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How does naming promote stimulus equivalence? An investigation into the role of instructions used during name training

Crowther, Lillemor

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HOW DOES NAMING PROMOTE STIMULUS EQUIVALENCE? AN INVESTIGATION INTO THE ROLE OF INSTRUCTIONS USED DURING NAME TRAINING

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LILLEMOR CROWTHER

UNIVERSITY OF WALES, BANGOR

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How does naming promote stimulus equivalence? An investigation into the role of instructions used during name training.

Summary

The main aim of this thesis was to investigate further the conditions under which stimulus naming promotes responding in terms of equivalence relations and in particular the role played by the instructions used during name training. In addition, thirteen children (aged 4-5 years) participated in two studies carried out to investigate other factors that may facilitate conditional discrimination learning in children, and which formed the basis for the development of a novel matching-to-sample procedure.

This procedure was designed to overcome general problems when carrying out learning studies with children, such as motivation and boredom, besides problems specific to matching-to-sample tasks, e.g. discrimination between stimuli. The studies also provided useful information regarding the type of instructions suitable both for matching tasks with visual stimuli and for teaching stimuli names. The main changes to standard conditional discrimination procedures were the introduction of 3-D stimuli, the incorporation of an identity matching task with the stimuli serving as samples on every trial and the inclusion of a blocked trial presentation order, similar to one used by Saunders and Spradlin (1989).

The procedure was then implemented with an second subject pool of 20 children, aged 4-5 years, who all carried out conditional discrimination training. Fourteen of these children learnt the baseline task and passed a subsequent symmetry test. Five children also carried out equivalence tests, which three passed. Three children failed the baseline task and three others learnt it but failed the symmetry test. These six, plus one child who failed the equivalence test, were then taught to name the stimuli.

Comparisons were made between the effects of naming-instructions that included a relational term ("That is X") and naming-instructions that were non-relational ("Say X"). In addition, speed of naming acquisition was compared across instructions. Comparisons were also made between the effects of names taught prior to the acquisition of the baseline task and those taught after the baseline task had been learnt.

Despite the small number of subjects some interesting trends emerged. Overall, the relational instruction led to more rapid acquisition of stimulus names. The acquisition of sample names resulted in immediate acquisition of the baseline task. Common names learnt through the relational instruction led to success on the symmetry test. Only one child learnt names through the non-relational instruction and he failed the symmetry test until the relational instruction was introduced.

The findings may be of potential significance for understanding how naming and other aspects of language inter-relate with the emergence of equivalence in early childhood.

CONTENT

CHAPTER ONE
GENERAL BACKGROUND

Introduction

This thesis is a report of an investigation into how stimulus naming promotes the emergence of stimulus equivalence, a relatively recent area of research within the approach to psychology known as behaviourism or the experimental analysis of behaviour. The first chapter provides an introduction to the underlying philosophical and theoretical aspects of the behaviourist approach. It also deals with the question of how adequate the approach is for dealing with all aspects of human behaviour, and in particular how language acquisition and the emergence of novel patterns of behaviour can be accounted for within this paradigm. The suggestion that language has a controlling function over other behaviours is also discussed in terms of the distinction between rule-governed and contingency shaped behaviour. Mead and Vygotsky discussed these issues from a similar standpoint, and their writings are outlined in chapter Two. Chapters Three and Four contain detailed discussions of stimulus equivalence research, which can provide a method for investigating these issues within a behaviourist framework. The development of the procedure employed in the experimental studies for this thesis is described in chapters Five, Six and Seven. The experimental studies are reported in chapters Eight, Nine and Ten the discussion of the results can be found in chapter Eleven.

Theoretical and philosophical aspects of behaviourism

Psychology, like other scientific disciplines, consists of many, and at times, opposing approaches. These approaches change over time, because scientific ventures by their nature often lead to new discoveries, which may contradict previously held beliefs. There is also a tendency to uphold the most recent approach as the "real truth" and reject previous or alternative theories. Kuhn's 1970 book *The Structure of Scientific revolution* is an influential work on the topic of changes within sciences. It deals with the natural sciences, but many authors have interpreted changes within psychology in terms of Kuhn's ideas (e.g. Henley, Johnson, Jones & Herzog, 1989; Kleinginna & Kleinginna 1988)

Kuhn's notion of paradigmatic shifts

Kuhn (1970) described changes in science as going through sequences of evolutions and revolutions. He termed these changes paradigmatic shifts and defined paradigms in science as including almost everything used in science: metaphysical assumptions, research methods and theories. A new science initially develops through a pre-paradigmatic stage with competing perspectives, until a consensus forms on a particular paradigm. Once consensus is reached, the science will go through a relatively stable stage of "normal science". The paradigm will inevitably be found to be inadequate; holes in the framework are discovered, and eventually a point of scientific revolution is reached. During this revolutionary phase, some researchers try to "patch up" the existing paradigm whereas others propose different and competing theories. "A period of confusion therefore exists involving the old theory and the new competitors. Eventually one of the new will emerge as the "winner" and, with the revolution complete, another long period of "normal" science can begin." (Henley et al., 1989, p.145).

According to a Kuhnian interpretation, the social sciences are immature, as they, unlike the natural sciences, have not yet developed an agreed-upon framework or paradigm. Psychology and the other social sciences are therefore in a pre-paradigmatic stage where researchers are still searching for a generally accepted paradigm. At the present time the main "competitors" within psychology are the cognitive and behaviourist approaches.

Whether or not psychology is close to becoming a "normal science" is open to debate. Kleinginna and Kleinginna have suggested that there is a trend toward convergence of the different perspectives. Others (e.g. Barnes & Holmes, 1991; Hayes, Hayes & Reese 1988; Schnaitter, 1987) have argued that behaviourist and cognitive perspectives are based on totally different theoretical assumptions and that they can therefore not be merged together into one perspective. (See below for a more detailed discussion of this view based on Pepper's notion of world hypotheses). If the latter is true, then psychology will never become a normal science in the Kuhnian sense, but will remain in the pre-paradigmatic stage, unless one approach vanishes.

At this moment it is true to say that psychology is not, and never has been, a unified discipline. It is therefore always necessary to choose one area/perspective and the one adopted here is that of behaviourism. It is not implied that this is superior or more advanced than any other, but it is different, and before discussing the actual research the underlying assumptions and historical development of behaviourism will be briefly summarised.

This summary consists of an account of:

a) Characteristic features of the behaviourist perspective and how it is distinct from other approaches. This will be discussed in terms of differences in underlying theoretical assumptions.

b) Historical overview, where major changes within the behaviourist field are described.

Characteristic features of the behaviourist perspective

The term "behaviourism" here refers to the approach to psychology pioneered by B.F. Skinner, which is alternatively called radical behaviourism, behavioural analysis, operant analysis, functional or experimental analysis of behaviour. This approach is based on the premise that all acquired behaviour (behaviour that is not governed by inborn reflexes) can be explained in terms of the principles of classical and operant conditioning. Much has been written about its characteristics and how it is distinct from other approaches, usually in articles designed to defend the approach against criticisms (e.g. Barnes & Holmes, 1991; Blackman, 1991; Catania, 1984b; Zettle, 1990). These criticisms are often based on misunderstandings of the underlying conceptual framework. This section will describe the main tenets of behaviourism and its underlying theoretical assumptions.

The emphasis within radical behaviourism is on how the individual interacts with the environment, i.e. on how the environment affects the individual which in turn affects his/her future behaviour within that environment. According to Skinner's definition, "environment" can be either social or non-social and "individual" can be human or non-human. The basic principle is that the consequences of a response made by an organism determine the likelihood of that response occurring again. Consequences that increase this likelihood are called reinforcers and those that decrease the likelihood are termed punishers. The relationship between the response and its consequence is called a contingency of reinforcement or punishment.

These contingencies do in other words control the different responses emitted by the organism. Responses are almost always emitted in the presence of environmental stimuli, and are often differentially reinforced with respect to the dimensions of the stimuli in the presence of which they occur (Catania 1984a, p. 127). These types of stimuli are called discriminative stimuli and they act as signals or cues for responses. If a response comes to depend on the presence of a discriminative stimulus then the relationship between this discriminative stimulus, the response and its consequences is called a three-term contingency. This contingency is conventionally expressed as S^D - R - S^R, where S^D stands for discriminative stimulus, R stands for response and S^R for reinforcing stimulus.

The three-term contingency serves as a conceptual framework for the prediction of behaviour. In other words, we can predict which stimuli will occasion which responses on the basis of a past history of reinforcement. It is the conditional relationship between S^D, R and S^R that is important not the actual stimuli or responses. Behaviour itself is the fundamental subject matter; "behaviour is not an indirect means of studying something else, such as cognition or mind or brain" (Catania 1984b, p.474). The aim is to avoid using hypothetical constructs (constructs that cannot be directly verified) as explanatory principles. Radical behaviourism does not deny the existence of unobservable internal events (covert events) but maintains that these are governed by the same principles as overt events. "Thinking, choosing and discriminating and the like are not concepts for explaining behaviour - rather they are behaviour, or relationships between behaviour, and they are to be explained in the same terms, with the same kind of functional relations as overt behaviour" (Hineline, 1980, p. 69).

How behaviourism differs from other approaches:
Karl Pepper's theory of "world hypotheses"

The distinction between behaviourist and cognitive approaches has been described by many (Barnes & Holmes, 1991; Hayes, 1987; Hayes et al., 1988; Kleinginna Jr & Kleinginna, 1988; Morris, 1988; Schnaitter, 1987; Zettle, 1990) in terms of different underlying philosophical assumptions or world hypotheses as proposed by Pepper (1942). The argument is that conflicts between different approaches to psychology are often based on philosophical issues, and that these need to be clarified in order to deal with the conflicts. Pepper's terms are useful for this purpose, because, although his book was not written about psychology, it "exposes the philosophical sources of current conflicts within behavior and the nature of its conflicts with other psychologies" (Hayes et al 1988, p. 97).

Pepper defined "hypothesis" as "simply a symbolic scheme for the arrangement of data, so that men can easily find and use the data they know" (Pepper 1942, p. 71). In other words, Pepper's use of the term "hypothesis" (meaning a convenient system for organising our knowledge) is not exactly the same as its meaning in a scientific context. Each hypothesis is described in terms of basic analogies which Pepper called "root metaphors". Root metaphors are based on some area of common sense facts, from which a set of categories is derived. All facts are then interpreted in terms of these categories. Because each world hypothesis is based on a different root metaphor each view is autonomous. We cannot judge the adequacy of one by comparing it with another. Adequacy can only be determined within each world hypothesis and is based on its scope and precision. "Scope" refers to the range of circumstance accounted for, with lack of scope defined by an inability to offer an interpretation of all fields of facts. "Precision" refers to how well the hypotheses "exactly fit, conform to, apply to, describe or in any other way strictly refer to the facts under consideration" (Pepper 1942, p.42). The ideal hypothesis has unlimited scope and is so precise that it permits only one interpretation of every event. However, in reality there tends to be a negative correlation between scope and precision.

We cannot use the categories of one hypothesis to analyse and criticise another, nor can one hypothesis be strengthened by revealing shortcomings in another. However, the adequacy of the different hypotheses can be compared. "Theories which show themselves up as dealing much less adequately with world wide scope of facts than others are said to be relatively inadequate, the others relatively adequate" (Pepper, 1942, p.116). Pepper made a sharp distinction between theories and the people who develop and write about them. "It is not what any author thinks about his theory that counts in determining its inadequacy, but what the theory itself in terms of its own logic thinks of itself" (p.116). However, judgements are made by people and ultimately adequacy is based on "multiplicative corroboration", i.e. corroboration between people.

Behaviourism and cognitivism can be described in terms of world hypothesis that are called, alternatively, contextualism and mechanism. They are based on different root metaphors and have different truth criteria. Therefore any direct comparison between them is inappropriate, as one world hypothesis cannot be criticised for not living up to the truth criterion of another. "One is not inherently better than the other. They offer different perspectives and accordingly must be evaluated by different criteria" (Zettle, 1990, p.47). Pepper presented each world view as "relatively adequate and autonomous within its own meta-theoretical framework, meaning also that cross-view criticisms are misplaced in that they contribute nothing to the intellectual validity of the alternative programs" (Morris, 1988, p. 291). The comparisons made below are therefore merely descriptive.

Mechanism and Contextualism

The root metaphor of mechanism is the machine and the world is described in terms of models. "The knower knows a copy of the world, not the world itself" (Hayes et al. 1988, p. 99). The truth criterion is based on how well the copy corresponds to the world. This correspondence cannot be directly observed and is therefore evaluated on the basis of corroboration among independent knowers. The basic categories are the parts of the machines, their qualities and the lawful relationship between the parts.

The root metaphor for contextualism is the historic event. However, the emphasis is on the ongoing act in context, on the act as it happens, not on past events. The truth criterion is "successful working", i.e. theories are evaluated in terms of accomplishment of particular goals. Evaluation can only be done through direct verification, indirect verification is not valid. The basic categories are change and novelty.

Cognitive psychology is based on a mechanistic world view, where hypothetical intervening variables are essential for making predictions about behaviour in new situations. Psychologists working in this area attempt to understand behaviour as a function of the internal states with which it is correlated. "The central aim of cognitivism is to infer the functional characteristics of the design according to which the organic machinery of the body works." (Schnaitter 1987, p.5)

Behaviourism on the other hand, is based on a contextualist world hypothesis. According to behaviourism all "causes" of behaviour are to be found in its context (defined in terms of its antecedents and consequences). An organism's behaviour can only be understood by studying the context which gives rise to that behaviour. The stress is on the ability to predict and control behaviour. "Behaviour is characterized as active and inherently developmental (evolutional) in nature. It is never 'being', but always 'becoming'. Contextualism's locutions are verb based and active" (Morris, 1988, p.299).

All the authors cited above, who have discussed psychological approaches in terms of Pepper's notion of world hypotheses, conclude that what behaviourists and cognitivists are doing are completely different kinds of things, based on completely different underlying assumptions. The adequacy of each approach can only be evaluated in relation to its underlying assumptions or truth criterion and any direct comparisons are illegitimate. In other words, it is inappropriate to argue about the relative merits of the different approaches. So although criticisms of the underlying philosophy of behaviourism are abundant, these are invalid according to this analysis. As Hayes et al (1988) put it; "the philosophical arguments between behavior analysts and other psychologists are pseudo conflicts among world views". (p.108)

Criticisms of adequacy, i.e. scope and precision, are however legitimate and the two main criticisms of behaviourism have been:

1. Principles of animal learning have inappropriately formed the basis for accounts of human behaviour, and

2. Behaviourism is incapable of explaining certain important phenomena such as language, remembering, problem solving and consciousness.

These are serious criticisms, which have not only been made by non-behaviourists as an argument for the superiority of alternative approaches, but have also been voiced within the field and many of the changes within behaviourism have occurred, at least in part, as a result of these criticisms. Kleinginna and Kleinginna (1988) have succinctly summarised recent changes within behaviourism as follows:

"Behaviourists are using more human subjects, studying more complex and socially important behaviour, using a greater variety of measures and methods, recognizing more behavioural differences across species and ages, recognizing more phylogenetic constraints or biological enabling factors. However, these changes are considered as mainly caused by a general broadening of the field of study rather than a fundamental change in perspective." (p.375)

These changes will now be considered in more detail.

