passed this test, and had received a total of eight C-A non-ostensive exposure trials. Further, DE's criterion level performance was sustained over the four subsequent B-C test sessions (see Figure K14).

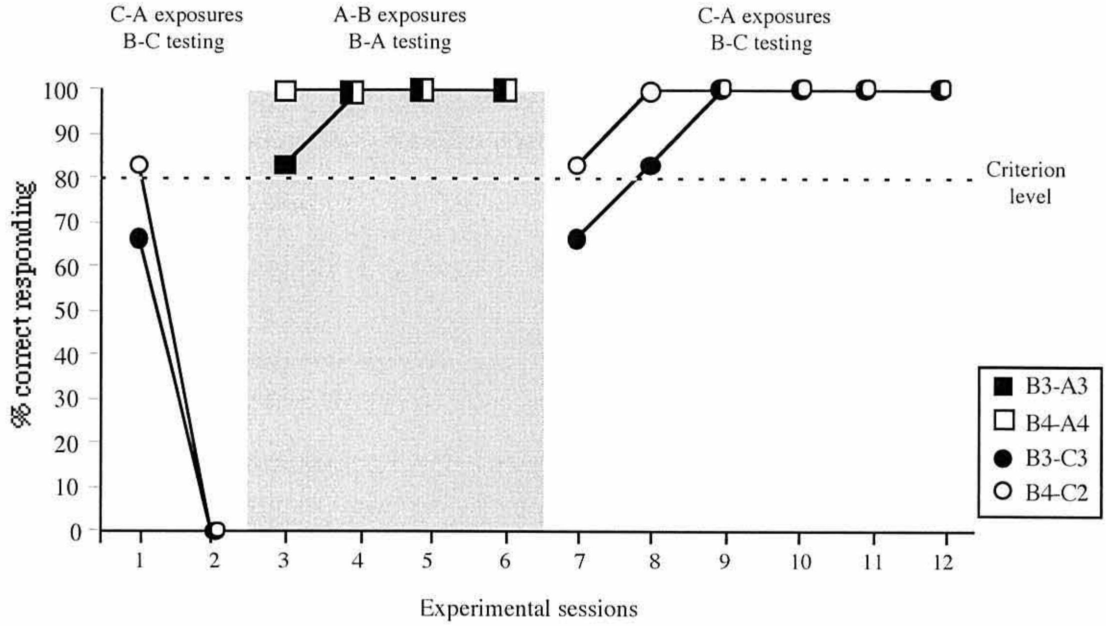

Figure K14. Participant DE: Percentage of correct responding on B-A and B-C trials in Phase 3 -- repetition 1. Percentage of correct responding was over 12 trials in each session. (The four B-A trials presented prior to C-A exposure and B-C tests are not shown in this figure; see Table 6.44 for DE's responses on these trials.)

Vocalisations. On each exposure trial DE was asked, "What's hiding in here," as he was shown the novel shape. On five C3-A3 trials and four C4-A4 trials he produced the correct novel word demonstrating derivation of the transitive C-B relations. Further, as the novel objects were revealed on exposure trials, DE correctly and spontaneously labelled the A3 stimulus on four trials and the A4 stimulus on two trials. Where he did not spontaneously label the objects he was prompted to do so by the experimenter; in two instances he correctly labelled A3, and in three instances he correctly labelled A4. On B-C test trials, DE also echoed the novel auditory stimulus presented on 32 B3-C3 trials and 28 B4-C4 trials; in only one of these instances did he select the incorrect comparison.

Session 13. C-A test. DE was given two C-A exposure trials and 12 C-A test trials; he responded with 100 percent accuracy on these trials, demonstrating acquisition of the C-A relations (see Table K29).

Vocalisations. When asked, "What's hiding in here?" on each exposure trial, DE produced the correct corresponding novel word, again providing evidence of emergent C-B matching. He also spontaneously and correctly labelled the both of the novel objects as they were revealed on these trials.

Session 14. A-C test. DE was given two C-A exposure trials and 12 A-C symmetry test trials; he responded with 100 percent accuracy on these trials, thus demonstrating acquisition of the A-C relations (see Table K29).

Vocalisations. DE produced the correct novel word when asked "What's hiding in here?" on both exposure trials.

Participant SS

Participant SS proceeded through one repetition of the procedure with Stimulus Sets 1 and 2.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing

SS had nine experimental sessions in Phase 2 (see Table K30). She did not pass the B-A symmetry tests following non-ostensive A-B exposure trials. Her responding in each experimental session was below criterion level (see Figure K15).

In the first five sessions, SS exhibited stimulus preferences for both of the novel objects: in Sessions 1 to 4 for the A1 stimulus, which she selected on 37/40 trials; and in Session 5 for the A2 stimulus, which she selected on all 12 B-A trials. In Sessions 6 and 7, these preferences were not evident, and thus SS was given two further exposure and testing sessions. In these two final sessions, Sessions 8 and 9, SS again exhibited a preference for the A1 stimulus, which she selected on 19/24 trials.

Table K30

Participant SS: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	A-B exposure trials		B-A test trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	4/5	1/6
2	1	1	6/6	0/6
3	3	3	2/2	0/3
4	3	3	5/6	0/6
5	3	3	0/6	6/6
6	3	3	2/3	3/3
7	1	1	4/6	4/6
8	1	1	5/6	2/6
9	1	1	4/6	0/6
Total	17	17	32/46	16/48

Note. 11 trials were conducted in Session 1 due to experimenter error; five trials were conducted in Session 3 as a result of SS's lack of attention; and six trials were conducted in Session 6 due to problems with the apparatus.

Vocalisations. SS echoed the auditory sample on one B1-A1 trial; this corresponded with her comparison selection. She also produced one instance of correct spontaneous labelling of the A2 stimulus; in this instance, before the auditory sample was presented on a B1-A1 trial, SS selected the A2 stimulus, placed it in the box and said, "The bosch in the box."

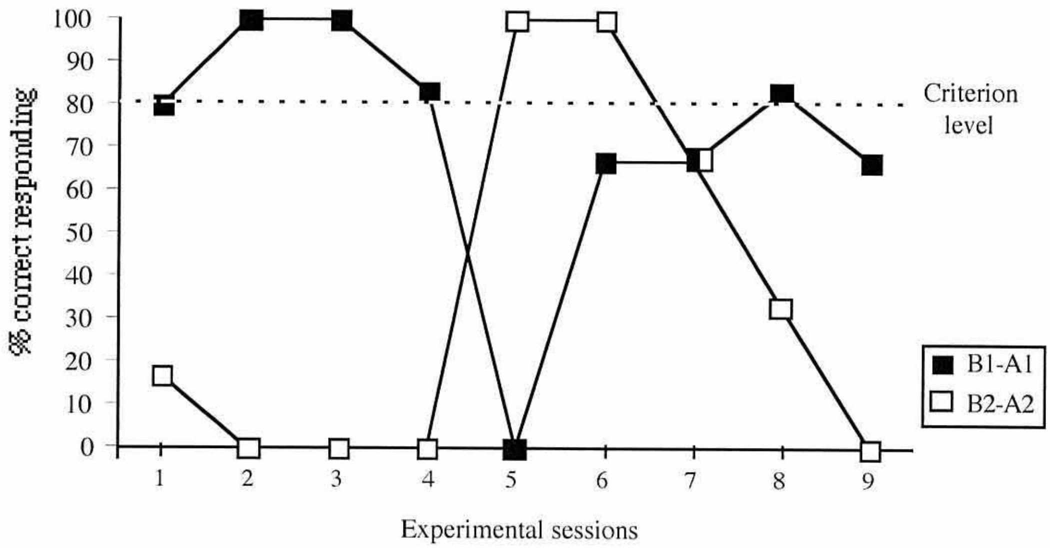

Figure K15. Participant SS: Percentage of correct responding on B-A trials throughout Phase 2. In Session 1, percentage of correct responding was over 11 trials (five B1-A1 and six B2-A2); in Session 3 over five trials (two B1-A1 and three B2-A2); and in Session 6 over six trials (three of each relation). In the remaining sessions percentage of correct responding was over 12 trials.

Training Phase

As SS did not demonstrate acquisition of the B-A relations, she proceeded to the training phase. SS received a total of 10 sessions in two training procedures, namely: generic training and training by exclusion.

Generic training (T1). SS was given one generic training session which comprised two A-B exposure trials and six B-A training trials; she responded with 33.3 percent accuracy overall (2/3 on B1-A1 trials and 0/3 on B2-A2 trials, see Figure K16). SS had a preference for the A1 stimulus, which she selected on 5/6 trials. On correction trials, SS did not always select the correct comparison by the second repetition of each trial. As a result, the session was abandoned.

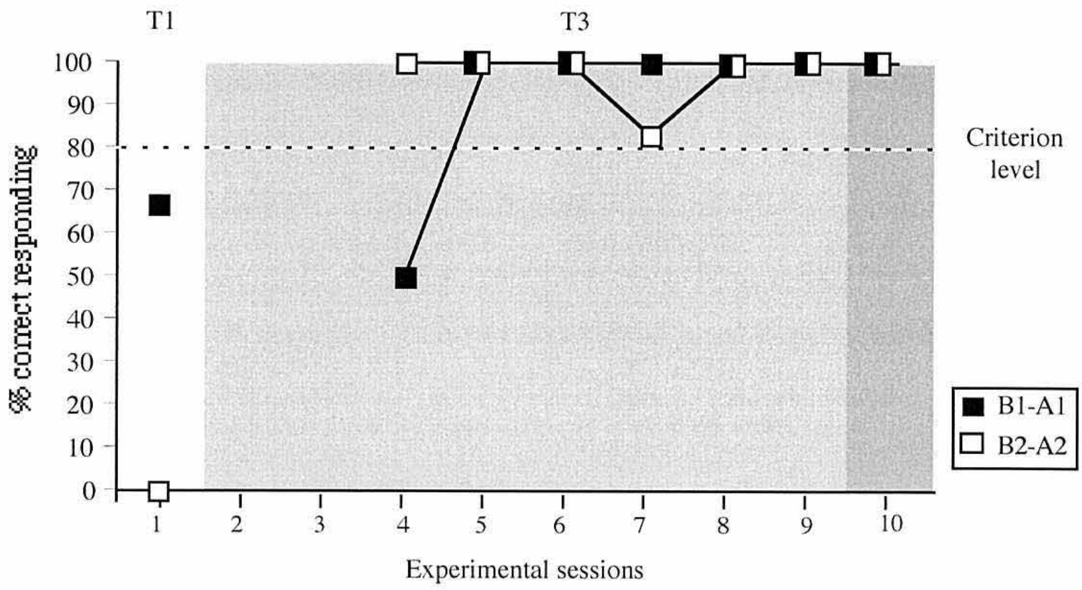

Figure K16. Participant SS: Percentage of correct responding on B-A training trials. Generic training (T1) was given in Session 1, in which percentage of correct responding was over six trials. Sessions 2 to 10 inclusive, comprised training by exclusion (T3); in Sessions 2 and 3, B-A training trials were not conducted; in Sessions 4 and 5, percentage of correct responding was over four trials; and in Session 6, over eight trials. The remaining sessions comprised 12 B-A training trials. In session 10, feedback and rewards were removed (this is indicated by dark shading in the figure). Note also that SS switched contexts in Session 9.