Historical overview of major changes within radical behaviourism

Behaviourism was synonymous with mainstream Western psychology until the 1950's, which saw the event of the "cognitive challenge". According to Gardner (1987) the catalyst for this challenge was the 1948 Hixon symposium on "Cerebral Mechanisms in Behaviour", where Karl Lashley delivered an address confronting the inadequacies of behaviourism. He argued that any theory of human activity would have to account for complexly organised behaviours like playing tennis, performing on a musical instrument, and - above all - speaking, commenting that "the problems raised by the organization of language seem to me to be characteristic of almost all other cerebral activity." (cited in Gardner 1987, p.12). Lashley concluded that associative chains between stimuli and responses cannot account for complex activities and that determinants of this type of behaviour can only be found within the organism. According to Lashley, complex behavioural sequences have to be planned in advance. "Rather than behavior being consequent upon environment promptings, central processes actually precede and dictate the ways in which an organism carries out complex behavior. Or to put it simply: rather than being imposed from without, organization emanates from within the organism." (Gardner 1987 p. 13).

This criticism has become "folk lore" and is still prevalent today. It is however based on a misunderstanding of radical or Skinnerian behaviourism, which is not based on S-R reflexology. Skinner's paradigm could better be described as R-S psychology because the emphasis is on the contingency between R and its consequences. It is ironic in the light of the criticisms levelled against him that Skinner's starting point was a dissatisfaction with Pavlovian S-R theory, having realised that S-R psychology could not account for all types of behaviour, particularly human behaviour. He therefore proposed a three-term contingency as opposed to the Pavlovian two-term. As discussed above Skinner's approach is contextualist.

However, Lashley was right to point out that behaviourism had so far ignored complex human behaviours. At the time there was no behaviourist account of language, and very little discussion within the field relating to other activities that are often labelled 'cognitive'. Watson and other early behaviourists held that the science of behaviour should only include publicly observable events. Private events had in other words been regarded as irrelevant. Skinner on the other hand recognised their importance and wrote extensively about 'what is under the skin' or covert behaviours and his (1974) book *About Behaviorism* contains detailed responses to the main criticisms levelled against radical behaviourism.

Lashley's criticisms have become generally accepted, and are rarely discussed outside the field of radical behaviourism, which is regarded by many as obsolete and no longer to be classed as mainstream. This view is illustrated by Simon (1980), who concluded that behaviourism has confined experimental psychology to "relatively simple memory and learning experiments, and to a preoccupation with laboratory rats rather than humans engaged in complex thinking and problem-solving tasks." (cited by Skinner 1985).

Lashley may have instigated a critique of behaviourism, but a much more famous and important attack was delivered ten years later, by Chomsky, in his review of Skinner's book *Verbal Behavior*. This book was published in 1957, in an attempt to apply the principles of operant conditioning to language acquisition. Chomsky's conclusion was that, not only had Skinner failed in this attempt, but that operant principles cannot in principle account for language development. A brief summary of the main points in Verbal *Behavior* will be given before going on to discuss these criticisms.

Verbal Behaviour

In his introduction to *Verbal Behavior* Skinner argued that so far there had been no data to show that there are essential differences between the principles governing human behaviour and those which apply to animal behaviour. He conceded that there might be such differences and that these would need to be investigated further. His book, however, is not based on any empirical investigations and Skinner's stated aim was to provide "an exercise in interpretation rather than a quantitative extrapolation of rigorous experimental results" (Skinner, 1957, p.11). He set out to show that human language is not outside the scope of radical behaviourism, that it can be accounted for by the same principles which govern all other behaviours. In other words, he argued that human interactions through language are governed by the same principles as interactions between any other organisms.

According to Skinner, verbal behaviour is any behaviour that is shaped and maintained by another organism and "any movement capable of affecting another organism may be verbal" (p.14). With humans this type of behaviour often takes place during social interaction, but it does not need to; e.g. reading and writing are also verbal behaviours. However, although verbal behaviour in this context is not restricted to human linguistic behaviour, almost all of the book *Verbal Behaviour* deals with human language and only in the last chapter did Skinner discuss animal behaviour. He dealt almost exclusively with vocal verbal behaviour on the grounds that it is the most common form and representative of other forms.

"Verbal behaviour" is a very broad term, which encompasses more than what we normally call "language". The former puts the emphasis on individual speakers, unlike "language" which usually denotes practices of a linguistic community. Skinner denied that speech has existence independent from the behaviour of the speaker. According to him words are not tools, or symbols, but behaviour - we don't use words, we do them - and he gave the following example to illustrate this point; "We have no more reason to say that a man 'uses the word water' when asking for a drink than to say that he 'uses a reach' in taking the offered glass." (Skinner, 1957. p 7).

Skinner's treatment of verbal behaviour is based on the idea that words are discriminative stimuli or responses like any other, and that language is acquired in the same way as any other behavioural repertoire. Words function as stimuli for certain responses or as responses to certain stimuli. The basic starting point is that all behaviour is ultimately under the control of environmental contingencies and to understand behaviour we need to carry out a functional analysis of the relationship between S^D - R - S^R. Skinner rebelled against what he called the "doctrine of ideas", i.e. the view that a verbal response is the result of ideas inside the organism, because this does not encourage causal analysis. For the same reason he criticised the term "meaning of words", arguing that verbal behaviour can be explained by the three-term contingency and that terms like "meaning" and "symbolic" are unnecessary. (Skinner 1957 ch. 5). The question of meaning is discussed in more detail below.

An analysis in terms of verbal behaviour makes a distinction between verbal stimuli and verbal responses. However, in everyday language this distinction is not made; "word" is used to denote both written and spoken form, both stimulus and response. As Catania (1984a) has put it, "Correspondence between verbal stimuli and verbal responses in formal verbal relations are implicit in the colloquial vocabulary" (ibid. p.223). Words are regarded as the same whether they are heard or spoken, seen or written. Skinner's contribution was to point out that these different forms represent different functions of words and that language consists of <u>all</u> components of verbal behaviour. Skinner's aim was to discriminate between all the different aspects of language, to analyse the functions of the different components, which he termed verbal operants.

Brief description of verbal operants

The verbal operants described here are tacts, mands, echoics, textual behaviour, transcription and autoclitics. Like non-verbal operants, verbal operants are not defined by their forms, but by their controlling variables. The same verbal utterance can function as either tact, mand, echoic etc. and how it is defined depends on its functional relationship to its antecedents and consequences.

Verbal behaviour by definition involves interaction between organisms, where the behaviour of one individual can act as the stimulus for another's response. Furthermore this response can become a stimulus for the response of the first individual. This is what happens during conversation between two people; the speaker's response is the listener's stimulus, but the roles of speaker and listener change during the interaction. However, operants are defined solely in terms of the speaker's behaviour and its effect on the listener, and Skinner did not really discuss interaction between speaker and listener. He agreed that the listener cannot be omitted, but has been criticised for doing just that in his writings on verbal behaviour (e.g. Hayes & Hayes, 1989).

A **tact** is "a verbal operant in which a response of a given form is evoked (or at least strengthened) by a particular object or event or property of an object or event" (Skinner 1957, p. 81-82). It is a verbal response occasioned by a non-verbal stimulus, e.g. saying "*house*" in the presence of a house. We cannot tact absent objects, so it is not the same as naming (Catania, 1984a). Tacts are usually controlled by properties of the environment, such as colour or size, not by individual objects or classes of objects. We can also tact relations among stimuli, e.g above, below, far.

A **mand** is "a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the control of relevant conditions of deprivation or aversive stimulation" (Skinner 1957, pp.35-36). A mand specifies its reinforcers, i.e. it includes the verbal response that in other circumstances tacts the reinforcing stimulus. A mand response may or may not occur in the presence of the reinforcing stimulus, which is supplied by the listener. Demands, commands and requests are all examples of mands. They are all responses which can function as stimuli for the behaviour of a listener. Skinner used the term "mand compliance" to describe the listener's response to a speaker's mand. Mand compliance means providing the stimulus specified by the speaker.

A tact is a verbal response occasioned by a non-verbal discriminative stimulus, and it is followed by generalised consequences. For example, the object apple can be a discriminative stimulus for verbal response "apple". A mand is a verbal response that is occasioned by a state of deprivation and which specifies its reinforcer. For example, the word "apple" can be a verbal response that results in getting an apple. In other words, the stimulus-response relationship involved in mands is in a sense symmetrical to the relationship involved in tacts.

The controlling stimuli for mands and tacts are non-verbal, but many verbal operants are under the control of other verbal behaviour. The simplest of these is the

echoic, which is merely repeating the verbal response of another individual. In other words, the discriminative stimulus is someone else's vocal response, and there is a point-to-point correspondence between this stimulus and the response.

A **textual** is a verbal response under the control of a written stimulus, a vocal response to a visual (or, as in Braille, tactual) stimulus. Textual operants are cross-modal in that stimuli and responses are in different modalities. Textual behaviour makes no demands on linguistic competence or grammatical behaviour, i.e. it is not the same as reading with understanding.

Transcription is the creation of a visual stimulus either on hearing an auditory stimulus (dictation) or seeing a written a written stimulus (copying). Both transcription and textual behaviour involve formal correspondence between stimulus and response, the nature of the correspondence being determined by the verbal community.

Autoclitics are higher level verbal behaviours in the sense that they modify the effects of other verbal behaviour. There are two main types of autoclitic; the first type describes, qualifies or comments on other verbal behaviours, the second type effects the ordering of other verbal behaviours. Skinner divided the former into three sub-types; descriptive, qualifying, and quantifying autoclitics. Descriptive autoclitics describe the type, strength or manner of a speaker's response; e.g. "I doubt", "I'm sorry", "I heard", "I guess". Qualifying autoclitics modifies intensity or direction of the listener's behaviour, and the most common example is negation; no, not, never, nothing. The most common quantifying autoclitics are the articles *a* and *the* , which "function to narrow the reaction of the listener by indication the relation between a response and a controlling stimulus" (Skinner, 1957, p. 329)

Autoclitics which have an ordering function over other verbal behaviours are termed **relational autoclitics.** Words such as "above", "before", "of" are all relational autoclitics, as are prepositions, conjunctions and grammatical tags such as -ly, -s, -e.

Skinner described sentence construction as the result of adding autoclitics to available verbal operants. He also argued that certain sentence patterns can form **autoclitic frames,** which are partially conditioned autoclitic response patterns. They are the result of a series of reinforced responses where for example a child learns to combine words into a basic repertoire; e.g. if the responses *the boy's shoe; the boy's hat,* are reinforced "we may suppose that the partial frame *the boy's . . .* is available for recombination with other responses" (Skinner, 1957, p.336). In the same way, the basic repertoire *"I have . . ."* may emerge as the result of having being reinforced for saying *I have a doll; I have a kitten.* -

Criticisms of Skinner's account

Chomsky's (1959) review was the first and also the most influential critique of Skinner's *Verbal Behavior* . Chomsky made his critique on two accounts; the first was that the basic principles of operant psychology are faulty and the second that the principles laid out in the book cannot account for human language. More than half of the paper is a criticism of operant analysis in general. This disagreement is fundamentally an epistemological one, a "paradigm clash" as Katahn and Koplin have put it (Katahn & Koplin 1968, cited MacCorquodale 1970). This kind of criticism is not a serious one if we accept Pepper's notion that world hypotheses are "self-contained", and it will therefore not be discussed further.

The criticisms of the verbal behaviour account itself are more serious, and were made in relation to three areas :

1. The main criticisms made related to <u>syntax</u> or language structure. Chomsky criticised Skinner for ignoring the creative aspects of language, and argued that the three-term contingency cannot account for novel behaviour, i.e. behaviour that occurs in the absence of reinforcement history. Therefore it cannot account for novel sentence constructions. Skinner argued that novel sentences are generated through autoclitics and that the term *grammar* describes the result of autoclitic processes, i.e. that grammar is the effect not the cause. However, Skinner's description of autoclitic processes is vague, and he did not make it clear how autoclitic learning occurs although his notion of autoclitic frames points to a process of generalisation.

Generalisation is the process by which the effect of a reinforcing stimulus in the presence of a particular stimulus can spread to other stimuli. This process can account for how organisms learn in the absence of differential reinforcement, i.e. learn novel behaviours. Any behaviour can be either the direct result of past reinforcement history or occur as the result of generalisation. The basis for generalisation is some feature or function common to all the stimuli. However, Skinner's account does not really make it clear how the process of generalisation operates as regards grammatical behaviour. As Stemmer (1990) has argued: "it is difficult to extract from his brief analysis a method for arriving at the controlling properties of grammatical generalizations and at the required contingencies" (ibid.. p.310).

There have been several replies to Chomsky's objections to *Verbal Behavior*, the most well known defence being that of MacCorquodale (1970). However, although MacCorquodale showed that a large number of Chomsky's criticisms were unjustified, he did not provide a satisfactory account of how this kind of generalisation comes about.

The second of Chomsky's objections related to Skinner's treatment of <u>semantics</u> or vocabulary. Skinner argued that terms like "reference", "meaning", "symbols", and "concepts" are unnecessary. According to Skinner discriminative stimuli come to control verbal responses through the principles of discrimination and generalisation. A tact learned in the presence of one stimulus may later be evoked by other stimuli with which it shares some common function or perceptual form. For example, a child having learned to say *dog* in the presence of a particular dog, will later utter the some response to several different types of dogs. This process, which Skinner termed tact extension, is a process of abstraction based on the properties of the stimuli.

"A well established common tact is necessarily an abstraction: it is under the control of a subset of properties which may be present upon a given occasion but probably never exclusively compose such an occasion" (Skinner 1957, p. 113)

Stimuli which control the same verbal response (as the result of generalisation) are said to belong to the same stimulus class. To use the example above, the word *dog* comes under the control of an increasing number of actual dogs present in the environment and hence the stimulus class "dogs" becomes enlarged.

The importance of Skinner's account is the stress on stimulus control, which he argued can account for processes traditionally termed "reference", "meaning", and "concepts". It could for example be argued, that the word *dog* does not refer to any particular dog, but to the concept "dog", and that a child uttering the word *dog* in the presence of a dog it has never seen before, is in some sense responding to the concept "dog". Skinner however argued that verbal responses, like all responses, are controlled by the properties of stimuli.

"We never reinforce a response when a 'concept' is present; what is present is a particular stimulus. The referent of an abstract tact, if this term has any meaning at all, is the property or set of properties upon which reinforcement has been contingent and which therefore control the response. We might say that the referent is the *class* of stimuli defined by such a property or properties, but there is little reason to prefer classes to properties. The property correlated with reinforcement must be specified, in physical terms, if we are to remain within the framework of an empirical science" (Skinner 1957, p.117).

The relation between a particular response and a controlling property of a stimulus can "only be discovered by examining contingencies between the properties and the absence or presence of the response" (ibid, p.117).

Skinner applied the same argument to the notion of the "meaning of a word", which is not the property of behaviour but of conditions under which the behaviour occurs, i.e. meaning can also be explained in terms of antecedents and consequences. The term "meaning" is unnecessary as it assumes something inside the person, something which mediates the verbal response.

Chomsky's objected to the notion of "stimulus control" arguing that it adds nothing to the explanation, that it is too to vague, can't explain the wide variety of responses to the same stimulus and "disguises a complex retreat to mentalism" (Chomsky, 1959). Chomsky also criticised the assumption that extrapolation from animals to human behaviour is valid, both as a general principle as well as in relation to verbal behaviour.

- *Animal-human differences*

As mentioned above Skinner's account was an attempt to apply principles derived from animal studies to human verbal behaviour. He agreed that verbal behaviour may be different from non-verbal behaviour, arguing that "behavior which is effective only through the modification of other persons has so many distinguishing dynamic and topographical properties that a special treatment is justified, and indeed, demanded" (Skinner, 1957, p.2).