Training by exclusion (T3). SS was given nine sessions in this phase (see Table K31). In Sessions 2 and 3, six exclusion trials and six control trials were presented; overall SS responded above criterion in both of these sessions (83.3 percent on exclusion trials and 100 percent on control trials in Session 2, and 100 percent on both trial types in Session 3, see Table K31). In Sessions 4, 5, and 6, B-A training trials were introduced and each of these sessions comprised four exclusion, four control, and four B-A training trials. Overall, SS responded above criterion level on B-A trials in these sessions (87.5 percent on B1-A1 trials, and 100 percent on B2-A2 trials).

As a result, the remaining sessions (Sessions 7 to 10 inclusive) comprised 12 B-A training trials. In each of these sessions SS achieved criterion level responding (see Figure K16). In Session 10, feedback and rewards were removed, and SS continued to respond at criterion level; thus she proceeded to Phase 3 of the study.

Table K31

Participant SS: Number of A-B exposure trials presented, and accuracy scores on exclusion, control, and B-A training trials, throughout training by exclusion. (Shading denotes sessions in which feedback and rewards were not presented; bold text denotes sessions in which criterion level was achieved.)

	A-B exposure trials		Exclusion trials			B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2	Control	B1-A1	B2-A2
2	1	1	3/3	2/3	6/6	-	-
3	1	1	3/3	3/3	6/6	-	-
4	1	1	2/2	2/2	4/4	1/2	2/2
5	1	1	2/2	2/2	4/4	2/2	2/2
6	1	1	1/1	0/1	2/2	4/4	4/4
7	1	1	-	-	-	**6/6**	**5/6**
8	1	1	-	-	-	**6/6**	**6/6**
9	-	-	-	-	-	**6/6**	**6/6**
10	-	-	-	-	-	**6/6**	**6/6**
Total	7	7	11/11	9/11	22/22	31/32	31/32

Note that in Session 9, SS switched to the table-top context; this session comprised 12 B-A training trials in the new context. As DE displayed confusion on exposure and test trials conducted in the magic context, he required two B-A test sessions in order to reliably demonstrate the responses required of him on the B-C test trials. As a result, SS also switched to the table-top context; this occurred prior to Phase 3 of the study in order that any failure to demonstrate derivation of the B-C relations could not be attributed to the switch in contexts.

Phase 3. C-A Non-Ostensive Exposures and B-C Testing

SS received four sessions in Phase 3, in each of which she was given B-A test trials, C-A non-ostensive exposure trials, and B-C test trials (see Table K32).

B-A test trials. Four B-A test trials were presented in Session 1 and Session 3, prior to the C-A exposure trials. SS responded with 100 percent accuracy on these trials in both sessions.

Table K32

Participant SS: Number of C-A exposure trials presented, and accuracy scores on B-C test trials, throughout Phase 3.

Session	C-A exposure trials		B-C test trials	
	C1-A1	C2-A2	B1-C1	B2-C2
1	1	1	4/6	4/6
2	-	-	2/6	2/6
3	3	3	2/6	2/6
4	3	3	4/6	3/6
Total	7	7	12/24	11/24

B-C test trials. SS did not demonstrate derivation of the B-C equivalence relations following non-ostensive C-A exposure trials. Her responding in each session was below criterion level (66.6, 33.3, 33.3, and 58.3 percent overall, respectively, see Figure K17). Patterns of preferential responding were not identified in this phase.

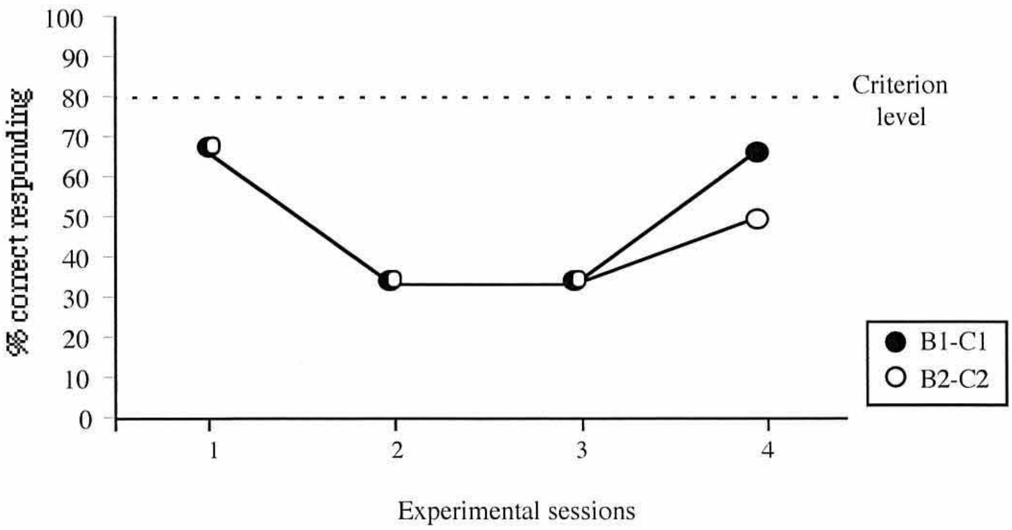

Figure K17. Participant SS: Percentage of correct responding on B-C trials throughout Phase 3. Percentage of correct responding was over 12 trials in each session.

Vocalisations. SS correctly labelled the A1 stimulus on four occasions and the A2 stimulus on three occasions in response to prompts from the experimenter. She also correctly and spontaneously labelled the A2 stimulus once.

On C-A exposure trials SS was asked "What's hiding in here?"; in response to these prompts SS responded on six C1-A1 trials, producing the correct novel word in all six of these instances; she also responded on five C2-A2 trials, producing the correct novel word in three of these instances. Thus there is some evidence that SS had derived the correct novel C-B (shape-word) transitive relations.

Participant SM

Participant SM proceeded through one repetition of the procedure with Stimulus Sets 1 and 2; she was given Phase 2, training, and Phase 3 experimental sessions.

Phase 2. A-B Non-Ostensive Exposures and B-A Testing

Participant SM had three experimental sessions in Phase 2 (see Table K33).

Table K33

Participant SM: Number of A-B exposure trials presented, and accuracy scores on B-A test trials, throughout Phase 2.

	A-B exposure trials		B-A test trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
1	1	1	1/6	3/6
2	3	3	2/6	3/6
3	3	3	2/6	2/6
Total	7	7	5/18	8/18

SM did not pass the B-A symmetry tests; her correct responding in each session was below criterion level (33.3, 41.6, and 33.3 percent overall, respectively, see

Figure K18). Patterns of preferential responding were not identified in Sessions 1 and 2, but SM exhibited a preference for the selection of comparisons in the left hand location in Session 3, which she selected on 10/12 trials.

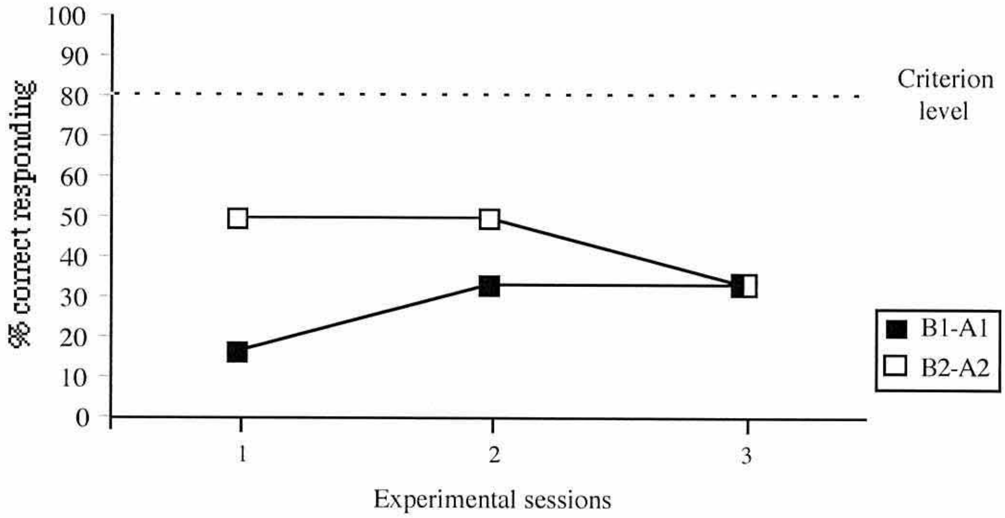

Figure K18. Participant SM: Percentage of correct responding on B-A trials throughout Phase 2. Percentage of correct responding was over 12 trials per session.

Vocalisations. SM echoed the novel word presented on two A1-B1 and one A2-B2 exposure trials, and she echoed the auditory sample on three B1-A1 and six B2-A2 test trials; these utterances corresponded with her comparison selections in only one instance. SM also produced one instance of prompted labelling, in which she incorrectly labelled the A1 stimulus a "Bosch".

Training Phase

SM received 23 sessions in four training procedures, namely: generic training, training by exclusion, training by descriptive samples, and training by increased rewards.

Generic training (T1). SM received one generic training session in which she was given two A-B exposure trials and 12 B-A training trials. She responded with 33.3 percent accuracy overall (33.3 percent on both B1-A1 and B2-A2 trials, see Figure K19).

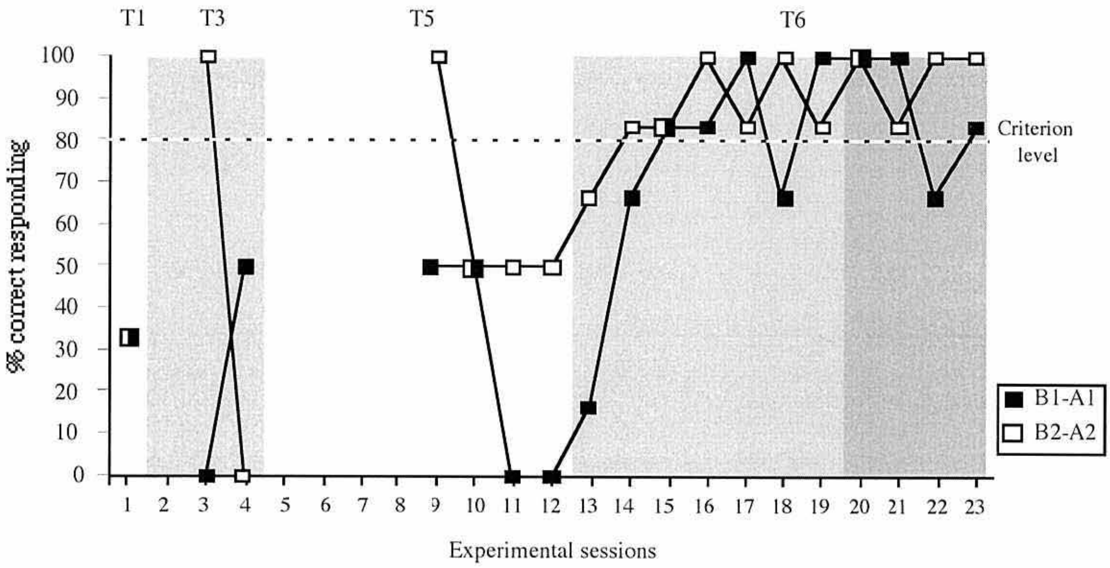

Figure K19. Participant SM: Percentage of correct responding on B-A training trials. Generic training (T1) comprised one session of 12 B-A training trials. Sessions 2, 3, and 4, comprised training by exclusion (T3); in Session 2 only exclusion and control trials were conducted, these are not represented on the figure; in Sessions 3 and 4, percentage of correct responding was over four trials. Training by descriptive samples (T5) consisted of Sessions 5 to 12 inclusive; B-A training trials were not presented in Sessions 5, 6, 7, and 8; in Sessions 9, 10, 11, and 12, percentage of correct responding was over four trials. In training by increased rewards (T6), percentage of correct responding was over 12 trials in each session. Note in Sessions 20 to 23 inclusive, feedback and rewards were not presented on B-A trials -- this is indicated by the area of darker shading on the figure.

On correction trials included in this session, SM selected the correct comparison on either the first or second correction trial; in one instance however, on a B2-A2 trial, SM did not select the correct comparison until the sixth repetition of the trial.

Vocalisations. SM echoed the B1 stimulus on two test trials (one a correction trial); in both instances she selected the corresponding A1 stimulus. She also echoed the B2 stimulus on 10 test trials (five of these were correction trials); she selected the corresponding A2 stimulus on two of these trials. SM did not label the objects in this session.

Training by exclusion (T3). SM received three training by exclusion sessions (see Table K34). In Session 2, SM was given six exclusion and six control trials, on which she responded with 100 percent accuracy. Thus four B-A training trials were conducted in each of Sessions 3 and 4. Whilst SM continued to produce correct responses on all control trials in these sessions, her response accuracies on exclusion trials declined to 62.5 percent overall (5/8 correct responses). Further, she did not achieve criterion level on B-A training trials (37.5 percent accuracy overall, see Figure K19). On correction trials presented in these sessions, SM selected the correct comparison on the first correction trial.

Table K34

Participant SM: Number of A-B exposure trials presented, and accuracy scores on exclusion, control, and B-A training trials, throughout training by exclusion .

	A-B Exposure trials		Exclusion trials			B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2	Control	B1-A1	B2-A2
2	1	1	3/3	3/3	6/6	-	-
3	1	1	1/2	2/2	4/4	0/2	2/2
4	1	1	1/2	1/2	4/4	1/2	0/2
Total	7	7	5/7	6/7	14/14	1/4	2/4

Vocalisations. SM echoed the novel word on presented on two A1-B1 exposure trials. She also echoed the auditory sample on one B1-A1 and one B2-A2 exclusion trial; in both instances she selected the corresponding novel stimulus. In addition, she echoed the auditory stimulus on two B2-A2 training trials; she selected the corresponding object in one of these instances. SM did not label the objects in these sessions.

Training by descriptive samples (T5). SM was given eight training by descriptive samples sessions. As SM had not previously referred to the objects with descriptive labels, Session 5 comprised a free play session in which E1 frequently labelled the objects with "bouncy" (A1) or "noisy" (A2) whilst SM interacted with them. In Sessions 6 to 12, SM was given A-B exposure trials, in which E1 also referred to the novel objects with the descriptive labels, and various training trials (see Table K35).

Table K35

Participant SM: Number of A-B exposure trials presented, and accuracy scores on training trials, throughout training by descriptive samples.

	A-B exposure trials		Descriptive sample trials		Descriptive + novel sample trials		B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2	B1-A1	B2-A2	B1-A1	B2-A2
6	-	-	6/6	6/6	-	-	-	-
7	-	-	-	-	3/6	5/6	-	-
8	-	-	-	-	5/6	5/6	-	-
9	1	1	-	-	4/4	3/4	1/2	2/2
10	1	1	-	-	4/4	4/4	1/2	1/2
11	1	1	-	-	3/4	3/4	0/2	1/2
12	1	1	-	-	4/4	4/4	0/2	1/2
Total	4	4	6/6	6/6	23/28	24/28	2/8	5/8

Session 6 comprised six descriptive sample only trials, on which SM responded with 100 percent accuracy. Thus Session 7 comprised 12 descriptive + novel sample trials, on which SM responded with 66.6 percent accuracy overall. As this was below criterion level, these trials were repeated in Session 8, in which she achieved criterion level (83.3 percent correct responding). Thus four B-A training trials were included in each of the subsequent sessions (see Table K35). SM did not demonstrate acquisition of the B-A relations; her performance on the B-A training trials, in Sessions 9to 12, was below criterion level overall: 25 percent on B1-A1 trials, and 62.5 percent on B2-A2 trials (see Figure K19). Patterns of preferential responding were not identified in this phase.

Vocalisations. SM echoed the novel word presented on one A1-B1 exposure trial, and one B1-A1 training trial. She also correctly labelled the A2 stimulus in response to a prompt from E1.

Training by increased rewards (T6). SM was given 11 training by increased rewards sessions, each of which comprised two A-B exposure trials and 12 B-A training trials (see Table K36).

Table K36

Participant SM: Number of A-B exposure trials presented, and accuracy scores on B-A training trials, throughout training by increased rewards. (Shading denotes sessions in which feedback and rewards were not presented, and bold text denotes sessions in which criterion level was achieved.)

	A-B exposure trials		B-A training trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2
13	1	1	1/6	4/6
14	1	1	4/6	5/6
15	1	1	**5/6**	**5/6**
16	1	1	**5/6**	**6/6**
17	1	1	**6/6**	**5/6**
18	1	1	4/6	6/6
19	1	1	**6/6**	**5/5**
20	1	1	**6/6**	**6/6**
21	1	1	**6/6**	**5/6**
22	1	1	4/6	6/6
23	1	1	**5/6**	**6/6**
Total	7	7	52/66	59/66

SM responded at criterion level on B-A training trials. Although she responded below criterion level in Sessions 13 and 14 (41.6 percent and 75 percent accuracy overall, respectively), she achieved criterion level in Session 15 (see Figure K19). She maintained this performance in all of the subsequent sessions (except Sessions 18 and

22; see Figure K19). Note that in Sessions 20 to 23 inclusive, feedback and rrewards were not presented; SM maintained criterion level performance in three of these sessions, and thus proceeded to Phase 3.

Vocalisations. SM echoed the auditory sample on one B2-A2 trial; this corresponded with her comparison selection. She correctly labelled the A2 stimulus on three occasions, in response to prompts; however, she also incorrectly labelled A1 a "Bosch" on two occasions, in response to prompts.

Phase 3. C-A Non-Ostensive Exposures and B-C Testing

In Phase 3, SM was given B-A test trials, C-A exposure trials, and B-C equivalence tests. As she did not reliably respond correctly on B-A trials conducted at the beginning of each session, A-B exposures and B-A training and tests were also conducted in this Phase (see Table K37).

Table K37

Participant SM: Number of A-B and C-A exposure trials presented, and accuracy scores on B-A training and test trials, and B-C test trials, throughout Phase 3. (Bold text denotes sessions in which criterion level responding was achieved, and shading denotes sessions in which B-A trials were generic training trials in which correct responding was rewarded.)

	A-B exposure trials		B-A test trials		C-A exposure trials		B-C test trials	
Session	A1-B1	A2-B2	B1-A1	B2-A2	C1-A1	C2-A2	B1-C1	B2-C2
1	-	-	2/2	2/2	1	1	3/6	4/6
2	-	-	5/6	3/6	3	3	2/6	2/6
3	1	1	4/6	2/6	-	-	-	-
4	1	1	6/6	3/6	-	-	-	-
5	1	1	**6/6**	**5/6**	-	-	-	-
6	1	1	**5/6**	**6/6**	-	-	-	-
7	1	1	**5/6**	**6/6**	-	-	-	-
8	-	-	-	-	1	1	3/6	1/6
9	-	-	2/2	2/2	3	3	2/6	3/6
Total	5	5	35/40	29/40	8	8	10/24	10/24

B-A and B-C test trials. In Session 1, SM responded correctly on the B-A trials and was thus given C-A exposures and B-C test trials; she failed to achieve criterion on the B-C test, on which she responded with 58.3 percent accuracy overall (see Figure K20). In this session she demonstrated a location preference; she selected the object in the right hand position on 9/12 trials.

In Session 2, SM produced one correct response on the initial four B-A trials; consequently, a further eight trials were conducted (see Table K37). On these trials SM responded with 66.6 percent accuracy overall (see Figure K20); this was below criterion level, but because SM responded correctly on the final four trials presented she was then given C-A exposure trials and B-C test trials. Again, SM did not demonstrate derivation of the B-C relations; she responded with 33.3 percent accuracy overall (see Figure K20).

In Session 3, SM responded correctly on 2/4 B-A trials; consequently, as in the previous session, a further 8 trials were presented. SM now failed to achieve criterion level on the B-A trials: she responded with 50 percent accuracy overall (see Figure K20) and thus C-A exposures and B-C test trials were not conducted (see Table K37).

Instead, Sessions 4 and 5 comprised generic B-A training sessions in order to bring SM's responding on B-A trials back to criterion level. In Session 4, SM demonstrated a location preference; she selected comparisons in the right hand position on 9/12 trials. In Session 5, however, no preferences were identified and SM responded above criterion level: 91.6 percent accuracy overall (100 percent on B1-A1 trials and 83.3 percent on B2-A2 trials, see Figure K20). Thus in each of Sessions 6 and 7, the rewards were removed, and 12 B-A test trials were conducted; in both sessions SM responded above criterion level (91.6 percent accuracy overall in both sessions).