However, he made no explicit distinction between verbal behaviours of different species, arguing that at the time there were no evidence against the assumption that principles derived from animals could be extrapolated to humans. Although this was true, there were no evidence to support it either, because until the late 1950's there had been a concentration on the study of non-human subjects within operant psychology. The aim, based on a belief in continuity between species, had been to find general laws of behaviour, and extrapolation had often been done without any evidence. "Anecdotes, extrapolation by analogy, and speculation have been used in lieu of experimental support in the extension of nonhuman animal -based principles to human affairs by behaviour analysts" (Galizio, 1987, p.12). Skinner's view was that the question of extrapolation is an empirical one and should be treated as such:

"The importance of a science of behavior derives largely from the possibility of an eventual extension to human affairs . . . Whether or not extrapolation (from the behavior of the rat) is justified cannot at present be decided. It is possible that there are properties of human behavior which will require different kind of treatment. But this can ascertained only by closing in upon the problem in an orderly way and by following the customary procedure of an experimental science" (Skinner, 1938, p.440-441).

However, at the time of publication of *Verbal Behavior* there had been no systematic comparative studies. Since then there has been an increase in studies into human behaviour on traditional operant tasks, focusing mainly on schedules of reinforcement. This is clearly illustrated by the rise of human studies as a percentage of all studies published in the most prestigious behaviourist journal, The Journal of Experimental Analysis of Behavior, from 10% in period 1958 - 85, to 17.5% in the period 1982 - 87 (Buskist, 1987). The majority of these studies have yielded the same conclusion, that there are differences in the performance between humans and non-humans. The main differences are that humans exhibit more inter-subject variability and are less sensitive to changes in reinforcement contingencies. (See Harzem & Williams, 1983; Lowe 1979; Weiner, 1983, for reviews of the inconsistencies between human and non-human studies).

That fact that human behaviour on schedules of reinforcement is different has lead critics of operant psychology to conclude that this approach is of no value (e.g. Brewer, 1974). However, the basic principles of control by antecedents and consequences are not invalidated by these findings. "It is not the case that human behavior is not subject to environmental control. Rather, the controlling variables are different both in themselves and in interaction with other variables" (Buskist, 1987, p.6). Verbal behaviour is the variable most commonly quoted as being the basis for species differences (Etzel, 1987). The argument is that animal behaviour is primarily shaped and controlled by experimental contingencies, whereas human responding is also affected by instructions, provided either by the experimenter or formulated by subjects themselves. In other words, the differences are explained in terms of the distinction Skinner (1966) made between rule-governed and contingency shaped behaviour.

Rule-governed and contingency shaped behaviour

This distinction refers to differences between behaviours mediated by language, and those occurring as the result of direct contact with contingencies. Contingency shaped behaviour is the result of direct contact with antecedents and consequences. Rule-governed behaviour on the other hand is an account of learning in the absence of such direct contact and is based on the causal relationship between verbal and non-verbal behaviour. Rules are verbal descriptions of contingencies and function as discriminative stimuli, i.e. they signal that a certain consequence may follow a certain response. A rule is however not just a discriminative stimulus, because it is a formulation of the whole contingency. Learning a rule is learning what behaviour will have what effects under what circumstances, it involves an "awareness" of the functional relationship between a behaviour and its antecedents and consequences. Rules are based on contingencies, on past experiences, but not necessarily the experiences of the person following the rules, which may have been formulated by ourselves or by other members of the verbal community. Rule-governed behaviour can account for how we learn without direct contact with environmental contingencies, i.e. it is an example of novel behaviour. Rule following is often advantageous, because it increases the amount of learning.

However, it can also be "maladaptive" because the rules can override natural contingencies and therefore obeying rules can mean that contact with environmental contingencies is prevented. There are numerous studies which show that human subjects on schedules of reinforcement respond in accordance with instructions given by the experimenter, even if these do not correspond to the contingencies in operation (e.g. Buskist, Bennett, & Miller, 1981; Lippman & Meyer, 1967; Kaufman, Baron, & Kopp, 1966; Matthews, Shimoff, Catania, & Sagvolden, 1977; Shimoff, Catania, & Matthews, 1981). There are also studies showing that even if no specific instructions are given human responding can be consistent and insensitive to experimental consequences (Catania, Matthews, & Shimoff, 1982; Lowe, Harzem & Bagshaw, 1978; Weiner, 1964). The latter phenomena has lead to the suggestion by some researchers (most notably Lowe and co-workers), that human subjects formulate their own rules, which then control responding (Bentall, Lowe, & Beasty, 1985; Lowe, 1979; Lowe, 1983; Lowe & Horne, 1985). Further evidence for this position comes from studies which show a correlation between self-verbalisation and performance on schedules of reinforcement (Bentall, Lowe & Beasty, 1985; Lowe, 1979; Lowe, Bentall & Beasty, 1983; Lowe, Harzem & Bagshaw, 1978).

The argument over instructional control, and in particular the role of self-instructions, is still a matter of controversy. Although several studies have shown a correlation between human responding on schedules of reinforcement and subjects' verbal behaviour it is difficult to determine if what subjects say is a cause or a consequence of their non-verbal responding. The problem is compounded by the difficulty in collecting verbal reports. The argument is that subjects' covert verbal behaviour control nonverbal responding, but only overt verbal responding can be analysed. There are three methods for doing this; spontaneous verbalisation, asking subjects' to "think aloud" or post-experimental questionnaires. The problem with first two methods is that it is possible that the verbal behaviour simply is a tact describing the subject's non-verbal behaviour (Etzel,1987; Galizio, 1987; Weiner, 1983) and post-experimental verbal reports are unreliable and often bear no relationship to verbal behaviour during experiment (Hird & Lowe, 1985).

In order to go beyond correlation studies and arrive at experimental rather than interpretative data, verbal self-instructions need to be introduced as experimental interventions. Bentall and Lowe (1987) have carried a series of such studies with young children, which provide strong evidence in support of the hypothesis that verbal behaviour, in the form of instructions, can function as controlling stimuli for other behaviours.

To summarise : Until the 1970's behaviourism was regarded as a main force in psychology and research focused on animal studies. Since then the assumption that animal studies are sufficient for the understanding of human behaviour has been criticised both outside and inside the behaviourist field, with many behaviourists now arguing that human behaviour can only be understood by concentrating on human subjects. The increase in experimental analysis of human behaviour has resulted in a debate about the role of language in human behaviour. Several researchers most notably Catania, Hayes and Lowe, have concentrated on investigating the "language hypothesis"; that species differences observed between humans and non-humans can be explained in terms of human capacity for language. These studies have concentrated on the role of verbal instructions, which have been shown to have a controlling function in human performance on operant tasks. The implications are that much of naturally occurring human behaviour is controlled by verbally formulated instructions or rules, rather than environmental contingencies. Catania has even gone so far as to state that "the primary function of language is to change behaviour" (Catania, 1984a, p. 238). Animal behaviour on the other hand is under direct control of its antecedents and consequences.

However, this question is far from being settled. Even if we accept that verbal behaviour can have a controlling function over other behaviours we are still left with the problem of how this comes about. As Wulfert & Hayes (1988) have pointed out, there has been little progress in understanding of instructional control, and an adequate comprehensive behaviourist account of language acquisition is still lacking. The argument for verbal control of behaviour rests on the assumption that rules act as discriminative stimuli. They do in a sense "stand for" or "refer to" contingencies. Skinner did not discuss the relationship between rules and the contingencies they stand for/refer to, as he argued that the notion of reference is unnecessary. Hayes (1991) has however argued recently that the question cannot be ignored and that we cannot deal with rule-governed behaviour without some notion of reference. Rules are not "ordinary" discriminative stimuli, nor do they fit into any of the categories of verbal behaviour. They are not tacts, as we cannot tact things in their absence. Rules are functionally substitutable for contingencies, in the sense that behavioural outcomes of following a rule and making direct contact with contingencies can be identical.

This then leads us back to the problem of the question of reference and the relationship between verbal and non-verbal behaviour. Are verbal stimuli and responses different from other types of behaviour? If verbal behaviour has a controlling function over non-verbal behaviour, how is this established? This leads us back to the question of meaning, symbols and concepts, and if we are not careful a metaphysical roundabout. The problem can only be resolved by systematic investigations, but there is no reason to abandon the basic principles of behaviourism.

"The development of appropriate methods to study these new issues may lead behaviour analysts to some unfamiliar places. New methods are needed to permit the analysis of the complex topography of verbal behaviour. To accomplish this we will have to be familiar with the history of research in this area. but because we explore this unfamiliar territory does not mean that we must abandon our commitment to the methodological principles of the experimental analysis of behavior" (Galizio, 1977, p.15)

Conclusion regarding the adequacy of the behaviourist approach

* In the last 20 years behaviourism had been increasingly criticised for being unable to deal adequately with complex human behaviours, especially language. There is also a strong argument that this failure is due to invalid extrapolation from animal studies. These criticisms have come from behaviourists as well as from psychologists working outside the field.

* The main criticism has been that the three-term contingency, which forms the basis for the behaviourist approach, is inadequate for accounting for novel behaviours, i.e. behaviour that occurs in the absence of past reinforcement history. Therefore it cannot account for creative aspects of human behaviour, such as problem solving, novel sentence construction and learning new vocabulary.

* Studies into the experimental analysis of human behaviour have revealed animal-human differences

* These differences are explained by some behaviourists in terms of the human capacity for language.

* As the behaviourist account of language is inadequate, further investigations into human operant behaviour are needed. In particular we need to examine issues such as "reference", "meaning", "symbols" and "concepts".

* Behaviourism is not unique in its problems in dealing with these issues, which have been the subject of extensive philosophical debate for centuries. There are no commonly agreed upon definitions and most definitions resort to hypothetical constructs. The principles of operant conditioning may however provide a framework for systematic investigations of these issues. It is likely that novel methods may be needed, i.e. that procedures developed for animal studies are inadequate. This does not however invalidate the basic principles of contextualism.

* Operant principles and Skinner's account of verbal behaviour allows us to deal with one aspect of language at a time. Skinner's contribution has been to separate the different aspects, which is important because it allows us to study how learning one form of verbal behaviour affects other forms. The latter was not really discussed by Skinner, but it could be useful in trying to establish a non-hypothetical definition for terms like "meaning", "symbol", "reference" etc.

* Skinner dismissed these terms as unhelpful for his analysis, because he argued that they do not encourage a functional analysis. However, even if we dispense with the terms, we are still left with the following questions which Skinner did not answer adequately:

How are different aspects of verbal behaviour related to each other?

How is verbal behaviour related to environmental stimuli?

Is verbal behaviour different from other types of behaviour?

How is verbal behaviour causally related to other behaviours?

The latest development within behaviourism has been the advent of stimulus equivalence research, which has been claimed to provide some of the answers to these questions, i.e. claimed to increase the scope of the behaviourist approach. Before proceeding to stimulus equivalence, this discussion will focus on the theories of Mead and Vygotsky, who wrote extensively about the kind of questions outlined above. They are no usually considered as behaviourists, but their basic approaches were based on contextualism, and many of their ideas are very similar to Skinner's. The following chapter gives a summary of their main arguments.

CHAPTER TWO

THE APPROACHES OF VYGOTSKY AND MEAD

Similarities and differences to Skinner

Vygotsky was a Russian whose ideas has had a great influence on the development of modern Soviet psychology and recently his writings have also begun to have an impact outside the Soviet Union. Like Skinner he took as his starting point Pavlovian stimulus-response theory, stressing the active role of the individual. Unlike Skinner, Vygotsky argued strongly in favour of species differences and concentrated on studies of human behaviour. He stressed the importance of "symbolic" behaviour, and in particular language, in the development of human behaviour . He made a distinction between mediated and unmediated behaviour, which was very similar to Skinner's distinction between rule-governed and contingency controlled behaviour. Vygotsky formulated his ideas in the 1920's and -30's, and at the same time very similar views were being put forward by Mead, an American philosopher. Their main ideas are outlined below, followed by a comparison with Skinner.

Lev Vygotsky

Vygotsky advocated a developmental approach to the understanding of human behaviour, arguing that we should study behaviour as it unfolds in its context, rather than trying to determine the context afterwards. According to Vygotsky, many uniquely human functions become "fossilised" once we are adults, therefore we must study children to understand these functions. He also stressed that there are important animal-human differences which he described in terms of a distinction between higher and lower mental functions. Higher mental functions are characterised by mediated activity, and Vygotsky explained the essential difference between elementary (lower) and higher functions as follows:

"The central characteristic of elementary function is that they are totally and directly determined by stimulation from the environment. For higher mental functions, the central feature is self-generated stimulation, that is, the creation and use of artificial stimuli which become the immediate cause of behaviour." (Vygotsky, 1978, p. 39). He argued that Pavlov's stimulus-response theory could explain elementary behaviour, as this is the result of a direct link between a stimulus (S) and response (R) and according to Vygotsky all animal behaviours are of this form. Most adult human behaviours, on the other hand, are the result of mediated behaviour, where an auxiliary stimulus intervenes between S and R. This auxiliary stimulus operates on the individual, not the environment. It "transfers the psychological operation to higher and qualitatively new forms and permits humans, by the aid of extrinsic stimuli, to control their own behavior from the outside." (ibid, p.40). The type of auxiliary, or artificial stimulus, most frequently used by adults is the verbal sign or word.

The mediating function of words develops gradually with words initially functioning merely as stimuli which elicit certain responses or as responses to certain stimuli. In other words, young children are only capable of elementary mental functions. According to Vygotsky children's first words are not differentiated from the objects or events they are associated with, but the word for an object "for a long time appears to the child as an attribute or a property of the object" (Vygotsky, 1986, p.61). Words are "indistinguishable from all other stimuli, from the objects that they must designate." (ibid, p.102). This is similar to Piaget's view of first words as indicators (Piaget & Inhelder, 1966)

Vygotsky further argued that children develop a distinctly human form of consciousness through their interactions with more mature humans; that "we become ourselves through others". Humans, unlike animals, are able to break away from biological activity and create new forms of culturally based psychological processes, i.e. higher mental functions. These mental processes develop from an elementary level, where responses are made directly to stimuli in the environment and thought at this level is in the form of perception. Human thinking is then gradually transformed into a higher level, where humans can mediate between their perception of the environment and their responses, i.e. they can control their own behaviour, a control which is only possible through language. At first the child uses overt speech to regulate his behaviour, and speech then gradually becomes internalised, but its regulatory function does not change through this internalisation.

Language has a dialectical role in that it is both the tool and the result of intellectual development. According to Vygotsky, language transforms thinking which in turn influences language acquisition. As Holzman (1985, p.360) has put it : language is a vehicle for learning about the world and one of the things to be learnt about the world is language itself. Vygotsky did not say that language becomes thought (which is often argued, e.g. by Bruner 1967) but that higher mental functions are the result of interaction between language and elementary thinking. Even in adults it is still possible to have language without thinking and thought without language , i.e. although most of our activities are mediated ones, not all of them are. Animals on the other hand, are incapable of higher mental functions.

George Herbert Mead

Mead used the term "gesture" for any act, performed by an organism, that result in an adjustment in the behaviour of a second organism. A gesture is a social stimulus and is part of a social act, which according to Mead is any instance where the behaviour of one individual evokes a response in another. This then is very similar to Skinner's definition of verbal behaviour. However, unlike Skinner, Mead discussed the issue of "meaning" in extensive detail. According to Mead, meaning is contained not just in the gesture, but in the whole act of which the gesture is a part. The basis for meaning lies in the relationship between the gesture of one organism, the adjustive response of another and the outcome of the act. (Mead 1934)

Mead distinguished between two types of gestures, non-significant and significant. Non-significant gestures do not have the same meaning for all the individuals participating in the act, i.e. they do not evoke shared meanings, and according to Mead all animal gestures are of this kind. Significant gestures on the other hand, indicate the same meaning to all participants. This presupposes that the individual making the gesture is aware of the meaning his/her gesture has for another, which Mead called taking the role or attitude of the other participant. A significant gesture is one which is made knowing in advance how that gesture will effect the outcome of the social act. He further argued that "it is only the vocal gesture to which one respond or tends to respond as another person tends to respond to it" (Mead 1934, p.67). In other words, vocal gestures (words) are the only significant ones; there is something special about words, which makes human interaction different to that of animals. Words evoke common or shared meanings, and we can only learn those meanings through interaction with other individuals and this is a particularly human ability. According to Mead, "conversation of gestures is not significant below the human level, because animals have no mind or thought" (Mead 1934, p.81). He also argued that human consciousness, thinking and ability to control one's own behaviour depends on the use of language. Humans are the only species capable of language and this provides us with other abilities, those that we usually call "cognitive".