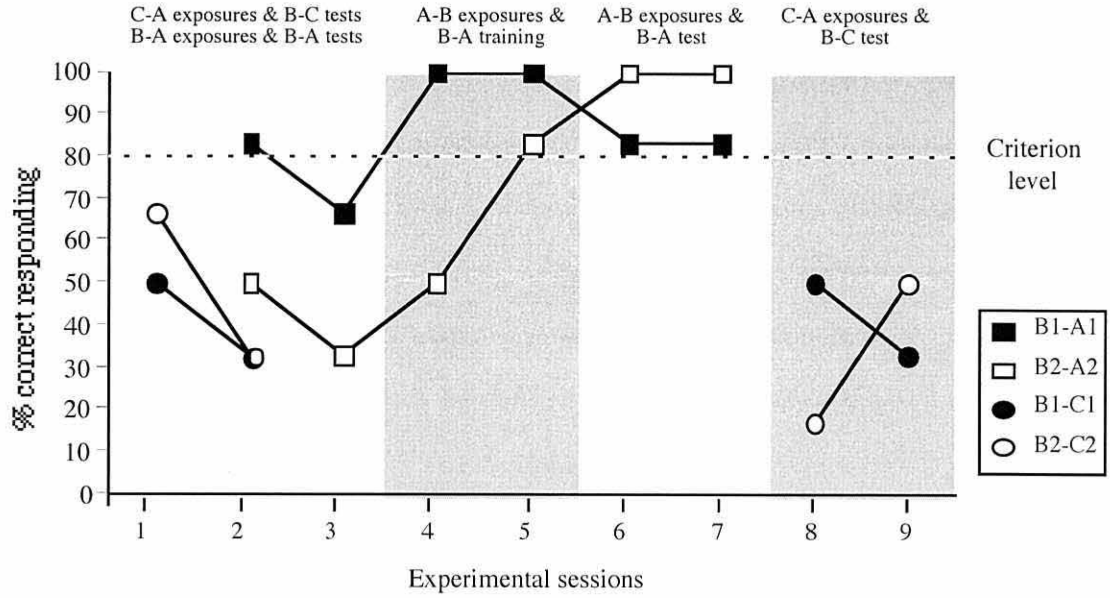

Figure K20. Participant SM: Percentage of correct responding on B-A and B-C trials throughout Phase 3. In each session percentage of correct responding was over 12 trials; B-A tests are represented only where a block of 12 trials were presented in a session (SM's responses on blocks of four B-A test trials, conducted prior to the C-A exposures, are not represented in the figure; see instead Table K37).

In Sessions 8 and 9, C-A exposures and B-C testing were resumed. SM did not demonstrate derivation of the B-C relations following C-A non-ostensive exposure trials: her responding was below criterion level in both sessions (33.3 percent and 41.6 percent overall respectively, see Figure K20).

Vocalisations. SM echoed the novel word presented on one A2-B2 exposure trial. On C-A exposure trials, when the novel object was revealed the experimenter asked, "What's this?"; on eight C1-A1 trials and eight C2-A2 trials SM produced the correct corresponding novel word. In addition, she also correctly and spontaneously labelled the novel object presented on five C1-A1 and four C2-A2 exposure trials.

On C-A exposure trials the experimenter also asked, "What's hiding in here?" as the novel shape was presented. On six C2-A2 trials SM responded with the corresponding novel word "Bosch". However, she also incorrectly responded with this novel word on three C1-A1 trials. On two further C1-A1 trials she produced the correct novel word "Tak" on one occasion, and on one trial said, "Bosch . . . tak."

C-A test trials. SM received one session in which she was given 12 C-A test trials. She responded with 58.3 percent accuracy overall (33.3 percent on C1-A1 trials and 83.3 percent on C2-A2 trials). SM demonstrated a preference for the A2 stimulus, which she selected on 9/12 trials.

Vocalisations. When asked "What hides in here?" on each C-A trial, SM responded with the novel word "Bosch" on seven trials; these utterances always accompanied her selection of the corresponding A2 stimulus, and corresponded with the C2 stimulus in 3/7 instances.

A-C test trials. SM had one session which comprised 12 A-C symmetry trials. She responded with 66.6 percent accuracy overall on these trials (66.6 percent on trials of both relations). She demonstrated a preference for the selection of comparisons in the left hand location, which she selected on 10/12 trials.

Vocalisations. SM correctly labelled the A1 stimulus on one occasion in this session.

APPENDIX L

STUDY 5 DATA

Participant JT

Phase 2.1. Traditional Exclusion Exposure and Learning Outcome Testing, Set 1

Stimuli

Set 1 comprised the novel auditory stimuli "Tak" and "Bosch". The corresponding novel visual stimuli were the multi-coloured plastic 'slinky spring' and the multi-coloured 'koosh ball', respectively.

Exclusion exposure sessions. Each session consisted of between a minimum of four and a maximum of 8 trials; half of these trials were control trials and the remaining half were exclusion trials. The exclusion trials were further sub-divided into equal numbers of trials of each novel relation.

JT received a total of eight exclusion exposure sessions. Overall responding on these sessions, for all trial types, is shown in Figure L1. JT responded above criterion level on control trials and exclusion trials of both novel relations; thus her responses on exclusion trials were controlled by the novel auditory sample presented.

Learning outcome sessions. Learning outcome sessions consisted of between a minimum of 12 and a maximum of 25 learning outcome trials. In each of these sessions, learning outcome trials were subdivided into equal numbers of trials of each novel relation. (This varied in one session where 25 learning outcome trials were presented; these comprised 12 'bosch' trials and 13 'tak' trials.)

Appendix L

JT received a total of eight learning outcome sessions, each of which directly followed an exclusion exposure session. JT's performance on learning outcome trials is shown in Figure L1.

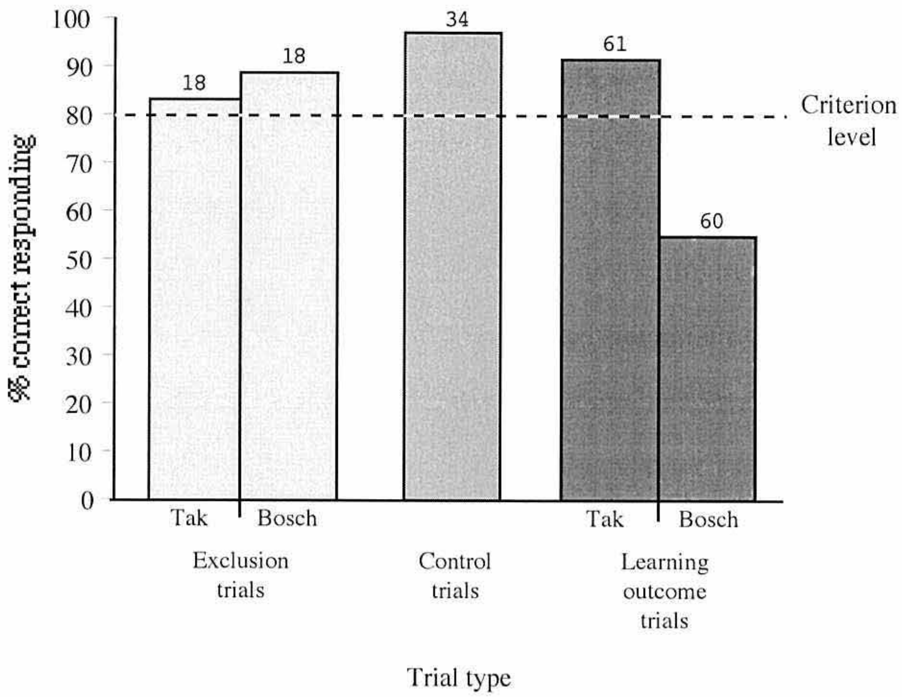

Figure L1. Participant JT: Overall percentage of correct responding on each trial type in Phase 2.1. (Numerals above bars indicate the total number of each trial type presented.)

Although she performed above criterion level on control trials and exclusion trials, she did not, as a result, demonstrate acquisition of the novel relations. Her performance on learning outcome trials was below criterion level; correct responding on learning outcome trials of both novel relations failed to reach 80 percent.

JT exhibited a preference for the visual stimulus corresponding to the auditory stimulus "Tak", (i.e., the multi-coloured slinky spring). In the first four sessions she selected this comparison on a greater number of trials (11/12, 10/12, 9/12, 10/12 in each session, respectively) than the comparison corresponding to "Bosch." Although this pattern of preferential responding declined in intensity in later sessions, the preferred visual stimulus was always selected on a greater number of trials. In learning outcome sessions overall, the frequency of selection of each visual comparison differed greatly, with the preferred visual stimulus being selected on 83/121 trials, and the stimulus corresponding to "Bosch" on only 38/121 trials.

Vocalisations. JT never produced either novel word. Instead, during episodes of informal play, it appeared that JT had formed her own names for both of the novel visual stimuli. The multi-coloured 'slinky spring' (i.e., corresponding to the novel auditory stimulus, "Tak") she labelled "Slinky" in four instances; the multi-coloured 'koosh ball' (i.e., corresponding to the novel auditory stimulus "Bosch") she labelled "Squashy," in five instances.

As JT appeared to have formed her own names for the two novel visual stimuli, and did not demonstrate any acquisition of the novel relations on learning outcome trials, Phase 2 of the study was repeated with a second set of stimuli.

Phase 2.2. Traditional Exclusion Exposure and Learning Outcome Testing, Set 2 Stimuli

Set 2 comprised the novel auditory stimuli "Kiekie" and "Os". The corresponding novel visual stimuli were the white 'koosh ball' and the pink and white concertina snail, respectively.

Exclusion exposure sessions. Exclusion exposure sessions consisted of between a minimum of four and a maximum of eight trials. JT received a total of five exclusion exposure sessions. Overall responding in these sessions, for each trial type, is illustrated in Figure L2. JT responded without error on both exclusion exposure trials and control trials.

Learning outcome sessions. All learning outcome sessions consisted of 12 learning outcome trials, which comprised six trials of each novel relation. JT received a total of five learning outcome sessions, each of which directly followed an exclusion exposure session. Although JT performed above criterion level on both exclusion and control trials, she did not demonstrate acquisition of the novel relations (see Figure L2). Responding overall was below criterion level (56.6 percent on 'kiekie' trials and 63.3 percent on 'os' trials). No patterns of responding were identified with this set of stimuli.

Vocalisations. JT did not produce either of the novel words throughout this phase of the study, either spontaneously or when prompted.

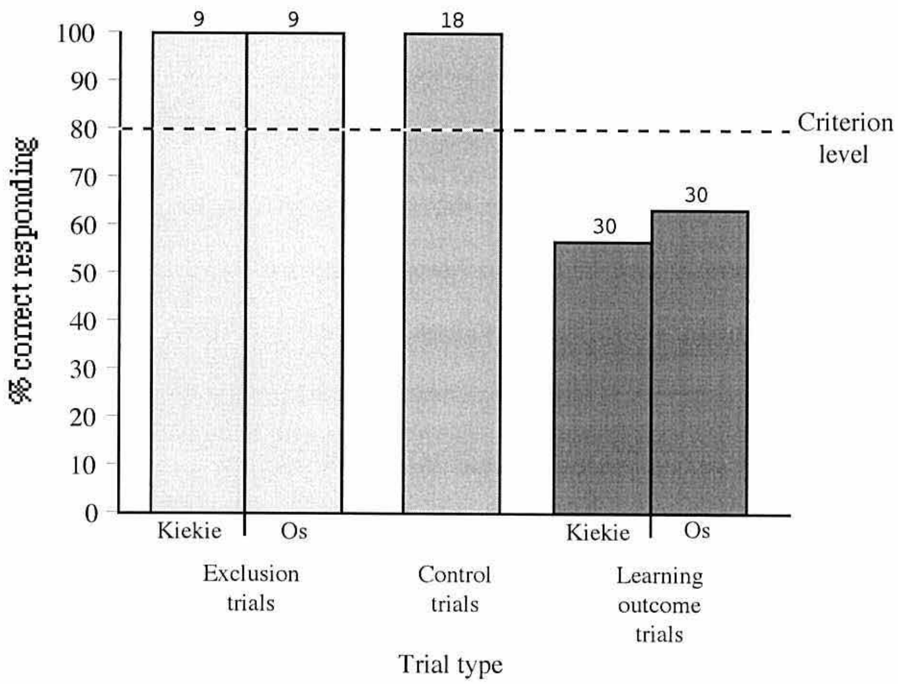

Figure L2. Participant JT: Overall percentage of correct responding on each trial type in Phase 2.2. (Numerals above bars indicate the total number of each trial type presented.)

Participant IW

Phase 2.1. Traditional Exclusion Exposure and Learning Outcome Testing

The novel auditory stimuli comprised the nonsense words "Tak" and "Bosch"; the corresponding visual stimuli comprised the multi-coloured 'slinky spring' and the 'giggle stick', respectively.

Exclusion exposure sessions. IW received five traditional exclusion exposure sessions. Each of these sessions consisted of between 4 and 14 trials; these comprised equal numbers of control trials and exclusion trials. Exclusion trials consisted of equal numbers of trials of each novel relation (except Session 5 which comprised two 'tak' trials and five 'bosch' trials).

Over the five exposure sessions IW performed above criterion level on control trials. However, he failed to perform above criterion level on exclusion trials (see Figure L3). Although IW responded with 100 percent accuracy on 'tak' exclusion trials, responding on 'bosch' trials was only 66.6 percent correct.

Learning outcome sessions. IW received five learning outcome sessions, each of which directly followed an exclusion exposure session. Each of these sessions consisted of 12 to 16 learning outcome trials. Overall performance on these sessions was below criterion level (see Figure L3). IW did not, therefore, demonstrate acquisition of the novel relations. This was predicted as IW did not achieve criterion level on exclusion exposure trials.

Vocalisations. IW produced only one instance of echoing of the novel word "Bosch" throughout this phase.

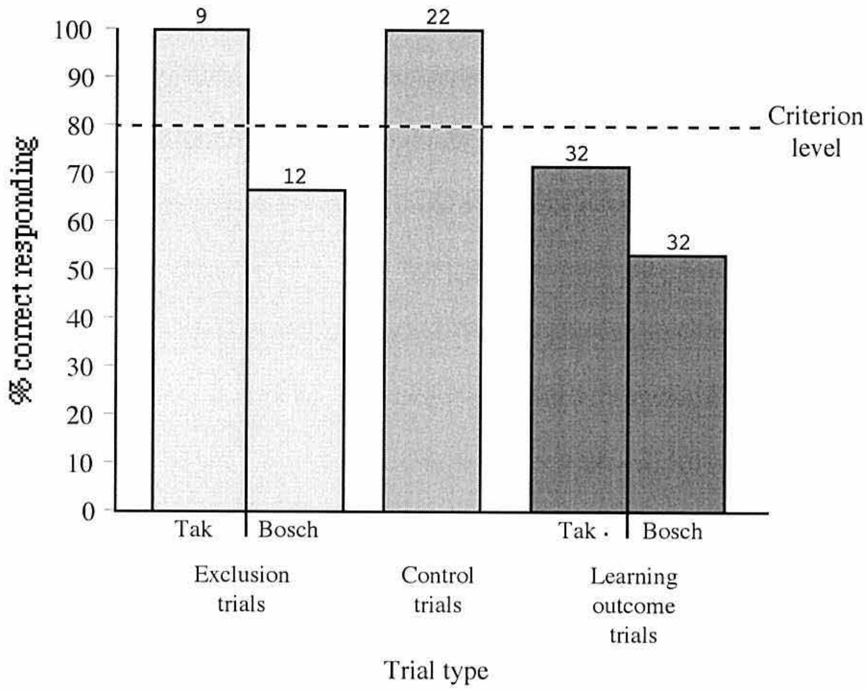

Figure L3. Participant IW: Percentage of correct responding on all trial types in Phase 2.1. (Numerals above bars indicate the total number of each trial type presented.)

Phase 2.2. Successive Exclusion Exposure and Learning Outcome Testing

The stimuli utilised in Phase 2.2 were identical to that of Phase 2.1. As IW failed to achieve criterion level on traditional exclusion trials, modified exclusion trials were employed Phase 2.2. Here, novel relations were introduced in succession.

Exclusion exposure sessions. Exposure sessions consisted of exclusion trials of only one novel relation. As IW's responding on 'bosch' exclusion trials, in Phase 2.1, was below that of the 'tak' exclusion trials, and below criterion level, then this relation was the first to be introduced in exposure sessions. Exposure sessions comprised equal numbers of control trials and 'bosch' exclusion trials. IW received five of these sessions. In the first two of these sessions, whilst IW performed above criterion level on control trials, his responding on exclusion trials remained below criterion (55.5 percent correct responding, see Figure L4).

Consequently, in the remaining three sessions, rewards for correct responding were introduced. IW was rewarded for each correct response on exclusion and control trials. Responding on both control trials and exclusion trials improved: response accuracies were above criterion level (see Figure L4).

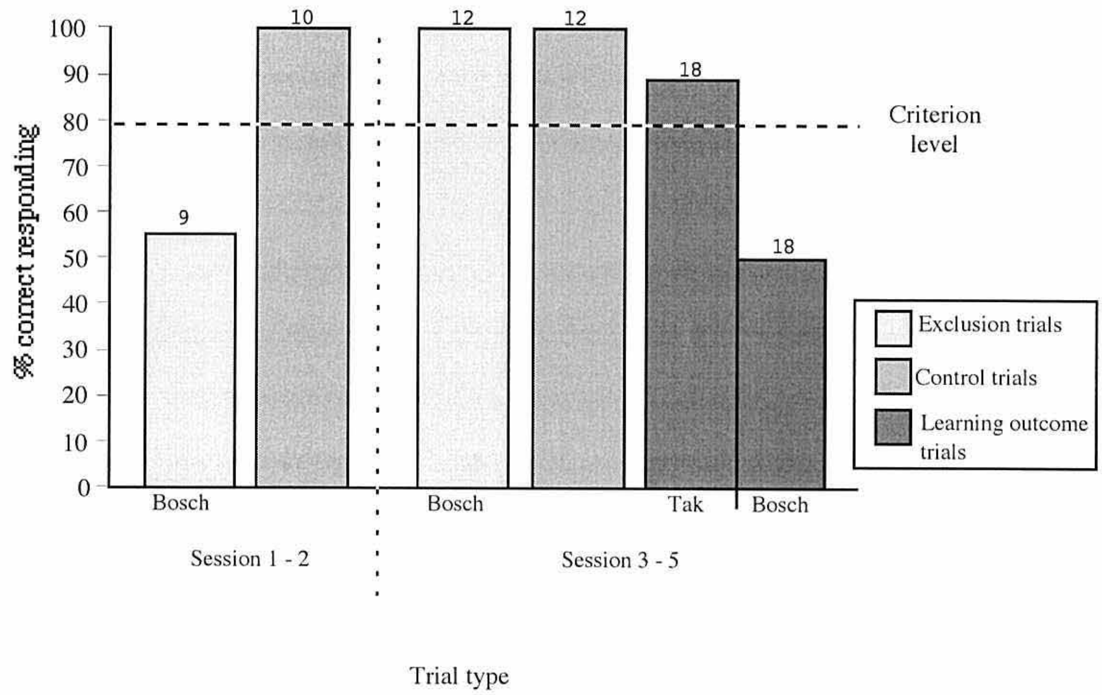

Figure L4. Participant IW: Percentage of correct responding on all trial types in Phase 2.2. (Numerals above bars indicate the total number of each trial type presented.)

Learning outcome sessions. The second novel relation -- 'tak' -- was introduced in contrast to the first relation in learning outcome sessions (i.e., on 'tak' trials the S- was always the stimulus corresponding to 'bosch'). Each session consisted of 12 learning outcome trials, six of each novel relation. IW received three of these sessions, each of which directly followed an exclusion exposure session. All learning outcome sessions were unreinforced.

IW did not demonstrate acquisition of the novel relations (see Figure L4), despite the successive introduction of the novel relations in exposure sessions in which correct responses were rewarded. He developed a stimulus preference for the 'slinky spring' (the visual stimulus corresponding to "Tak") which he selected on 25/36 trials. This is evident in Figure L4: whilst responding on 'tak' learning outcome trials was 88.8 percent, responding on 'bosch' trials was at chance level.

Vocalisations. IW began to produce the novel words with greater frequency in Phase 2.2. He produced three instances of echoing of the novel word "Bosch", and echoed the word "Tak" on two occasions; in 3/5 of these instances the vocalisations were consistent with his selection of the corresponding visual stimulus.

IW also correctly and spontaneously labelled the object corresponding to "Tak" in two instances. In the first instance IW responded incorrectly on a 'tak' trial, then on the same trial he pointed to the 'tak' object and said "Tak". On the following 'bosch' learning outcome trial, in response to being requested to select the 'bosch', IW pointed to the tak stimulus and said "Tak"

Participant LN

Phase 2.1. Traditional Exclusion Exposure and Learning Outcome Testing

The novel auditory stimuli, "Tak " and "Bosch", were paired with the multi-coloured 'slinky spring' and the 'Galt pocket alarm', respectively.

Exclusion exposure sessions. LN received four traditional exclusion exposure sessions. Each session comprised eight trials, half of which were control trials and half were traditional exclusion trials. Exclusion trials were further divided into equal numbers of trials of each novel relation. LN's performance in these sessions is illustrated in Figure L5. She responded above criterion level on exclusion trials, and performed without error on control trials.