Comparison with Skinner

There are many similarities between the accounts of behaviour put forward by Skinner, Vygotsky and Mead as they are all based on the world view of contextualism, i.e. the view that an act can only be understood in terms of the context in which it occurs. Mead's notion of non-significant gesture and Vygostky's account of early language is similar to Skinner's account of verbal operants. There are however important differences between Mead and Vygotsky on the one hand and Skinner on the other. Skinner viewed words as either stimuli or responses which function in the same way as any other S or R, regardless of whether the organism involved is human or animal. Mead and Vygotsky on the other hand stressed that adult human language is different from other types of behaviour in two main respects, namely:

a) they viewed language as a special type of behaviour, whose relationship to environmental stimuli is different because it can in some sense "stand for" those stimuli'

b) Language can have a controlling function over other behaviours, and behaviours which are mediated through language are different from non-mediated behaviours.

The first distinction refers to the issues of "reference" and "meaning", terms which Skinner dismissed as unnecessary for discussions about verbal behaviour. He did however consider the controlling function that verbal behaviour can have over other behaviours. The distinction made by Skinner between contingency shaped and rule governed behaviour is very similar to Vygotsky's distinction between higher and lower functions and Mead's notion of significant and non-significant gestures. They all argued that much of human behaviour is influenced by social and historical factors and that it is not necessarily directly controlled by environmental stimuli, but mediated through language.

Mead and Vygotsky argued that animals are incapable of certain types of behaviours, which they termed "symbolic", which have a controlling function over other behaviours. Skinner argued that there are no functional differences between basic verbal operants (tacts, mands, echoics, textuals and transcription) and other non-verbal operants. He also argued that we can extrapolate from animal experiments to human behaviour when discussing different functions of verbal behaviour. He did however make a distinction between basic and higher levels of verbal behaviour, the autoclitics, which he argued are not part of the animal repertoire. Rule-governed behaviour depends on higher levels of verbal behaviour as the combination of verbal operants into rules, which can come to control other behaviours, is under the control of the autoclitics. The controlling function of verbal behaviour only occurs in humans as animals do not exhibit higher level verbal behaviour (verbal operants under control of verbal behaviours). In other words, animals only show verbal behaviour under control of environmental stimuli and their behaviours are therefore never rule-governed.

Mead and Vygotsky discussed the distinction between words and other forms of stimuli and responses in terms of "word meaning".

Definitions of meaning

Skinner argued that "meaning and referents are not to be found in words but in circumstances under which words are used by speakers and understood by listeners." (Skinner, 1974, p.192). He also argued that this process can be fully accounted for in terms of the three-term contingency. Mead's view is very similar, as illustrated by the following quote:

"We want to approach language not from the standpoint of inner meanings to be expressed, but in its larger context of co-operation in the group taking place by means of signals and gestures. Meaning appears within that process." (Mead 1934, p.6). Interaction between organisms occur through gestures and the meaning of a gesture can only be understood in terms of how others respond to it and the outcome of the interaction. This can be expressed in a three-term contingency where the gesture of organism A functions as a discriminative stimulus for the response of organism B, and the reinforcement or punishment is the consequence of B's response. (S^D = gesture of organism A; R = response of organism B; S^R= consequence of B's response).

Mead's notion of "gestures" appears to be different from Skinner's contingency for verbal operants, which, like all operants, are defined in relation to their antecedents as well as their consequences. According to Skinner, for any verbal operant, S^D = a stimulus in the environment or a state of deprivation; R = verbal response of organism A; S^R= response of organism B and the consequence of B's response. Mead did not stipulate antecedents for gestures, but if we add a discriminative stimulus for the gesture made by organism A, then the contingency for Mead's gestures becomes the same as Skinner's verbal operants. In other words, the differences between the two accounts disappear if the behaviours are considered in terms of interactions between organisms rather than concentrating on the behaviour of one individual.

Vygotsky defined word meaning as generalisations which change with development. "Word meanings are dynamic rather than static formations. They change as the child develops. "(Vygotsky, 1986, p.217). Initially words are treated like attributes of objects or events; they function as stimuli or responses. Words then gradually come to stand for groups or classes of objects, rather than for single objects and this process is the result of generalisation. Skinner also argued that stimuli classes can develop as the result of generalisations, but he stressed that these are always based on physical properties of the stimuli. Vygotsky made no such assumption, on the contrary he argued that in adult language words stand for concepts, which are "groupings based on abstract and logical bonds".

Mead and Vygotsky both argued that children learn the meaning of their own actions through the social-cultural consequences of these actions. These relations are internalised, through language, and becomes regulators of the child's behaviour. Vygotsky saw the development of concepts and language as an interactive process; it is not the case that the child first forms a concept and then learns a name for it, nor is it true that the name is learnt before the concept. The child learns gradually from adults that a word stands for object and events at the same time as he learns how objects and events are grouped into concepts in adult thought. Concept development occurs in stages, from simple groupings through complexes into concepts and the function of the child's words change accordingly. First words are merely stimuli or responses associated with particular features of objects or events. At this stage there is no difference between a child's response to a word and the response of an animal to the same word, e.g. "sit!", "come". Early language use as defined by Vygotsky is the same as the basic verbal operants defined by Skinner, they are no different from other stimuli and responses. Vygotsky however, argued that this is not the case for adult language. Like Mead he stressed that there are differences between adult human vocal utterances and animal behaviour, and between animal and human responses to words.

Conclusion

The discussion of Skinner, Mead and Vygotsky and their views on language is by necessity a theoretical one as they did not provide any experimental data to support their ideas. Vygotsky carried out investigations but did not publish details, Mead was a philosopher, and Skinner's *Verbal behavior* was only intended as a theoretical work. However, to resolve the questions discussed we need to treat them as empirical rather than purely philosophical issues. The rationale behind stimulus equivalence research is that it allows us to do just that by providing a paradigm for studying issues related to language within a operant analysis framework.

Chapters One and Two have dealt with the general background to understanding why equivalence research has generated a lot of interest and the background to questions that may be addressed by this type of research. Chapters Three and Four provide details of the equivalence paradigm and previous studies plus a discussion of how this line of research can shed light on the contentious issues of animal-human differences; emergence of novel behaviours, including syntax; word meaning, and in particular naming as opposed to tacting.

CHAPTER THREE

THE STIMULUS EQUIVALENCE PARADIGM

Introduction

The two previous chapters have been mainly descriptive, "setting the scene" for an evaluation of the behaviourist approach to human language and the criticisms levelled against it. Mead's and Vygotsky's ideas have been described because they are based on a similar paradigm to that advocated by Skinner, while at the same time emphasising the distinct nature of human language. They argued for a special "symbolic" nature of adult language, i.e. made a distinction between words and other responses. Skinner on the other hand argued that words are functionally related to their antecedents and consequences in the same way as all other responses. His view is succinctly illustrated by the following quote:

"*Verbal Behavior* is best conceived as a hypothesis that speech is within the domain of behaviors which can be accounted for by existing functional laws, based upon the assumption that it is orderly, lawful, and determined, and that is has no unique emergent properties that require either a separate causal system, an augmented general system, or recourse to mental way-stations" (MacCorquodale, 1969, p. 832).

Mead and Vygotsky have by no means been alone in making a distinction between the symbolic and non-symbolic function of words. Similar arguments were made for example by Piaget and more recently by linguists working from a Piagetian perspective (e.g. Anisfeld, 1984). The question of how to define "word meaning" and "symbol" is a philosophical issue as yet unresolved, i.e. there are no clear, commonly agreed upon definitions. Skinner "opted out" of the debate by dismissing the terms as unnecessary. The question is: has he dismissed something essential about human language in the process?

As explained in Chapter Two, a behaviourist approach attempts to explain *word reference, meaning and generation of novel sentences* (i.e. grammatical behaviour) in terms of stimulus control. "A word 'refers to' or 'means' something to the extent that a stimulus (the 'referent') exerts discriminative control over it." (Wulfert & Hayes, 1988 p.125). Grammatical behaviour is controlled by autoclitics. "Responses evoked by a situation are basically non-grammatical. They are grouped or ordered through the effects of complex discriminative stimuli, termed autoclitics, that have an effect upon the listener, including the speaker himself (ibid, p.125). Chomsky argued that this account of grammar does not explain how a speaker generalises from previous sentences to novel ones and criticised Skinner's account for not explaining what the functional classes are through which previous training in word order transfers to new instances. The argument regarding syntax will be returned to later, but for the moment the discussion will focus on the question of semantics, and on how adequately this can be dealt with through the notion of stimulus control.

Semantics

The semantic aspects of language, i.e. the relationship between words and objects and events, have been the focus of much philosophical debate, but there is agreement that words do not "refer" to or "mean" any particular instances or objects, rather they are based on generalisations. In other words, many different stimuli can control a response but the response does not refer to them, rather to some abstraction. For example, the vocal response "*house*" does not "refer" to or "mean" any one particular instance of the object house. It can be occasioned by varying stimuli such as the physical presence of a house, a picture of a house, the written word "house" or by some other verbal stimulus such as "place to live in".

Meaning is not a question of a relationship between words and individual stimuli, but between words and stimulus classes. Classification can be based on certain features common to all the class members and/or relationships between the features. In other words, all members of a class can occasion the same response, but that response is not controlled directly by the stimulus, but by its class membership. "To categorize is to render discriminably different things equivalent, to group objects and events and people around us into classes, and to respond to them in terms of their class membership rather than their uniqueness." (Bruner, Goodnow & Austin, 1956).

Traditional operant analysis can only deal with classifications based on physical properties. This may at first glance suggest that word meaning cannot be completely accounted for in terms of stimulus classes, as there may be no physical features common to all the discriminative stimuli for a verbal response. For example, there are no properties common to both the object house and the written word "house". However, according to Skinner's analysis, although the two stimuli may elicit responses that are topographically identical they are functionally different, i.e. part of different contingencies. For example, the vocal response *"house"* in the presence of an actual house is a tact, but if the discriminative stimulus is the written word "house", it is textual behaviour.

Skinner argued that language cannot be defined in terms of any <u>one</u> aspect of verbal behaviour, because language consists of all verbal operants and argued that the different operants were acquired separately. He did for example make a distinction between contingencies where a written word functions as a stimulus (reading) and those where it functions as a response (writing). According to this analysis there is no obvious reason why reading behaviour should influence writing behaviour, as the two are functionally different and part of different reinforcement histories. However, intuitively it seems that there is a relationship between learning to read and learning to write. This has also been demonstrated experimentally, with studies showing that teaching children to spell (write) improves their ability to read (e.g. Ellis & Cataldo 1990).

The same is true for tacts and mands, a word learnt as a tact may later be uttered (come to function) as a mand. For example, imagine that you went to Sweden not speaking a word of Swedish. On the boat over you meet a Swede who doesn't speak a word of English. You have dinner together, and during dinner you try and teach each other your respective languages. You learn to say the word *Gaffel* when the Swede holds up a fork. (SD = fork, R= *Gaffel*, S = social approval, personal satisfaction). This is an example of tacting. Later on you go to a restaurant where you find that there is no fork by your plate, you then decide to practice your Swedish and say *Gaffel* to the waiter, who then gives you a fork. The word *Gaffel* is in other words now functioning as a mand.

There is a problem for the behaviour analyst here because the mand utterance seems to have emerged in the absence of an explicit reinforcement history. The response appears to be the result of some kind of generalised reinforcement history - i.e. there is a kind of symmetrical relationship between words and the objects and events that they stand for and we don't need to learn this explicitly for each word. Two different discriminations are involved, two different contingencies, but learning a word as a stimulus may lead to the spontaneous utterance of that word as a response. In the example above, the object fork was a discriminative stimulus for the spoken response *Gaffel*. But the reverse was also true, the spoken word *Gaffel* was a discriminative stimulus for a response involving a fork. Within an operant analysis there is no obvious reason why this should be the case, as the three-term contingency does not predict this kind of reversal. This does not necessarily invalidate the basic paradigm, it only shows that it may be incomplete. The adequacy of the paradigm can only be determined by further studies into stimulus class formation and generalisation between contingencies. In sum, to account for semantics we need a comprehensive, multi-functional understanding of verbal behaviour.

Studies into stimulus class formation

A large number of studies have been carried out into how humans form classes based on common physical features of stimuli (e.g. Bruner et al, 1956, Posner & Keele, 1968). In these studies the subjects are presented with stimuli, often in the form of complex geometric shapes, within which are embedded common elements. Subjects are then required to place the stimuli into different groups, i.e. to categorise the stimuli. If subjects group together stimuli with common features they are said to have "abstracted" those features.

This ability is not uniquely human. Herrnstein, Loveland & Cable (1976) for example, trained pigeons to discriminate between pictures of people and pictures that did not contain people. Food was only given to the pigeons if they pecked a plastic disc in the presence of a photographic slide that included people. The pigeons not only quickly learnt to discriminate between people and non-people slides, but their behaviour also generalised to novel slides; i.e. they responded correctly to slides that had not been included in the training sessions. New slides were sometimes even more accurately discriminated than those used in training. Other pigeons learnt discriminations between pictures with and without water, still others learnt to discriminate between tree and non-trees. Herrnstein et al (1976) therefore had to reject the idea that the birds' performance was based on any specific elements common to all members of a target class, as no such elements could be identified. For example:

"To be recognised as a tree, the pigeons did not require that it be green, leafy, vertical, woody, branching and so on. Moreover, to be recognized as a nontree, the picture did not have to omit greenness, woodiness, branchiness, verticality, and so on." (Herrnstein et al 1976, pp. 298-299).

Their conclusion was, therefore, that the pigeons were responding to clusters of features and certain features were only relevant in the presence of other features. For example the features "leaves" and "green" are neither necessary or sufficient for identifying an object as a tree. But they may become defining features if they occur together. In other words, the role of one stimulus depends on the presence or absence of other stimuli. The plastic disc was a S^D for a pecking response but only in the presence of certain slides. Discriminations in which the role of one stimulus is conditional upon other stimuli that are present are called conditional discriminations. Most of our behaviours are of this kind, a stimulus that act as S^D in one context may not be effective in others. For example, a red traffic light at a junction can be a stimulus for us to stop, but our response to the light depends on whether it is facing us or the other traffic (Catania, 1984a). The three-term contingency can itself be placed under stimulus control, i.e. controlled by conditional stimuli. "Conditional stimuli do not control responses directly, but determine the control which other stimuli exert over responses", they function as "selectors of discriminations, rather an of individual responses". The conditional stimulus extends the unit of analysis to a four-term contingency. "The four-term contingency is the fundamental unit of what we might call conditional, instructional or contextual stimulus control.". "Four term units consist of discriminations that are under contextual control." (Sidman 1986). This is directly relevant to any discussion about language as all verbal responses are under contextual control. We do not respond to all available stimuli, (e.g. by continuously tacting all the stimuli in our environment) and the meaning of words and phrases often varies according to context. In other words, verbal behaviour consists of conditional discriminations. Conditional discriminations have been studied within a behaviourist framework through a procedure known as matching-to-sample.

The matching-to-sample paradigm

A matching-to-sample task consists of training subjects to respond to one of several stimuli, known as comparisons. The correct selection of a comparison is conditional upon the presence of another stimulus, known as the sample. The types of stimuli used are often colours or geometrical shapes, often Greek or Hebrew letters. Traditionally a three key response panel (pictured in Figures 1a and 1b) has been used, and in most studies some form of automation (usually computer control) is used for the presentation of stimuli, the delivery of consequences and the recording of responses. The experimenter designates the stimuli as sample and the correct or incorrect comparisons and differential consequences are delivered accordingly.