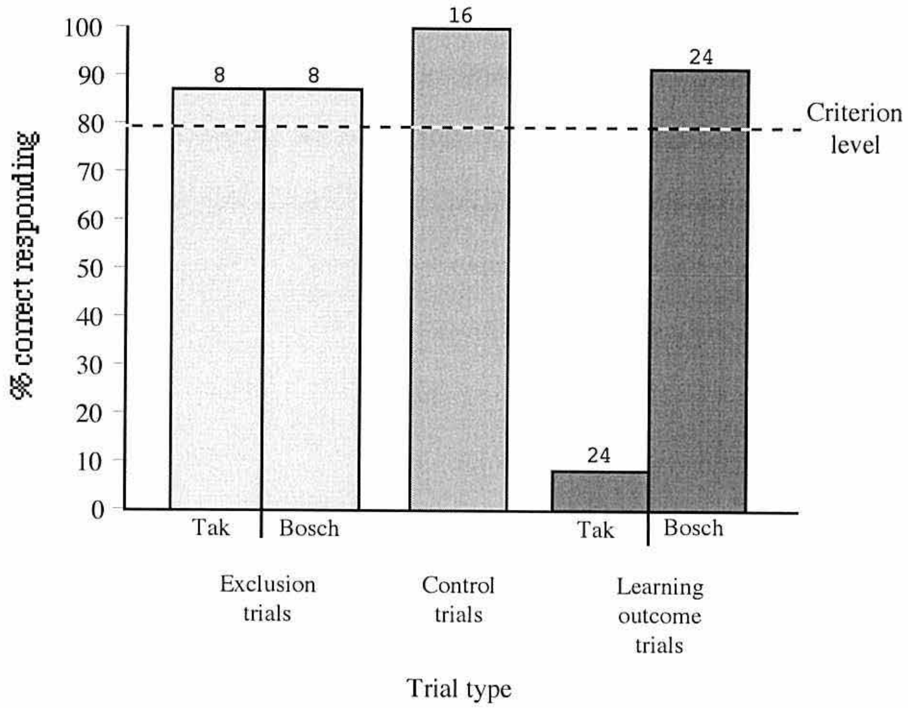

Figure L5. Participant LN: Percentage of correct responding on all trial types in Phase 2.1. (Numerals above bars indicate the total number of each trial type presented.)

Learning outcome sessions. LN received four learning outcome sessions in Phase 2.1, each of which directly followed an exclusion exposure session. Each of these sessions comprised six learning outcome trials of each novel relation. LN's responding overall was below criterion level (see Figure L5).

As is illustrated in Figure L5, LN exhibited a strong stimulus preference for the selection of the 'pocket alarm' (the object corresponding to the novel auditory stimulus "Bosch"). In each individual session, LN selected this on the majority of learning outcome trials (9/12, 12/12, 11/12 and 12/12 respectively); overall she selected this stimulus on 44/48 learning outcome trials. Consequently, LN performed at 91.6 percent correct responding on 'bosch' trials but only 8.3 percent correct responding on 'tak' trials.

Vocalisations. LN produced one instance of spontaneous labelling throughout this phase of the study. In this instance "Tak" was presented as the sample on a learning outcome trial; in response she pointed to the bosch visual stimulus and correctly said "Bosch".

LN also frequently echoed the auditory sample presented on learning outcome trials: in the first session she echoed the novel auditory sample on 7/12 trials; in Sessions 2 and 3, she echoed the novel auditory sample presented on all 12 trials per session. In the final session she did not produce any vocalisations.

Phase 2.2. Successive Exclusion Exposure and Learning Outcome Testing

The novel stimuli were identical to that of Phase 2.1. In this phase of the study the novel relations were introduced in succession.

Exclusion exposure sessions. Exclusion exposure sessions consisted of exclusion trials of only one novel relation -- the 'tak' relation. As LN exhibited a stimulus preference for the 'bosch' visual stimulus, the 'tak' relation was the first exposed. It was hoped that this would have the effect of reducing her stimulus preference, in learning outcome sessions, due to the relatively greater number of selections of the 'tak' visual stimulus on exclusion trials. Control trials were presented in all exclusion sessions; these remained identical to the previous phase. Each exposure session comprised eight trials -- four control trials and four 'tak' exclusion trials. LN received six of these sessions.

In the first three of these sessions LN's responding declined below criterion level on both control trials (75 percent accuracy) and 'tak' exclusion trials (58.3 percent accuracy) as is shown in Figure L6. Thus her responses did not appear to be controlled by the auditory samples presented.

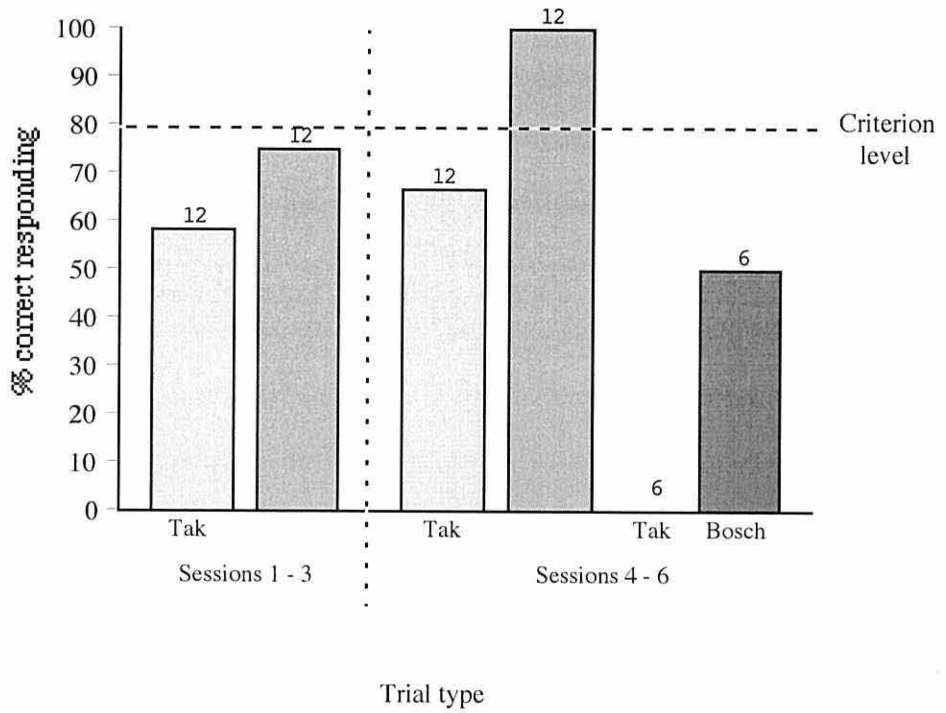

Figure L6. Participant LN: Percentage of correct responding on all trial types in Phase 2.2. (Numerals above bars indicate the total number of each trial type presented.)

As a result, in Sessions 4 to 6, inclusive, LN was rewarded for correct responses on exclusion trials and control trials. Her performance improved to criterion level on control trials (100 percent correct responding). Responding on 'tak' exclusion trials, however, did not reach criterion level (66.6 percent correct responding, see Figure L6).

Learning outcome sessions. LN received only one learning outcome session in this phase of the study. This session, which comprised 12 learning outcome trials, followed the final exclusion exposure session. Performance in this session was below criterion level. LN's preference for the visual stimulus corresponding to "Bosch" remained evident; she selected this on 9/12 trials. Thus, as predicted by her performance on exclusion and control trials, no learning outcome was evident.

Vocalisations. In this phase of the study one learning outcome session was presented, in which LN echoed the auditory sample on three trials. LN also produced one instance of incorrect prompted labelling, during free play, at the end of this session. When asked to label the visual stimulus corresponding to "Bosch" she incorrectly labelled it, "Tak."

Participant BT

Phase 2.1. Traditional Exclusion Exposure Sessions

The novel relations comprised the nonsense words "Tak " and "Bosch" and the multi-coloured plastic 'slinky spring' and the 'Galt pocket alarm', respectively.

Exclusion exposure sessions. Each session consisted of between a minimum of four and a maximum of 20 trials. In each session half of these trials were control trials and the remaining half were exclusion trials. Exclusion trials were further divided into equal numbers of trials of each novel relation (except Session 2 in which the seven exclusion trials were divided into four 'tak' trials and three 'bosch' trials). BT was given four traditional exclusion exposure sessions.

Overall, whilst BT achieved criterion level on control trials (86.9 percent correct responding), he did not perform at criterion level on exclusion trials (see Figure L7). His performance on both 'tak' and 'bosch' exclusion trials was below chance level (16.6 percent and 18.2 percent correct responding, respectively).

BT's responses indicated an aversion to the novel visual stimuli. In these sessions, BT selected the novel comparison present in the array on only 4/23 exclusion trials. Consequently, whilst performing at criterion level on control trials, his performance on exclusion trials was below criterion. As BT did not achieve criterion level on exclusion trials a number of interventions were introduced, in Phase 2.2, in order to eliminate his stimulus aversion.

Vocalisations. BT echoed the novel word "Bosch" in one instance. He did not, however, echo the novel word "Tak", and did not produce the novel words spontaneously in this phase.

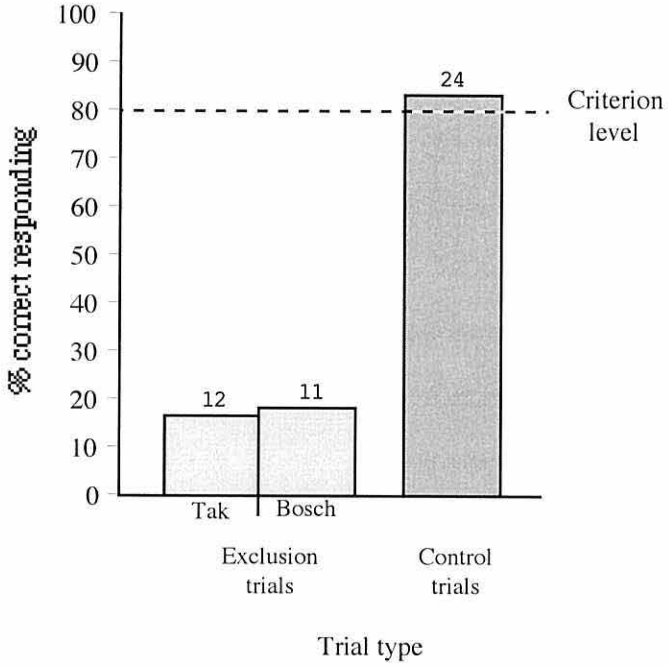

Figure L7. Participant BT: Percentage of correct responding on all exclusion and control trials in Phase 2.1. (Numerals above bars indicate the total number of each trial type presented.)

Phase 2.2. Modified Exclusion Exposure Sessions

The novel stimuli were identical to those in Phase 2.1.

Exclusion exposure sessions. In order to eliminate BT's novel stimulus aversion, three interventions were applied in succession. In each of these interventions modified exclusion trials were presented with control trials. Once criterion level responding was achieved on modified exclusion trials, then traditional exclusion trials (and control trials) were presented. Control trials were procedurally identical throughout every intervention.

BT's overall performance in Phase 2.2 is outlined, and the results of each intervention are then presented in detail. Figure L8 illustrates BT's overall performance in Phase 2.2.