Figure 1a

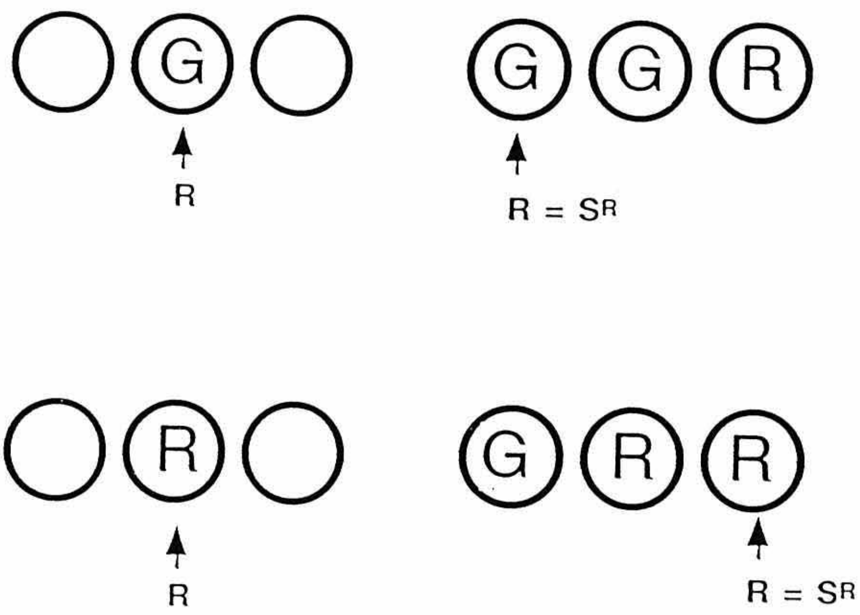


Figure 1a shows the standard 3-key procedure for teaching matching-to-sample based on identity with two stimuli. In this example the stimuli are green (G) and red (R) colours. The start of a trial is signalled by the appearance of a sample stimulus on the centre key. A response to the sample results in the appearance of two comparisons on either side of the sample. Reinforcement is then contingent on a response to the comparison that is identical to the sample.

Sample stimuli always appear on the centre key, but the position of the correct and incorrect comparison stimuli would normally be counterbalanced.

Figure 1b

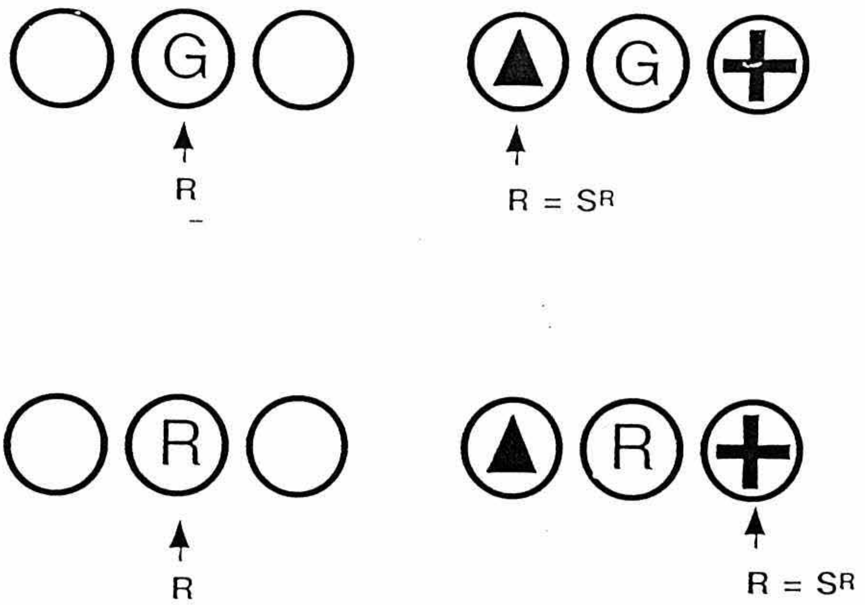


Figure 1b shows the standard 3-key procedure for teaching arbitrary matching-to-sample with four stimuli: the colours red and green, a triangle and a cross. The start of a trial is signalled by the appearance of a sample stimulus on the centre key. A response to the sample stimulus results in the appearance of two comparisons on either side of the sample. Reinforcement is then contingent on a response to the comparison that is arbitrarily designated as correct (in this case the cross).

Sample stimuli always appear on the centre key, but the position of the correct and incorrect comparison stimuli would normally be counterbalanced.

The sequence of one conditional discrimination trial is as follows:

1. The stimulus designated as sample is presented on the middle key, with outside keys empty.
2. The subject is required to respond to the sample by touching it. This is done to facilitate attention to the sample stimulus.
3. The consequence of this is the presentation of the comparisons. One of the comparison stimuli is designated as the correct choice in the presence of the appearing sample. The subject is required to indicate choice by touching a comparison.
4. All stimuli disappear and differential consequences for correct or incorrect choices are delivered.

When the experimenter-designated correct comparison is identical on some physical dimensions to the sample, the procedure is called identity matching to sample (see Figure 1a). For example, if the colours red and green are used as stimuli, on each identity matching trial one comparison will be red and the other green. A response to the green will be reinforced in the presence of the green sample and a response to the red reinforced in the presence of the red sample. The sample stimulus and position of comparisons changes from trial to trial.

Several experimenters (e.g. Ferster 1960, Wright & Cumming 1971) have trained pigeons to match identical colours using this procedure. Matching in pigeons does not however transfer easily to new colours (Catania 1984a). In other words, pigeons who have learnt to match green to green and red to red do not automatically match other colours. The performance is based on physical features shared between sample and comparison, rather then on the general (and abstract) notion of "sameness". Even when matching does transfer to new colours it can not be concluded that the pigeons have learnt identity matching in general. Generalised identity matching requires extra dimensional transfer, i.e. that matching transfers to other types of stimuli, e.g. shapes. To date there is no evidence that animals are capable of this kind of matching. Normally developing human adults and children above the age of five years are able to learn these sort of tasks relatively quickly. They also quickly learn matching tasks when the relationship amongst the stimuli are arbitrary (see Figure 1b) in the sense that there are no perceptual similarities between them, e.g. matching a green comparison with a triangle (Green, Mackay, McIlvane, Saunders & Soraci, 1990).

There has been increased interest in these sort of studies during the last twenty years, sparked off by Sidman's pioneering studies in the early 1970's, where he found that conditional discrimination training can result in the emergence of new, untaught, responses. Sidman's studies and the implications of these will first be briefly summarised to give an overall picture of this research area. This will be followed by a more detailed account of his studies and a discussion of the questions they raised.

Sidman's studies

Matching-to-sample tasks have been used as teaching methods in a number of settings, e.g. to teach conditional discriminations like left - right (Jeffrey 1967), and the value of coins. In the early 1970's Sidman used the procedure to teach reading comprehension to mentally handicapped adolescents. He modified the procedure and increased the number of comparisons on each trial to eight. (See Figure 2 for an example of Sidman's apparatus). The aim was to teach reading comprehension, defined as the ability to match printed words to corresponding pictures, and pictures to printed words.

Figure 2

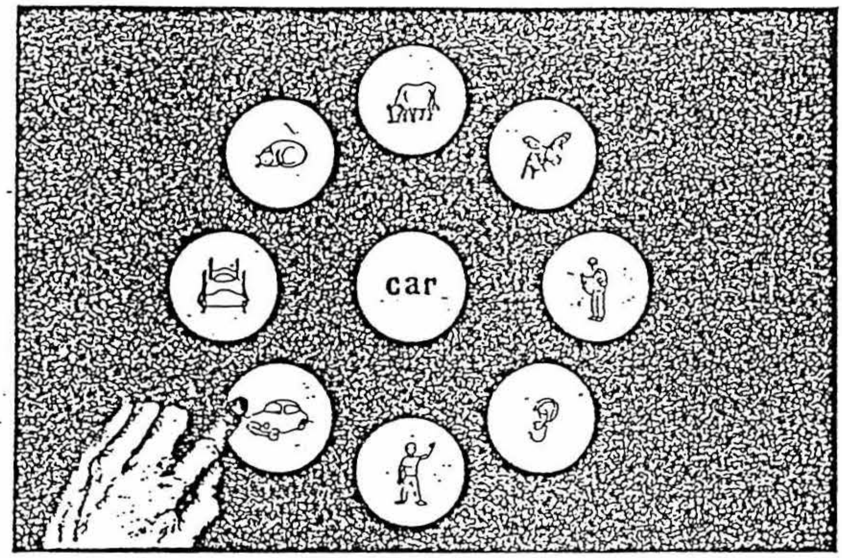
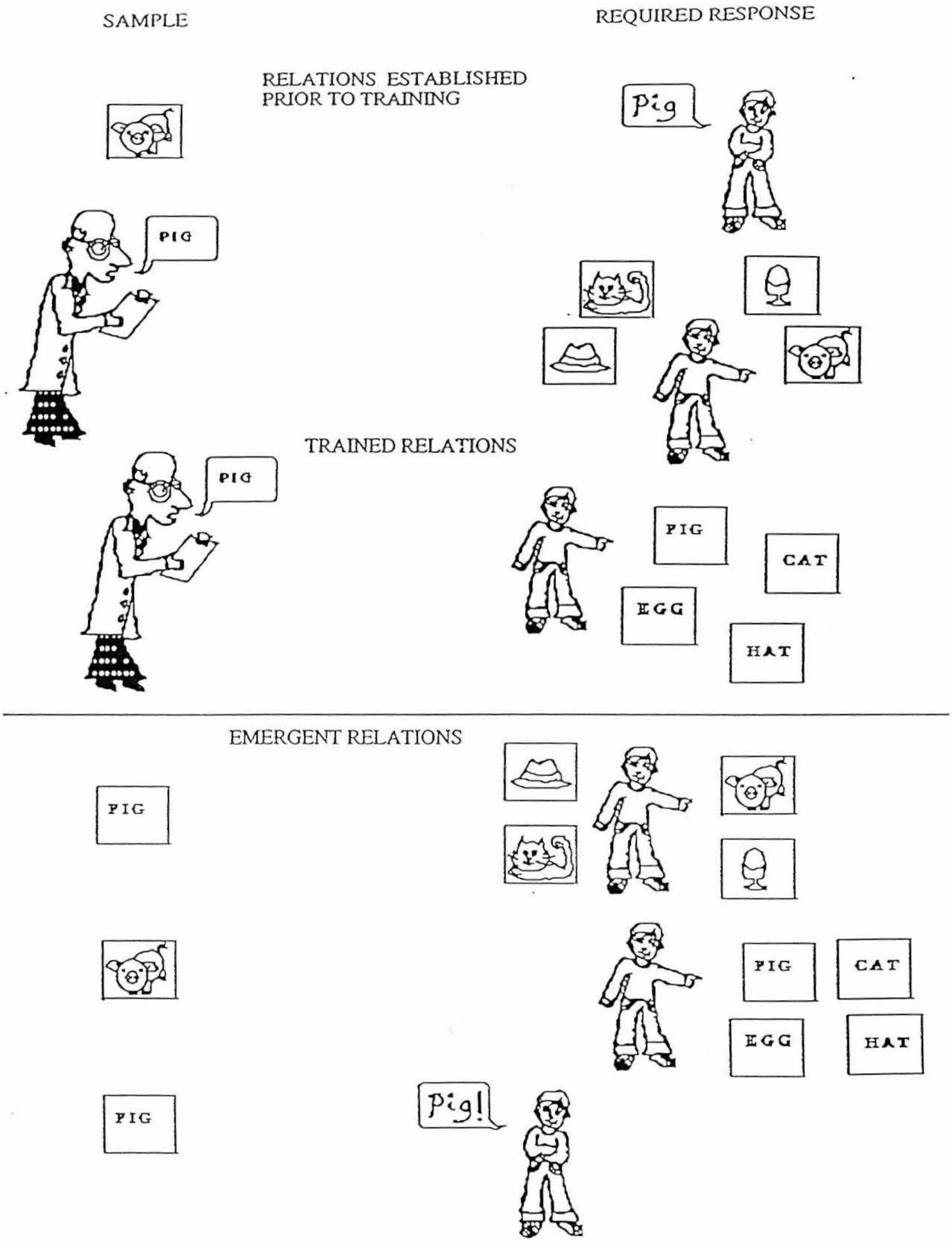


Figure 2 illustrates the matching-to-sample paradigm used by Sidman to teach reading comprehension, i.e. matching printed words to corresponding pictures, and pictures to printed words. This example (from Sidman, 1977) shows a subject selecting the picture comparison that corresponds to the printed word sample.

Figure 3 overleaf illustrates the relationships taught and tested in Sidman's (1971) study. Prior to the training phase the subject was able to match spoken words (auditory stimuli) to pictures (visual stimuli). He was then trained to choose printed words on hearing the corresponding spoken words. Subsequent test showed that he was also able to match printed words with pictures and name the printed words.

N.B. This figure is not an accurate reproduction of the stimuli used by Sidman and is only intended to give an overview of his paradigm. Apart from using different stimuli Sidman also presented eight comparisons on each trial.

Figure 3


SAMPLE
REQUIRED RESPONSE
RELATIONS ESTABLISHED
PRIOR TO TRAINING
Pig
PIG
TRAINED RELATIONS
PIG
PIG
CAT
EGG
HAT
EMERGENT RELATIONS
PIG
PIG
CAT
EGG
HAT
PIG
Pig!

Sidman's definition of reading in terms of the different types of matching involved makes it clear that textual behaviour (visual-auditory matching) is only one aspect of reading. According to his description there are three types of matching involved in reading:

1. "oral reading" or "oral naming of words" (visual-auditory matching), where the child gives appropriate vocal responses to printed words.
2. "auditory-receptive reading" (auditory-visual matching), where the child chooses a printed word on hearing its spoken counterpart.
3. "reading comprehension" (visual-visual matching), where the child matches printed words to corresponding pictures.

Sidman did however find that he did not need to teach all these relationships directly, but that some could emerge indirectly. His original study (Sidman, 1971) was of one young man, who prior to any experimental training, could name pictures and pick out the correct pictures on hearing their names. In other words, he was capable of matching spoken words (auditory stimuli) to pictures (visual stimuli) and vice versa. He was then trained to choose printed words on hearing the corresponding spoken words. Training consisted of repeated matching trials with feedback on every trial. (See Figure 3 for illustration of these relationships.) The interesting outcome of Sidman's study was that the subject, without any further training, was also able to match printed words to pictures, i.e. pass a reading comprehension test. In addition he could also name the printed words. During these test trials the subject received no feedback. In other words, the training trials had resulted in new untaught responses (See Figure 3)

These studies created excitement among behaviourist psychologists because they showed transfer of learning from an auditory receptive task to other tasks, including a verbal production task. As discussed above, this kind of transfer is not readily predicted by the three-term contingency and Skinner's account of verbal behaviour.

Sidman carried out several subsequent studies (e.g. Sidman & Tailby, 1982; Sidman, Kirk & Willson-Morris, 1985) which led him to conclude that these emergent relations are not restricted to printed words and pictures, but also occur between other visual stimuli, e.g. geometrical shapes. There are non-reading counterparts to all three types of matching, and whether it is reading or not is determined by the type of stimulus, i.e. absence or presence of printed words.