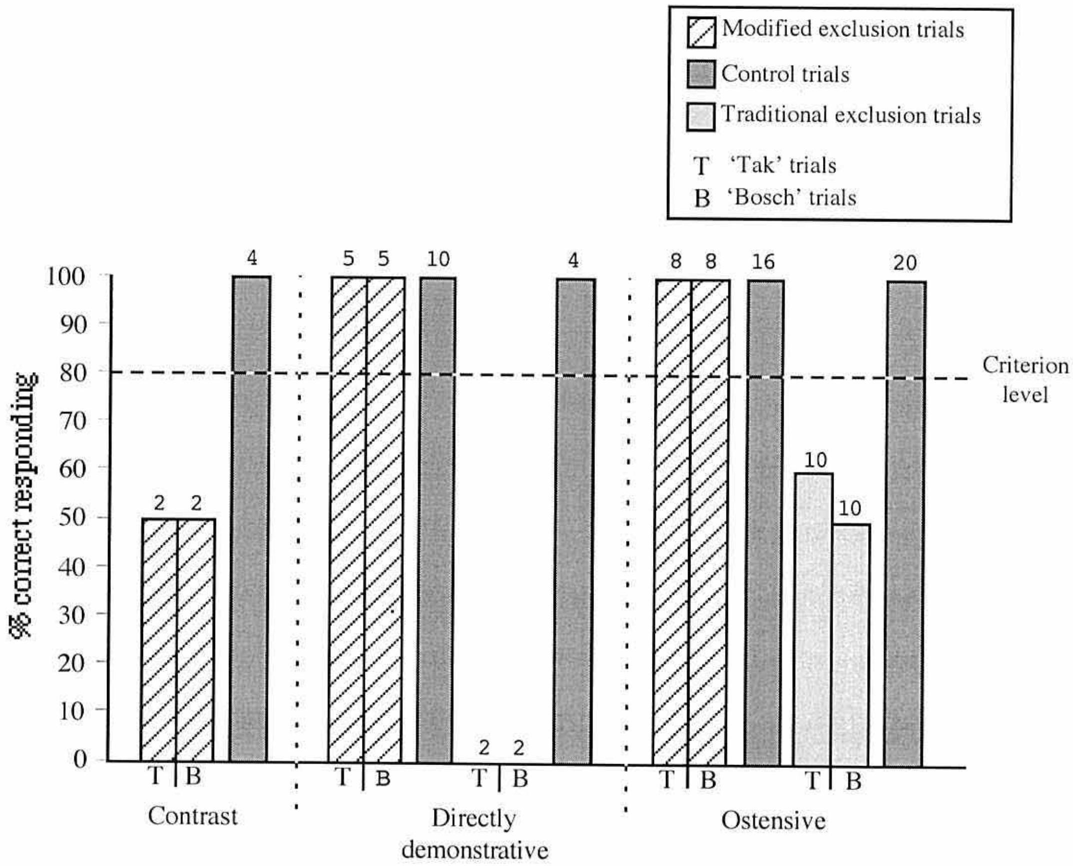

Figure L8. Participant BT: Percentage of correct responding on all trial types, in each intervention, in Phase 2.2. (Numerals above bars indicate the total number of each trial type presented.)

BT's performance on control trials throughout Phase 2.2 remained above criterion level. The inclusion of contrast exclusion trials failed to affect BT's stimulus aversion with performance on these exclusion trials remaining below criterion level. In the remaining two interventions BT achieved criterion level on both types of modified exclusion trials. However, performance on traditional exclusion trials, presented following each intervention, continued to remain below criterion level. The modified exclusion trials in these interventions failed to eliminate BT's stimulus aversion *and* maintain this effect on subsequent traditional exclusion trials (see Figure L8).

Appendix L

The first intervention employed involved contrast exclusion trials where BT was requested to, "Give the [novel], not the [familiar], give the [novel]." Only one session was presented. BT responded correctly on all control trials and on 2/4 exclusion trials presented. Although this encouraged BT to select the novel stimuli, his responses were extremely ambiguous and many repetitions of each trial were required. This intervention, hence, proved too inefficient.

Directly demonstrative trials were then employed. Again, BT's performance on control trials remained at 100 percent correct responding. The modified exclusion trials served to mask the stimulus aversion, and BT performed at 100 percent correct responding. However, when traditional exclusion trials were then presented this effect failed to be maintained, and BT did not select the novel stimulus on any trial (see Figure L8). Thus BT did not attend to the auditory samples on directly demonstrative trials.

Finally, ostensive exclusion trials were presented. BT's performance on both ostensive exclusion trials and control trials was above criterion level. However, once again this failed to eliminate BT's stimulus aversion, and his performance on subsequent traditional exclusion trials again declined to below criterion level (see Figure L8).

As BT's stimulus aversion cold not be eliminated, learning outcome sessions were not presented.

Vocalisations. BT did not spontaneously label the novel visual stimuli throughout the study, nor did he produce any labels when prompted. Despite this BT did produce the novel word "Tak" on seven occasions and the novel word "Bosch" on six occasions. There was no evidence that these vocalisations were anything other than echoic behaviour.

Appendix L

Participant RR

Phase 2.1. Traditional Exclusion Exposure Sessions

Stimuli consisted of the novel auditory stimuli "Tak" and "Bosch". The corresponding novel visual stimuli were the multi-coloured plastic 'slinky spring' and the pink and white concertina snail, respectively.

Exclusion exposure sessions. RR received two exclusion exposure sessions consisting of traditional exclusion exposure trials and control trials. The first session comprised five control trials and four exclusion trials; the second session comprised six control trials and two exclusion trials. In each session the exclusion trials were divided into equal numbers of trials of each novel relation.

Figure L9 illustrates RR's performance on all trial types in these sessions. Whilst he achieved criterion level responding on exclusion trials (100 percent correct responding on both novel relations) he did not perform at criterion level on control trials (45.4 percent correct responding). This was the result of a stimulus preference for the selection of the novel visual stimuli; RR selected the novel visual stimulus (S-) on 6/11 control trials. Thus there was no evidence that RR's responses, on both control and exclusion trials, were controlled by the auditory stimuli.

As a result, no learning outcome sessions were presented; instead, two interventions were introduced, in Phase 2.2, in order to eliminate his stimulus preference.

Vocalisations. RR did not produce either novel word throughout Phase 2.1.

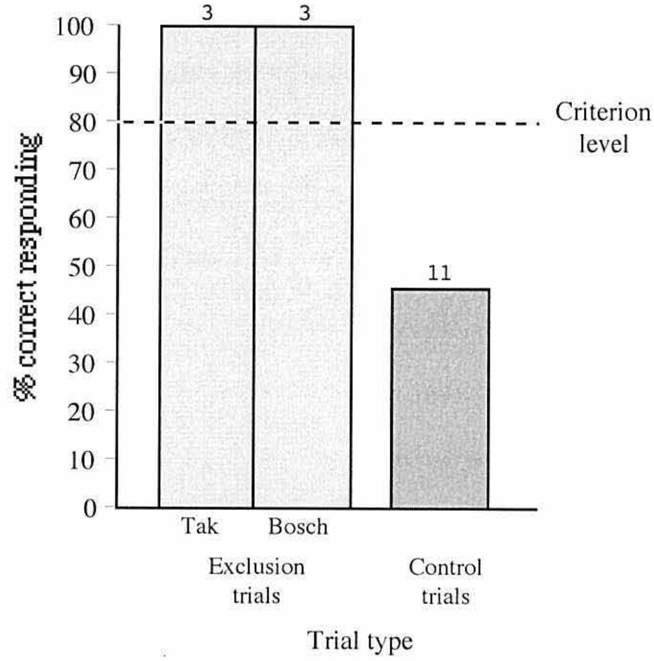

Figure L9. Participant RR: Percentage of correct responding on all exclusion and control trials in Phase 2.1. (Numerals above bars indicate the total number of each trial type presented.)

Phase 2.2. Modified Exclusion Exposure Sessions

Stimuli were identical to those of Phase 2.1.

Exclusion exposure sessions. In order to eliminate RR's stimulus preference, and bring his responding under control of the auditory stimuli, two interventions were introduced in succession. In each intervention only one exclusion exposure session was conducted due to RR's lack of availability for participation in the study. RR's performance in both of these interventions is illustrated in Figure L10.

The first intervention consisted of the introduction of baseline trials. These were interspersed among control trials and exclusion trials in the exposure session. On baseline trials, RR was required to select a familiar visual stimulus; this is because comparisons consisted of two familiar stimuli on all trials. It was hoped that this would reduce RR's novel stimulus preference and encourage him to select familiar stimuli on control trials. This session comprised six baseline trials, six control trials, and two exclusion trials; exclusion trials comprised one of each novel relation.

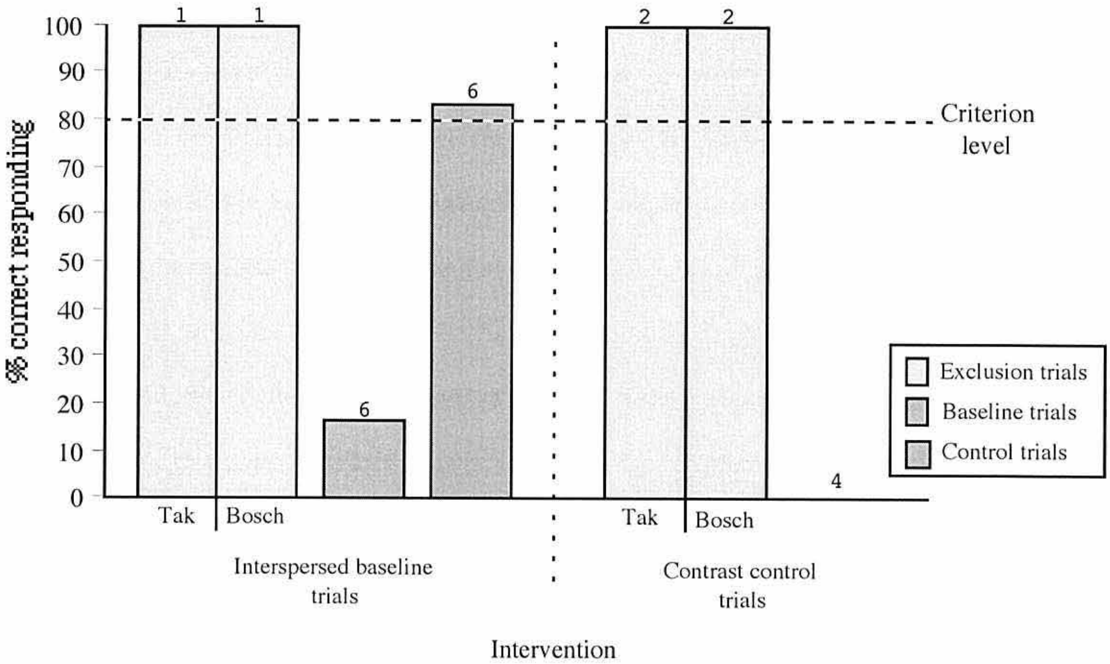

Figure L10. Participant RR : Percentage of correct responding on all trial types, in each intervention, in Phase 2.2. (Numerals above bars indicate the total number of each trial type presented.)