Type of matching	Reading	Non-reading
Visual-auditory	Name printed word	Name picture
Auditory-visual	Pick out printed word	Pick out picture
Visual-visual	Printed word-picture	Picture-picture

In 1982 Sidman together with Tailby formalised a procedure for testing for relations that emerge as the result of conditional discrimination training with perceptually different stimuli (Sidman & Tailby 1982). This procedure is based on the mathematical criteria for equivalence. "In logic and mathematics an equivalence class is a set of numbers or propositions in which every element is related to every other element by an equivalence relation" (Saunders & Green 1992. p. 230). The three defining properties of an equivalence relation are reflexivity, symmetry and transitivity (explained in detail below).

The equivalence testing procedure

Subjects are taught conditional discriminations via matching-to-sample procedures (as described above) and are then tested on untaught discriminations. These tests are carried out without contingent feedback. To control for pre-experimental matching experience the stimuli usually consist of geometrical shapes. The stimuli are arbitrarily divided by the experimenter into classes, usually denoted by numbers, 1, 2, 3, etc. The class members are usually denoted by capital letters, A, B, C, etc. So for example, if there are two classes consisting of three stimuli each, one class contains the stimuli denoted as A1, B1 and C1, one and the other class consists of A2, B2 and C2 stimuli (see Figure 4). As class membership is arbitrarily determined by the experimenter, and does not depend on physical features common to the stimuli within a class this kind of matching is referred to as arbitrary matching-to-sample.

The conditional discrimination training trials are usually referred to as A-B matching trials, where A stands for the sample and B stands for the comparison (see pp. 5-6 above for the sequence of a trial and Figure 4 overleaf for a diagram of taught and tested relationships). So for example, when A1 appears as sample, B1 is the correct comparison and B2 the incorrect one. In other words, subjects are taught to match B1 to A1 and B2 to A2. Training trials, with feedback on every trial, are repeated until a pre-determined criterion is reached, usually 90% correct responding. The stimuli denoted as C (see Figure 4) can then be introduced and the subject trained to carry out B-C matching, where B-stimuli are samples and C-stimuli are comparisons, i.e. subjects are taught to match C1 to B1 and C2 to B2. The training then establishes the following conditional relations; A1-B1, A2-B2, B1-C1, and B2-C2. Tests for reflexivity, symmetry and transitivity are then carried out to determine if the relationship between the stimuli are also equivalence relations.

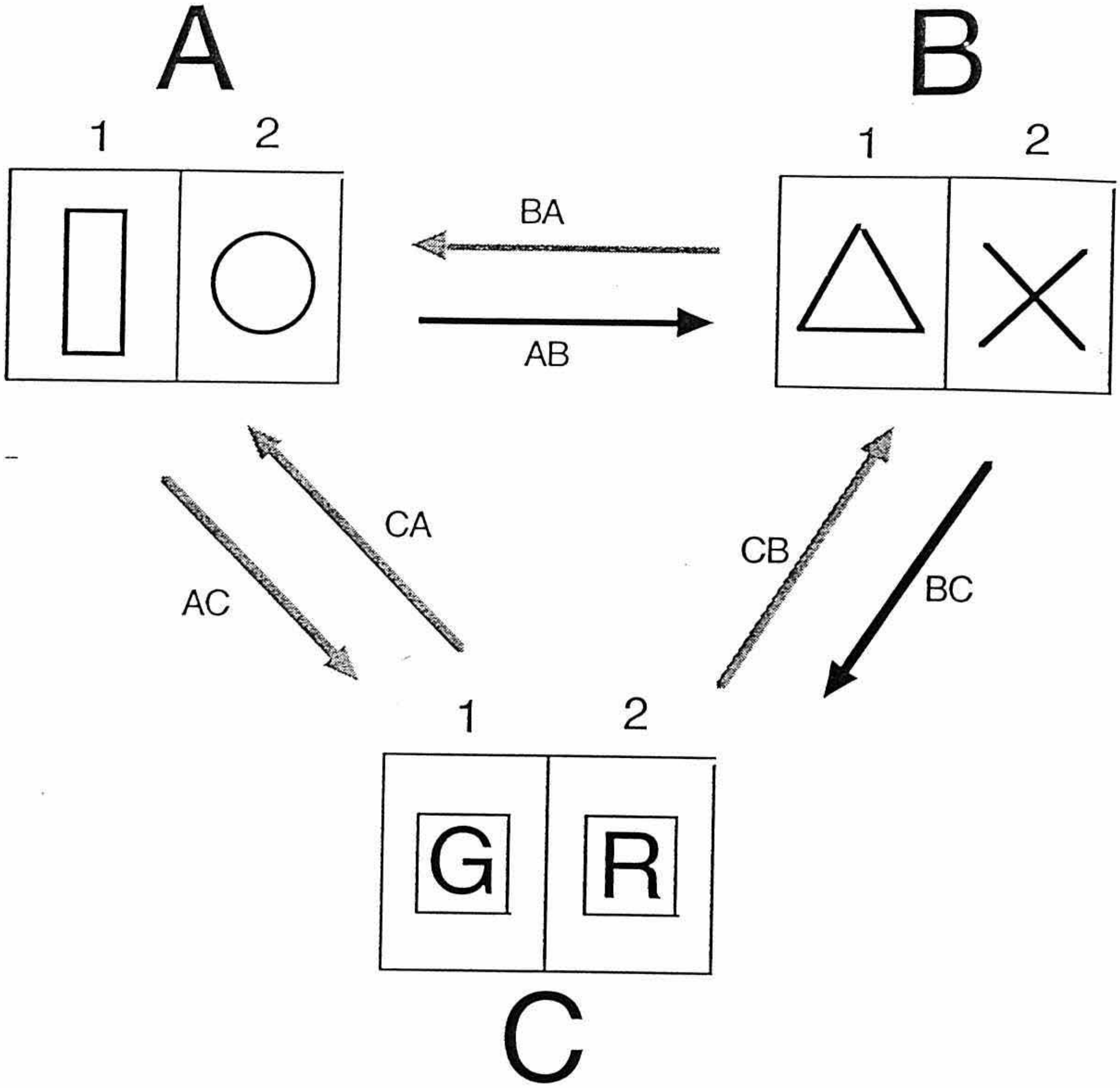


Figure 4 shows the relations between stimuli in an equivalence paradigm. The relations represented by the black arrows are taught during reinforced matching to sample procedure as described in the text above. The relations represented by the grey arrows are then tested for in the absence of contingent reinforcement. In other words, A-B and B-C are taught and B-A, C-B, A-C and C-A are then tested for. The B-A and C-B are tests for the symmetrical counterpart of the taught relations; the A-C test is a test for transitivity and the C-A test is a combined test for symmetry and transitivity. All relations need to be present for the stimuli to be called equivalent.

The stimuli in this example are those used by Hird and Lowe (1985) but the relations trained and tested in their study were different.

Reflexivity describes a conditional relationship that holds between a stimulus and itself, and can be determined by identity matching; matching A1 to A1, B1 to B1 and so on. However, Sidman argued that reflexivity can only be determined by generalised identity matching. As already mentioned this means that matching must transfer to other types of stimuli.

Symmetry is the relation in which the order of the stimuli is reversible, described as "functional sample-comparison reversibility" by Sidman & Tailby (1982). The previously trained relations described above are said to be symmetrical if subjects perform the following matches: B1-A1, B2-A2, C1-B1, and C2-B2.

Transitivity describes the relationship that holds between the A and C stimuli and is demonstrated if subjects match A1-C1 and A2-C2.

The transitive relation can also be symmetrical, C1-A1 and C2 -A2, and Sidman and Tailby (1982) referred to this as a simultaneous test for symmetry and transitivity. Simultaneous tests have subsequently been called *combined* (Catania, 1984a) or *global* (Sidman, Willson-Morris & Kirk, 1986) tests for equivalence, but are now often simply referred to as equivalence tests (e.g. Sidman, 1990; Sidman, Wynne, Maguire, Barnes, 1989). However, as Saunders & Green (1992) have pointed out, this may be misleading, as it suggests that an equivalence class consists of four different types of conditional relations: reflexive, symmetric, transitive and equivalence relations. This is clearly not the case as an equivalence relation is defined by the other relations.

Importance of the equivalence paradigm

There are both practically and theoretically important aspects of the stimulus equivalence paradigm, but the major importance of equivalence studies lies in the fact that class membership cannot be determined by any perceptual properties, because there are no perceptual similarities between the sample and the corresponding comparison. In other words, an equivalence class is a special type of stimulus class where membership is based on learned relations between the stimuli, rather than on their physical characteristics. Responding is controlled by the relationship between stimuli rather than by any intrinsic quality of the stimuli.

Theoretical implications

Prior to Sidman & Tailby (1982) behaviourists had been studying stimulus class formation in a less systematic way. The term *equivalence* was used in a different, less well defined way, meaning "belonging to the same class", or "having the same or a similar effect". This definition can be termed "assumed equivalence" because equivalence was often assumed on the basis of trained relations alone and there were no tests for the emergence of untrained relations (Green et al. 1990). The test developed by Sidman and Tailby on the other hand allows us to distinguish between trained and emergent responding, i.e. to study the emergence of novel behaviour.

Stimuli which belong to the same class on the basis of having the same or similar effect have been termed "functionally equivalent" (Sidman et al, 1989) because transfer of function is seen as evidence of the stimulus class. Stimuli are functionally equivalent if they control the same response, and if changes in the controlling function of one leads to corresponding changes in the other. Functional equivalence is, at least procedurally, different from "equivalence" defined by mathematical criteria. Sidman has emphasised the distinction by referring to the latter as "stimulus equivalence", which is demonstrated when "explicitly taught conditional relations give rise to untaught conditional discriminations that show the original relations to be reflexive, symmetrical and transitive" (Sidman et al, 1989). Sidman argues that the two types are behaviourally different because functional classes can lead to equivalence classes but do not always do so. This has been shown for example in a study by Sidman et al (1989), where a subject formed functional classes without being able to respond in terms of mathematical equivalence relations. Catania, Horne & Lowe (1989) have argued that the reverse is less likely to occur; suggesting that if stimuli are treated as mathematically equivalent, then transfer of function ought to occur. However, a study by de Rose et al (1988) suggest the possibility of the emerge of stimulus equivalence without functional equivalence. These authors also argue that it is not clear if entirely new functions given to members of pre-existing functional classes will transfer through these classes in absence of equivalence relations.

The present author recognises that there may not be a clear cut distinction between functional and equivalence classes, but, to avoid confusion, for the remainder of this thesis the term "equivalence" will be used synonymously with "stimulus equivalence" as defined by Sidman.

Equivalence research has been of great interest to psychologists working within a behaviourist framework because it seems to provide an account for "apparently novel behaviour that (a) occurs without an explicit reinforcement history and (b) cannot be explained by primary stimulus generalisation" (de Rose et al. 1988). It has been suggested that equivalence research may provide a context for the empirical analysis of language development, both semantics and syntax (e.g. Bush, Sidman & de Rose, 1989; Devany, Hayes & Nelson, 1986; Lazar, 1977; Lazar & Kotlarchyk, 1986; Spradlin, Cotter & Baxley, 1973; Sidman et al, 1986; Sigurdadottir, Green, & Saunders, 1990; Vanbiervliet, 1977), and for the formation of arbitrary concepts (e.g. Green, 1990).

Below follows an overview of the implications of equivalence studies to the study of language and concept development .

Concepts

In abstract concepts the basis for categorisation is the learned relations between stimuli, rather than shared physical features, i.e. the relationship is as arbitrary as the relationship between the members of an equivalence class. The relationship between words and objects and events is also arbitrary in this sense. It is possible that the equivalence paradigm can provide a procedure for studying how and when the ability to form abstract categories develops (Dixon & Spradlin, 1976), including any possible relationship between the development of language and the development of concepts.

Studying the expansion of equivalence classes may have relevance to conceptual and verbal behaviour. "For example a child who on different occasions has been told to label tulips and daisies as *flowers* may come to treat both types of flowers equivalently. Therefore, if the child learns to provide the label *plant* for one flower, that label may also generalize to the other flower. Additional contingencies will also teach the child that although tulips and daisies may control a common response in one context, their specific labels are nor freely substitutable. If they were, of course, there would not be two different labels." (Wetherby, Karlan, & Spradlin 1983 p.77)

Equivalence studies may therefore allow experimental studies of Vygotsky's view that we cannot form abstract concepts in the absence of language (Vygotsky, 1986).

Language

The equivalence paradigm can provide a method for distinguishing semantic behaviour from non-linguistic matching. Equivalence tests allow us to determine "whether matching-to-sample is linguistic performance or whether it represents an arbitrary stimulus-response chain that has no linguistic relevance" (Sidman, 1977). In relation to Sidman's original tasks, this means that printed word - picture matching can only be defined as reading comprehension if the word and the picture are related by equivalence relations, rather than mere conditional relations. Reading involves all the matches, including saying (or signing) the word. The most important thing is that these matching responses must be generalised skills, i.e. not trained for each set of stimuli or each relationship.

Language is stable over time, therefore if extrapolation from equivalence studies are valid, equivalence classes formed during training should also be stable over time. Result from studies carried out by Saunders and co-workers (Saunders, Wachter & Spradlin, 1988; Saunders, Saunders, & Spradlin, 1990) show that equivalence relations like linguistic relations can remain over prolonged periods of time without overt practice and without explicit feedback. Their subject's performance showed development of 112 derived relations, and he demonstrated stable performance on equivalence tests after 2 and 5 months (Saunders et al, 1988). On tests carried out 2 and 3 years after original study the subject's performance was identical to that on the first test. Saunders et al therefore concluded that "the current results strengthen the suggestion that equivalence classes of arbitrary visual and auditory stimuli may provide an excellent experimental analogue for research on some aspect of language." (Saunders et al 1990, p.302)

Sidman's original studies suggested that words are not stimuli and responses in the same sense as other stimuli and responses, i.e. that the three-term contingency can not capture all aspects of language. In other words, equivalence studies seem to provide evidence against Skinner's view that words are functionally related to their antecedents and consequences in the same way as other responses. This is particularly important for an account of semantics within a behaviourist framework.

Semantics

It has been argued that words and the things they stand for are "functionally substitutable" in the same way as the stimuli in an equivalence class (Devany et al, 1986; Sidman, 1990; Wulfert & Hayes, 1988). In terms of the matching-to-sample procedure, this means that members of an equivalence class are functionally interchangable because each can function as sample or comparison for all other stimuli within that class, i.e. the relationship is bi-directional. As argued previously, a similar bi-directional relationship seems to hold between words and the objects and events they stand for, in that a word can function as either a discriminative stimulus or as a response for a particular object or event. The argument in the equivalence literature is that "such bi-directional relations among stimuli may provide a basis for referential meaning: the word is a symbol for the referent and the referent is the meaning of the word because both are members of the same equivalence class. In this sense, stimulus equivalence transforms nonlinguistic conditional discriminations into semantic processes" (Wulfert & Hayes, 1988). Nonverbal events are not interchangeable in this way. For example, lever presses and key pecks are not analogously interchangeable with lights and tones (Saunders et al, 1990).

There are several studies showing that contextual control of transfer of function can be imposed after equivalence classes have developed (see Lynch & Green, 1991 for review). This is seen as analogous to language acquisition and the argument is that the conditional control of equivalence classes may provide an understanding of how the same word can mean different things in different contexts. Contextual control of word meaning is necessary to prevent identical words with different meaning entering into the same class. Many words function as nouns in one context and verbs in another, e.g. *fly, saw, dump, despair, desire, syringe* etc. These words are members of different equivalence classes; e.g. *"fly"* may become related to *"bee", "mosquito", "ladybird"* in one class and to *"swim", "run", "crawl"* in another and without some kind of contextual control these words may all enter into one class (Lynch & Green, 1991)

Syntax

The emergence of several untrained relations following training of only a few possible relations is seen as important for understanding the generative nature of language. The suggestion is that transfer of function through equivalence classes may parallel one way in which novel utterances are generated and ordered in different ways without direct training. "It seems plausible that a speaker could produce novel utterances by substituting equivalent stimuli for stimuli that occurred in specific ordinal positions on one or more phrases taught directly" (Sidman et al, 1986, p.287). In other words, novel sentences can be produced as the result of leaning grammatical classes; we don't need to learn all possible individual word sequences, we only need to learn class sequences. For example children in an English speaking community learn that certain words are members of an equivalence class of nouns and other words are members of a class of adjectives, and are taught to combine some of these words, e.g. *"big house", "red car", nice doggy"*. They might then generate a number of grammatically correct utterances by substituting other members of the equivalence classes in the same ordinal positions as those in the phrase that was taught, e.g. *"red house", "big doggy"*. This kind of transfer of function within stimulus classes has been demonstrated experimentally (see Green, Sigurdadottir, & Saunders, 1991 for review).

Animal-human differences

Equivalence studies, like studies into performance on schedules of reinforcement, have highlighted differences between the operant behaviour of animals and humans. Human subjects seem to have little problem responding according to equivalence relations, but to date there has been no undisputed demonstration of stimulus equivalence in non-humans (see Hayes, 1989; Hayes, 1991; Hayes & Hayes, 1992 for review). Studies, such as McIntyre, Cleary & Thompson (1987) and Vaughan (1988) which have been cited as evidence in favour of animals' ability to respond according to equivalence relations have been criticised on methodological grounds (Hayes, 1989; Saunders, 1989). The question of whether or not animals are capable of responding in this way is an empirical question which at present remains unanswered and the focus for much debate. It is however clear that non-humans do not show equivalence responding as readily as human subjects do. The equivalence paradigm therefore forms part of investigations into animal-human differences and is unique in the behaviourist tradition in that the procedure was originally developed with humans, and extrapolation to animals has then been attempted.

Practical implications

Equivalence studies can have major educational implications, e.g. increasing literacy and teaching arbitrary concepts, especially since matching-to-sample is already a widely used teaching procedure, both in regular and special education class rooms, including language training for severely language deficient individuals. The equivalence test itself can be part of the teaching process in that subjects acquire new stimulus-control relations without explicit reinforcement.

As described above, equivalence research has provided a better understanding of basic units of conceptual and verbal behaviour and it has been suggested that this may aid in the development of specific techniques for teaching reading and other verbal skills (Joyce & Wolking, 1989) This view is succinctly summarised in the following quote from Sidman and his co-workers:

"A more complete understanding of the conditions responsible for this remarkable outcome will undoubtedly improve the efficiency of our techniques for teaching pre-academic skills, simple vocabularies, and perhaps even advanced linguistic skills." (Sidman et al, 1986).

Many early studies showed the usefulness of the equivalence paradigm for teaching reading skills to adults with mental handicaps (Spradlin, Sidman & Cresson, 1973; Sidman, Cresson, & Willson-Morris, 1974; Spradlin & Dixon, 1976). Subsequent replications showed that the paradigm is equally useful for teaching normally developing children (Joyce & Wolking, 1989) and profoundly hearing-impaired preschool children (Osborne & Gatch, 1989).

In addition, the equivalence paradigm can facilitate investigations into individual differences regarding class formation. Some individuals, particularly those with mental handicaps, can have problems forming stimulus classes even after extensive training (e.g. Lazar, 1977; Dixon & Spradlin , 1976), and the paradigm can be useful for investigating what kind of training can be effective in establishing equivalence classes; to find out if failure is due to a non-remedial deficit, or if equivalence relations can be established through teaching.

Other practical implications include the teaching of pre-mathematical skills (Gast, VanBiervliet & Spradlin, 1979). There are four types of stimuli involved in pre-mathematical skills: sets of objects or events, spoken numbers, printed numbers and printed number words. Equivalence relations between these stimuli is the basis for mathematical operations, e.g. 3; XXX ; the printed word "three" and the spoken word "*three*" must be treated as being equivalent. In a study by Gast et al. (1979) children, who could already count and use spoken and printed numerals, were taught names for printed number words in an auditory-receptive task. They were than able to match printed number words to numerals, and match printed number words to sets without further training.

The paradigm has also been employed in sign language learning. Studies with severely mentally handicapped adults with no productive speech has shown that learning sign language can facilitate learning to read as well as to speak if sign language, speech, pictures, and/or printed words are made equivalent (Clark, Remington, & Light, 1986; Remington & Light, 1988; Van Biervliet, 1977). It has also been useful in the study of social classifications (Watt, Keenan, Barnes, & Cairnes, 1991). Many important social classifications are not based on physical characteristics, such as age, height, race, but on the basis of roles involving contingencies. The paradigm can therefore be of particular importance for teaching people with learning difficulties, a population that is known to have problems with learning both social and cognitive skills.

Summary

The equivalence paradigm provides a method for studying generalisation that is not based on physical properties of stimuli. This has implications for studies into concept and language development and the interaction between the two. There is agreement in the field that stimulus equivalence is important because it may allow us to account for aspects of language that traditional account of verbal behaviour cannot deal with, and to do this within existing functional laws.

One major controversy within the field concerns the possible causal relationship between language development and the ability to respond according to equivalence relations.

This and many other theoretical and practical questions about the structure and functions of equivalence classes remain unanswered. So far very little is known about variables that facilitate or hinder development of stimulus equivalence. The aim of the experiments reported in this thesis is to further our understanding of the phenomenon by investigating the role of language, and particularly the role of stimulus naming, in the formation of stimulus equivalence classes.

Prior to discussing these experiments a review of Sidman's original studies and the questions they raised is presented in chapter Four.

CHAPTER FOUR

THE ROLE OF RESPONSE MEDIATION THROUGH COMMON NAMING

Review of early equivalence studies

Sidman's original matching-to-sample studies showed that training on visual-auditory matching can lead to the emergence of untrained visual-visual matching, and he suggested that "the auditory-visual equivalences involved in simple auditory comprehension transfer in some way to the purely visual equivalences (printed words and objects) involved in simple reading comprehension" (Sidman & Cresson Jr., 1973, p.515). This left unanswered the question of how this transfer comes about and Sidman therefore set out to investigate the phenomenon further and in particular why it happens. His first line of inquiry was the possibility that visual-visual matching emerged as the result of mediation by words spoken either by the experimenter or the subject.

Early laboratory studies into the development of stimulus classes consisting of dissimilar stimuli was based on verbal mediation theory (Kendler, 1972; Miller & Dollard, 1941; Osgood, 1953). These studies consisted of simple discrimination learning where subjects were taught to utter one verbal label in the presence of each of two different stimuli, and a different label in the presence of two other stimuli. In other words, two classes were created by the experimenter, each class consisting of two stimuli, which had been given the same label. After labelling training the subjects were asked to carry out a two-choice discrimination task with one stimulus from each class. One stimulus was designated as correct choice (S+), and the other as incorrect choice (S-), and subjects were reinforced for choosing S+. Subjects were then presented with the other two stimuli, to test for a generalised discrimination response. If subjects selected the stimulus with the same label as the positive stimulus in the previous task, acquired stimulus equivalence was said to be demonstrated. This was then explained in terms of response mediation, on the assumption that classes were formed because the stimuli had become associated with a common response.

Sidman set out to replicate his studies and to investigate the possibility that visual-visual matching (picture-printed word) emerged because the subjects responded with the same spoken word to both picture and printed word, i.e. response mediation through common naming. In his original studies subjects who were already able to name the pictures, were taught to choose printed words in response to words spoken by the experimenter but were not required to name (read) the words. However, later tests showed that they were clearly able to do so, and a possible mediating function of the names could therefore not be ruled out. Sidman argued that perhaps subjects learned oral reading indirectly as a by-product of auditory-receptive reading and he and his colleagues therefore set out to eliminate the possibility of naming emerging as the result of "receptive training".

The first study (Sidman, Cresson Jr., & Willson-Morris, 1974) was of a mentally handicapped boy aged 14, who was taught auditory word-picture (A-B) and picture-printed word (B-C) matching, i.e. he was not taught the relationships between auditory words and printed words in order to prevent him from learning to name the printed words. He could however name the pictures prior to the experiment. Figure 5 shows the paradigm employed in this study.

Figure 5

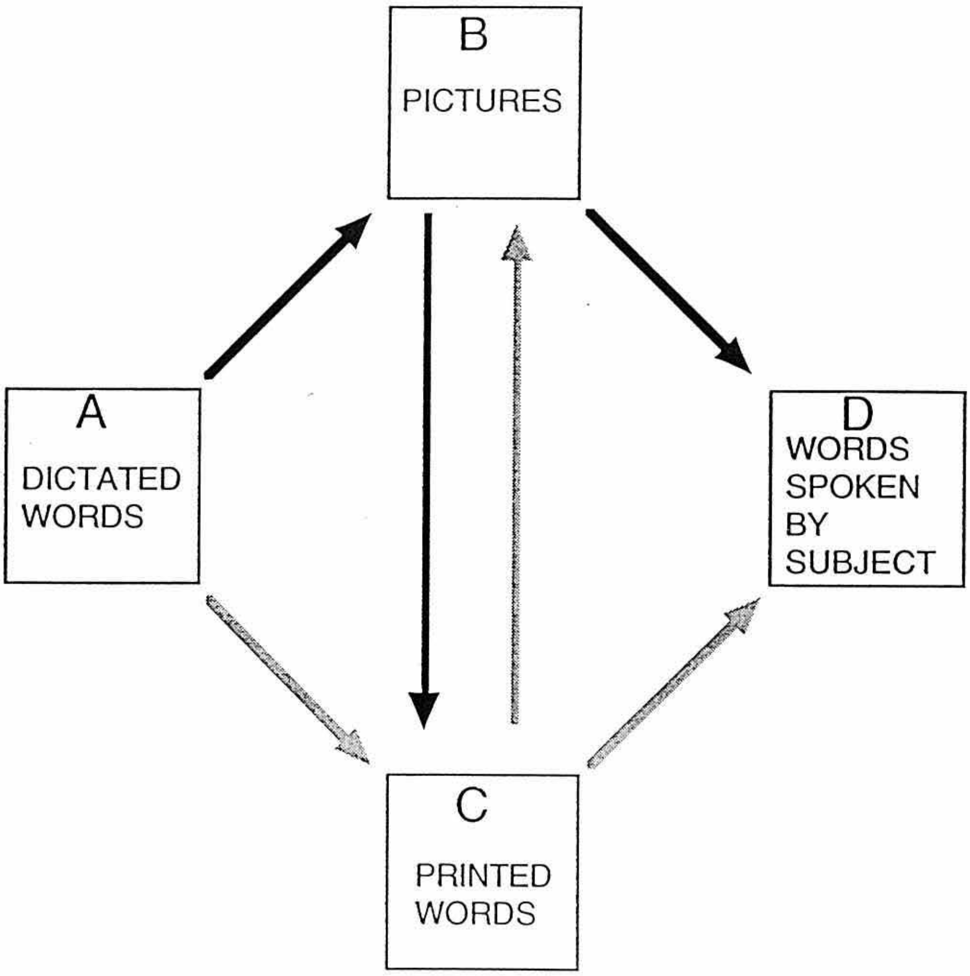


Figure 5 show the design employed by Sidman, Cresson & Willson Morris for one of their subjects. The relations represented with the black arrows had either been established prior to the study (B-D) or were explicitly taught to the subject (A-B an B-C). The grey arrows show the relationships which were tested for after training. The subject responded 100% correctly on C-B. Performance on A-C test was 75% correct and 50% on C-D.

After extensive training (the whole study took 3.5 years) the subject was able to perform auditory word-printed word (A-C) and printed word-picture (C-B) matching. He had initially not been able to read any printed word but although his performance on oral reading (C-D test) improved during the study it remained at 50% level. Sidman et al interpreted their results in terms of stimulus mediation rather than response mediation, arguing that the pictures (B-stimulus) mediated between the auditory words and printed words. This may of course have been the case, but verbal response mediation cannot be ruled out as the subject was able to name the pictures. In other words, the picture names rather than the actual pictures may have mediated the emergent A-C performance. It is less likely that the C-B relations were mediated by spoken words as the subject did not perform above chance level on reading tests.

In subsequent studies Sidman attempted to avoid this possibility by using visual stimuli that his subjects were unfamiliar with, such as Greek and Hebrew letters. He also increased the number of stimuli within each class while maintaining the basic approach of auditory-visual followed by visual-visual training. For example, Sidman et al (1986) employed six stimuli sets, where set-A consisted of dictated Greek letter names and sets B, C, D, E and F consisted of printed Greek letters. Two normally developing 5-year old children and four mentally handicapped men aged 19 -20 were trained to match sets A-B and A-C (auditory-visual matching) and to match sets D-E and D-F (visual-visual matching). They were then tested on BC, CB, EF, FE, ED, FD, in that order. They were also given post-experimental oral naming tests of all stimuli. The results from this and similar studies (Sidman and Tailby, 1982; Sidman et al, 1985) showed that subjects often formed equivalence relations without using common naming for all the stimuli in a class and also that some subjects who failed equivalence tests did use consistent names during naming tests. Sidman and colleagues (Sidman et al, 1986) therefore concluded that naming is neither necessary nor sufficient to establish equivalence relations, and suggested that "the emergence of stimulus equivalence and the emergence of common names for members of a class may be independent consequences of the training procedure" (ibid, p.16). The role that common naming may play in success on equivalence tasks will now be discussed in more detail, starting with the question of whether common naming is necessary or not.

Is common naming necessary?

Although differential responses can function as mediators, matching-to-sample tasks do not require subjects to make differential responses to the different stimuli. However, subjects who are trained on auditory-visual matching may of course spontaneously name the visual stimuli as a result of having heard the names spoken by the experimenter. The main question raised by these early studies was whether or not the equivalence phenomenon could be demonstrated if the task involved purely visual stimuli, i.e. could be demonstrated in the absence of dictated names as class members. The argument was that success on equivalence tests employing unfamiliar visual stimuli, which had never been paired with auditory stimuli and which subjects did not name, would provide strong evidence against the mediating role of naming. A number of studies, both with mentally handicapped and normally developing subjects, seem to indicate that equivalence relation can emerge with purely visual stimuli without subjects assigning common names to each class member (e.g. Lazar, Davies-Lang & Sanchez 1984: ; Spradlin, Cotter, & Baxley, 1973; Spradlin & Dixon, 1976; Stromer & Osborne, 1982; Van Biervliet, 1977; Gast, VanBiervliet & Spradlin, 1979; Wetherby et al, 1983)

Sidman has suggested that even when subjects do name the stimuli it is possible that the "naming responses may be products of the naming test itself, playing no role in the establishment of equivalence relations" (Sidman et al, 1986, p.16). It is however difficult to evaluate the possible role of stimuli naming in these studies because the conclusions are based on retrospective reports which are open to distortion and misinterpretation. For example, Sidman interpreted subject hesitancy about naming the stimuli after the experiment as evidence that these stimuli had not been named during the matching task. Any firm conclusions about the role of naming based on post-experimental naming tests are however unjustified because such tests have been found to be unreliable methods of assessing what subjects say during the experiment. For example, Hird & Lowe (1985), recorded the spontaneous verbal behaviour emitted by five subjects during training and testing stages. All the subjects named the stimuli and described the relationship between them. There were however often great differences between these names and the ones used when questioned by the experimenter afterwards. As Stoddard and McIlvane (1986) have argued :

"Suppose a given subject characterizes all the stimuli in the entire visual classes with a common descriptive adjectival term, like 'rounded' or 'pointing that way' perhaps derived from primary stimulus generalisation . . . Alternatively suppose that a common descriptive term such as 'Set 1' vs 'Set 2' was applied, as we do in talking about stimuli within classes. .When asked the question "What is it?", in relation to a given stimuli, perhaps the subject's verbal conditioning history had not prepared him or her to use descriptive terms as labels, leading to "I don't know" (its name) responses on the naming tests. Would other methods of testing have evoked descriptions?" (ibid, p.157)

Recording of subjects' spontaneous verbalisations during the experimental sessions can establish if subjects *did* assign names to the stimuli. The problem is that we can never exclude the possibility that verbally able subjects may have named the stimuli covertly. In other words, we can never be sure that they *didn't* name the stimuli. The question can only be settled by studying animals and pre-verbal infants. To date there is no evidence that animals can respond according to equivalence relations (See Hayes, 1989 for review). There have been no reported studies with pre-verbal infants, probably because of the immense methodological problems involved when working with this population. At present it is therefore not possible to determine if stimulus naming is a necessary requirement for equivalence responding.