RR's performance in this session is illustrated in Figure L10. RR continued to respond correctly on exclusion trials, and he also responded correctly on 5/6 baseline trials. However, his responses on control trials remained below chance level (16.6 percent correct). Despite selecting familiar visual stimuli on baseline trials, when presented with a familiar stimulus (S+) and novel stimulus (S-) on control trials, RR continued to select the novel stimuli on 5/6 trials. This intervention failed to eliminate RR's stimulus preference.

As a result a second intervention was introduced. This employed contrast control trials in which RR was requested, "Where is the [familiar], not the [novel], where is the [familiar]?" In this session, four contrast control trials and four traditional exclusion trials were presented. RR's performance in this session is presented in Figure L10. Again, he responded correctly on all exclusion trials. However, the use of contrast control trials failed to eliminate RR's stimulus preference. He did not select the familiar stimulus on any contrast control trial presented, selecting instead the preferred novel visual stimuli on all trials. (Following this session RR was no longer available for participation in the study.)

Vocalisations. RR did not produce either of the novel words.

Participant CM

Phase 2.1. Traditional Exclusion Exposure and Learning Outcome Testing, Set 1 Stimuli

The novel auditory stimuli consisted of the words "Tak" and "Bosch"; the corresponding novel visual stimuli comprised the multi-coloured 'slinky spring' and the 'giggle stick', respectively.

Exclusion exposure sessions. CM received two exclusion exposure sessions. Each session consisted of 12 trials. The first session comprised six control trials and three exclusion trials of each novel relation; the second session consisted of six control trials, four 'tak' exclusion trials, and two 'bosch' exclusion trials.

CM's performance in these sessions is illustrated in Figure L11. CM performed above criterion level on control trials (91.6 percent accuracy). However, responding on exclusion trials was below criterion level. He responded correctly on all 'bosch' trials but on 'tak' trials his responding was 28.5 percent.

Learning outcome sessions. CM received one learning outcome session following the second exclusion exposure session. This consisted of 12 trials, six of each novel relation. In this session CM did not respond above criterion level. Responding on 'bosch' trials was 83.3 percent correct whilst responding on 'tak' trials was below chance level at 16.6 percent correct responding. Thus, CM did not demonstrate any acquisition of the novel relations. This was predicted as CM did not perform above criterion level on exclusion trials.

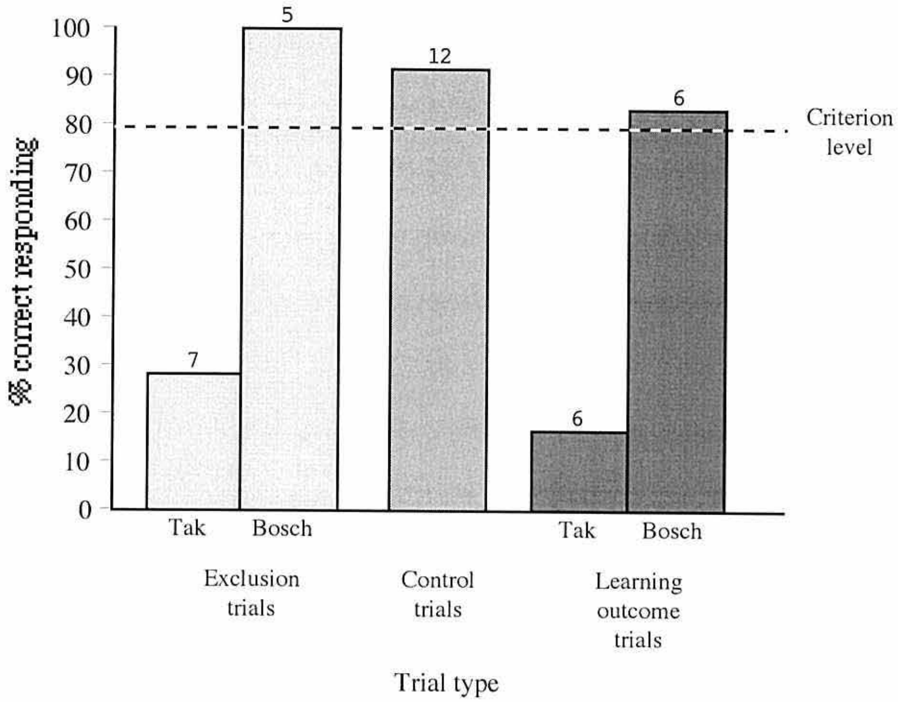

Figure L11. Participant CM: Percentage of correct responding on all trial types in Phase 2.1. (Numerals above bars indicate the total number of each trial type presented.)

CM's poor performance on both exclusion and learning outcome trials appeared to be due to a stimulus aversion to the selection of the 'slinky spring', the novel visual stimulus corresponding to the novel auditory stimulus "Tak". In exposure sessions, CM responded correctly on all 'bosch' exclusion trials. However, on 'tak' exclusion trials he selected the correct comparison on only 2/7 trials. Moreover, on learning outcome trials he selected the 'tak' stimulus on only 2/12 trials. It was unlikely that this was simply a case of preferential responding towards the 'bosch' stimulus as CM always selected the familiar stimuli on control trials where the 'bosch' stimulus was the incorrect comparison. Thus, it appeared that CM was averse to selecting the 'slinky spring' (the 'tak' stimulus) and may have responded correctly on exclusion and learning outcome trials if this object was not the correct comparison. As a result, in the next phase of the study, the 'tak' relation was replaced with a new novel relation.

Vocalisations. CM did not produce the novel words throughout Phase 2.1.

Phase 2.2. Exclusion Exposure and Learning Outcome Testing, Set 2 Stimuli

A new novel auditory-visual relation was introduced in this phase of the study. The new novel auditory stimulus was "Kiekie" and the corresponding novel visual stimulus was the 'giggle stick'. The stimuli for the 'bosch' relation were identical to Phase 2.1.

Successive exclusion exposure sessions. The novel relations were, initially, introduced successively. In these exposure sessions only the 'bosch' relation was exposed, and the second 'kiekie' relation was introduced in contrast to this; that is, it was introduced in learning outcome trials where "Kiekie" was the auditory sample and both the novel visual stimuli were presented as comparisons.

CM received two of these successive exposure sessions. The first of these sessions consisted of two control trials and two 'bosch' exclusion trials. The second session comprised four control trials and four 'bosch' exclusion trials. CM's performance in these sessions is illustrated in Figure L12. Responding on both control trials and 'bosch' exclusion trials was above criterion level with 100 percent correct responding on both trial types. CM's responses therefore appeared to be controlled by the auditory stimuli.

Learning outcome sessions. CM received two learning outcome sessions, each of which directly followed a successive exclusion exposure session. In these sessions the second novel relation 'kiekie' was exposed in contrast to the 'bosch' relation. Each session comprised six learning outcome trials of each novel relation.

Appendix L

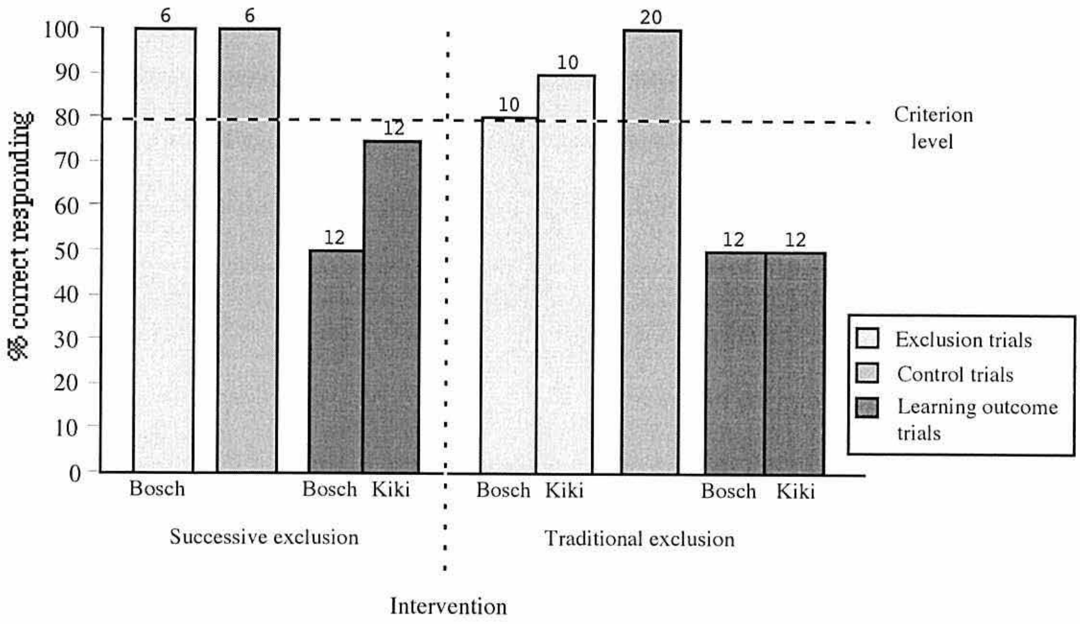

Figure L12. Participant CM: Percentage of correct responding on all trial types in Phase 2.2. (Numerals above bars indicate the total number of each trial type presented.)

CM's performance in these sessions is shown in Figure L12. CM failed to respond above criterion level on learning outcome trials with 50 percent correct responding on the 'bosch' relation and 75 percent on the 'kiekie' relation. Thus, he did not demonstrate acquisition of the novel relations. However, CM did not demonstrate any stimulus aversion with this set of stimuli.

As CM did not demonstrate any stimulus aversion with this set of stimuli, and failed to demonstrate acquisition of the novel relations as a result of successive exposure, further exposure and learning outcome sessions were conducted. Here the relations were exposed in traditional exclusion exposure sessions.

Traditional exclusion exposure sessions. CM received five traditional exposure sessions, each of which consisted of a total of 12 trials. These were divided into equal numbers of control trials and exclusion trials. Exclusion trials were further divided into equal numbers of exclusion trials of each novel relation. CM's performance in these sessions is illustrated in Figure L12. CM responded above criterion level on both control trials and exclusion trials.

Learning outcome sessions. CM received two learning outcome sessions following the traditional exposure sessions. Each session consisted of six trials of each novel relation. Despite criterion level responding on control trials and exclusion trials, CM failed to demonstrate any acquisition of the novel relations. Responding on both 'bosch' and 'kiekie' learning outcome trials was at chance level (50 percent). No stimulus aversion was exhibited with CM selecting the novel visual stimuli with equal frequency.

Vocalisations. CM did not produce either novel word throughout Phase 2.2.