Sidman, recognising that we have no 'hard' evidence, is prepared to accept 'soft' data, and has suggested that equivalence responding may be "a given".

"The three-term contingency is a stimulus-response-reinforcer relation, and the four-term contingency adds a stimulus-stimulus relation. Just as the conditioned reinforcement function appear at the level of the three-term contingency, equivalence relations appears at the level of the four-term contingency. And just as the stimulus functions, reinforcement, discrimination, conditioned reinforcement, and conditional discrimination represents unanalyzable primitives in the description of behavior, equivalence may represent yet another primitive." (Sidman, 1990, p.111)

"Equivalence relations emerge from conditional discriminations for the same reason our behavior is reinforcable, and for the same reason our behavior is controllable by discriminative and conditional stimuli -- because contingencies of survival have made us that way." (ibid., p. 113)

But even if we accept that the capacity for equivalence responding is innate, and the result of evolution, in the same way as the capacity for walking upright and speaking is innate, it is still useful to discover the circumstances under which it develops in the life-history of the individual. It is also important to discover why equivalence sometimes fails to emerge. As discussed in chapter Three, an understanding of factors which may control the formation of equivalence classes can have important practical and theoretical implications regarding our understanding of areas such as language, meaning, concept development and reading and the interaction between them.

The discussion will now turn to consider if common naming, although not a necessary requirement for responding according to equivalence relations, may be sufficient for this type of responding.

Can common naming be sufficient?

Sidman generalised his conclusions regarding the mediational role of common naming to other aspects of language and argued that, as there is no evidence for the former, language does not play a role in the emergence of stimulus equivalence. However, verbal mediation is not necessarily restricted to common naming. Studies showing correlation between performance on equivalence tasks and level of language development (Devaney et al, 1986; Beasty & Lowe, 1985), indicate that language development and the ability to form equivalence classes are closely related, but gives us no clues to the nature of the relationship as there are three possible conclusions. It is possible, as Sidman has argued (Sidman 1990), that equivalence is a requisite for language learning, but it may be the case that some degree of language development is necessary for the formation of equivalence classes (Beasty & Lowe, 1985; Dugdale & Lowe, 1990). Alternatively, it is possible that equivalence responding and verbal behaviours are two different facets of a single behavioural competence (Catania et al 1989; Hayes, 1989). This remains an ongoing debate, that will perhaps never be satisfactorily resolved.

There is however agreement that naming and other aspects of language can facilitate responding in terms of equivalence relations. (Mackay & Ratti, 1991; Saunders, 1989; Sidman, 1990; Spradlin & Saunders, 1986). It is therefore perhaps more profitable to concentrate on investigating the condition under which this occurs and the experiments reported in this thesis (chapters 9 - 11) were designed for that purpose.

If language has a mediating function - what precisely is that function?

Performance on equivalence tests may depend on how subjects describe the stimuli or the relationship between them during baseline training. Talking about the task can also help performance on baseline task. Fjellstrom (1988) for example showed that young children (aged 4 years 5 months to 5 years 4 months) who were initially unable to carry conditional discriminations on matching-to-sample task were able to do so after being taught to overtly ask themselves as series of questions about the stimuli and answer their own questions. When told not to use self-questions and answers, performance deteriorated. They were then taught covert self-questions and answers, and performance improved again.

Beasty & Lowe (1985) found that descriptive labels of stimuli can facilitate equivalence responding. Recordings of the verbal behaviour of their subjects, children aged 2-5 years, showed that the children who passed the equivalence tests had labelled the stimuli during the training phases, using descriptive words such as "up", "green", and "triangle". The children didn't always wait for the comparison to appear to label it, for example, given a vertical line as a sample and a green colour as comparison, they would often say "up - green" in presence of the sample only. Beasty and Lowe therefore argued that the children had in fact described the relationship between the stimuli and that this mediated the emergence of equivalence. They supported this conclusion further by showing that children who initially failed equivalence tests, passed after being taught to label the relationship between samples and comparisons, using these kinds of descriptions. For example, subjects who were taught to say "up-green" in the presence of a vertical line as sample and a green square as comparison, and taught to say "up - triangle" to a line and a triangle, were later able to match the green stimulus with the triangle without further training.

However, as Dugdale (1988) has pointed out, these results can also be interpreted in terms of common naming. For example, the word "up" may have functioned as a common name for both the green stimulus and the triangle in the example above. It is therefore possible that common naming may be sufficient for the emergence of equivalence. Dugdale set out to investigate this further, by teaching common names for the samples and comparisons outside the matching task to children who had previously failed to learn the baseline A-B task. The stimuli were presented one at a time and the children were taught to say "Omni" to the Set 1 stimuli and "Delta" to Set 2. Following name training the children were not only able to perform the A-B task but they also passed a B-A symmetry test without any further training.

Dugdale and Lowe (1990) have suggested that the words "Omni" and "Delta" had a mediating function because they entered into a symmetrical relationship with the visual stimuli. The children were taught the uni-directional relations between the words (denoted as set-X) and the visual stimuli sets A and B, i.e. A-X and B-X (see Figure 6). The argument is that the symmetrical counterparts of this, X-A and B-X emerged as a result and that A-X and X-B resulted in correct responding on A-B, likewise B-X and X-A resulted in B-A (see Figure 6). In other words, stimulus-stimulus relations emerged through mediation via stimulus-response symmetry between the spoken words and visual stimuli.

Figure 6

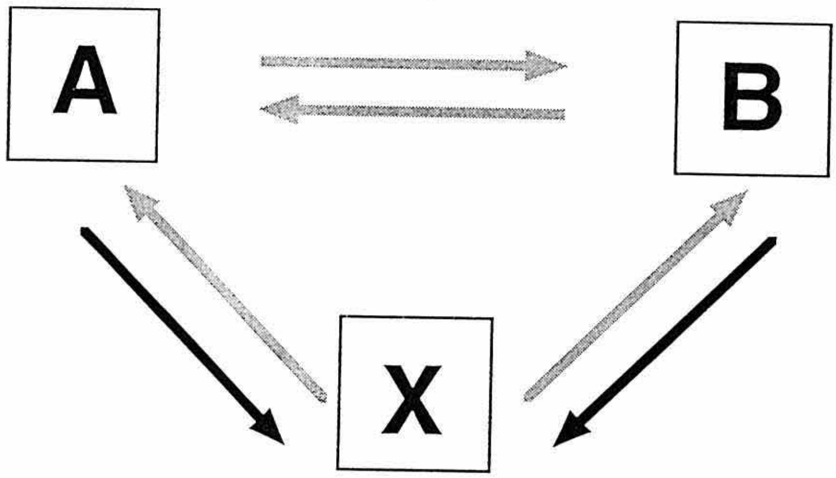


Figure 6 shows the designed employed by Dugdale and Lowe (1990) in teaching subjects to label visual stimuli with the spoken words *Omni* and *Delta*. The letters A and B stand for the visual stimulus sets and the letter X stands for the words. The black arrows depict the relationships A-X and B-X which subjects acquired through reinforced training trials. The grey arrows show the relationships which Dugdale and Lowe argue emerged as the result of this training. The subjects had previously received reinforced A-B training trials but had not learnt the task. The B-A and A-B relations were directly tested for, and the authors' suggestion is that subjects responded correctly on these tests because the spoken words mediated the responses to the visual stimuli.

In considering where this type of symmetry originates, Dugdale and Lowe (1990) suggested that it may occur as the result of numerous exemplars of reinforced stimulus-response symmetry during early language acquisition, when children are reinforced for saying words in response to objects and events and also to point to or otherwise carry out responses involving those objects and events in response to hearing the words.

"One possibility is that stimulus-response symmetry emerges in the course of the training that occurs naturally within the developing child's linguistic environment. During the early stages of language learning, the child is taught language production and comprehension, i.e. to function both as speaker and as listener. More specifically, the child is taught to say a particular word (or produce a particular sign) conditional upon a stimulus (the referent) and to do the reverse, i.e. select that stimulus conditional upon the spoken word (or sign). The child receives an extraordinary extensive history of reinforcement for responding correctly to innumerable exemplars of such stimulus-response symmetry. Perhaps, then, naming relations emerge in childhood as one is repeatedly exposed by the verbal community to conditions in which stimulus-response reversals are reinforced." (ibid. p.135)

This view can account for animal-human differences observed on matching-to-sample tasks. If we assume that human subjects demonstrate stimulus equivalence because they have a history of stimulus-response symmetry, we can explain why animals fail to do so by their lack of any previous symmetrical responding. However, although this account may explain why children are capable of responding in terms of stimulus equivalence it does not explain why they do or do not do so during experimental conditions, i.e. we are still left with questions regarding the controlling conditions for equivalence responding. Explaining equivalence responding by appealing "to derived relations between stimuli and names that are of the same sort as the derived stimulus relations they mean to explain" (Hayes & Hayes, 1992, p. 1388), is unsatisfactory unless we can also account for how the stimulus-response symmetry emerges during the matching-to -sample task.

We do in other words need to consider the controlling variables for performance on equivalence tasks. This issue has been discussed in detail by Steven Hayes (Hayes, 1991; Hayes & Hayes, 1989; Hayes & Hayes, 1992) who disagrees with the "language hypothesis" favoured by Dugdale and Lowe, arguing instead that, although there is a relationship between language development and performance on equivalence tasks, this is not causal. According to Hayes equivalence responding and language are manifestations of the same response pattern, or "relational frame" as he calls it. This pattern or "frame" is the result of early reinforcement history and later responding in accordance with it is determined by contextual cues. The term "relational frame" is intended merely as a metaphor, used as a "semantically convenient description of particular interactions between the organism and the environment". (S. Hayes, 1991)

Details of Hayes' relational frame theory

Hayes's starting point is that, although equivalence formation occurs quite readily during experimental studies, "the interchangability of functions characteristic of stimulus equivalence are not readily shown in most contexts or with most organisms (ibid, p. 20). Sidman described stimulus equivalence as a fourth term contingency and has also argued that a fifth term is needed to explain when and why equivalence responding occurs (Sidman, 1990). The fifth term is the context under which the fourth term (the sample) and the third term (the comparison) enter into an equivalence class; so for example given context X and sample A1 the subject will respond to B1, i.e. the context determines the nature of the relationship between the third and fourth term. If in context X reinforcement is given for matching A1-B1 and A2-B2 and in context Y, A1-B2 and A2 -B1 is reinforced, then X will yield B1-A1 and context Y yield B1-A2. However, as Wulfert & Hayes (1988) has shown the fifth term does not enter into the equivalence relations. If it did, then for example X, A1, A2, B1, and B2 would all end up belonging to one class and the distinctive classes, A1-B1, A1-A2, would break up.

As Hayes points out, equivalence responding must be under conditional control, otherwise everything would become equivalent to everything else.

"If stimulus equivalence occurred automatically whenever conditional discriminations were encountered, eventually the great variety of conditional discriminations in normal life would yield stimulus equivalence among virtually all stimuli. Everything would become one gigantic class. This obviously does not happen, and it is contextual control that prevents it from happening" (S. Hayes, 1991, p.27)

The question then is why do some conditional discriminations lead to stimulus equivalence while others don't. Sidman (1990) has suggested that during development we learn when <u>not</u> to respond according to equivalence relations, rather than learning when to <u>do</u> so. Hayes has considered the issue in more detail and suggests an explanation in terms of higher order type of responding, arguing that stimulus equivalence can interpreted as a special case of what he calls "arbitrarily applicable relational responding".

Arbitrarily applicable relational responding

The term "relational responding" will be discussed prior to explaining what Hayes means by "arbitrarily applicable".

<u>Relational responding</u>

"Relational responding" refers to performance on conditional discrimination tasks where subjects do not respond to some features of the stimuli but to the relationship between them.

Hayes (1989; S. Hayes, 1991) has proposed three characteristics central to the description of the relationship between any stimuli, termed mutual entailment, combinatorial mutual entailment and transfer of function. His account is based on the principle that specification of a uni-directional relationship between stimuli always implies something about the bi-directional relationship between them.

1. Mutual entailment (entail = implied)

If we specify the relationship between A and B we do also imply something about the relationship between B and A. For example, "A is bigger than B", implies "B is smaller than A". One specified relation implies another equally specific relation, so if A is related to B in a certain way then B is also related to A. The specific relationship can of course vary, and can be for example "the same", "opposite", "comparative".

2. Combinatorial Mutual Entailment

This applies when there are more than two stimuli present and the implied (entailed) relationships may not be specific. If we specify the relationship between A-B and B-C then the relationship between B-A and C-B is also specified (mutual entailment), but we may not know anything about A-C and C-A. Whether we know or not depends on the type of relationship. For example, knowing that "A is different from B" and "B is different from C" tells us nothing about the relationships A-C and C-A, which could be "different" or "same". But if "A is the longer than B" and "B is longer than C" then "A is longer than C" and "C is shorter than A", i.e. in this case the relationship is specified.

The nature of the relationship between A-B and B-C does however imply whether or not the relationships A-C and C-A are specified. "Different" for example implies that the relationship between the A-C is not specified, "longer" implies that it is. "We can not always say what the mutual relation is between A and C, but we can say that we cannot say." (Hayes, 1989) The nature of the relationship between A and B may of course be different from that between B and C, e.g. A is bigger than B and B is faster than C.

3. Transfer of function

Given mutual entailment and combinatorial mutual entailment between A, B and C, a given psychological function of A entails functions of B and C in terms of the underlying relations. In other words, if we know the relationship between A, B and C, then we also know how the function of one stimulus will apply to the others. Suppose that subjects are trained on conditional discriminations tasks with three stimuli sets; A, B and C and that A is smaller than B and B smaller than C, and subjects are trained to select the smallest stimulus. Responding will then generalise to other, untrained stimuli, i.e. subjects will always pick the smallest. According to Hayes "the concept of 'smaller than' has been abstracted." i.e. subject's responding is controlled by the relation "smaller than", not by the actual stimuli, but by the relationship between the stimuli.

Arbitrary and non-arbitrary relations

Relational responding which is determined purely by the physical qualities of the stimuli, such as "smaller than" or "longer than" are called non-arbitrary and most living organisms are capable of relational responding based on non-arbitrary characteristics. However, as the stimuli used in equivalence studies have no common physical features, the relationship between them is arbitrary in the sense that it is determined by the experimenter. "arbitrary" meaning dependant on the discretion of a judge.

Hayes' argument is that to respond to non-arbitrary characteristics, organisms need only see stimuli, but to respond to arbitrary characteristics this is not enough. He also points out that to decide if a relationship between stimuli is arbitrary or not we need to specify not only the relation itself but also the relatae; e.g. "a" is shorter than "b" is non-arbitrary if we just look at the physical characteristics of the letters. But if "a" and "b" are treated as symbols the relation can be either arbitrary, e.g. "green is shorter than red", or non-arbitrary; "stick 'a' is shorter than stick 'b'". As mentioned above, Hayes also stresses that arbitrarily applicable relational responding must be under contextual control because

"if relational responding can be applied arbitrarily and if it is not under contextual control, nothing would prevent all types of responding occurring with regard to all events. In other words, mutual entailment , combinatorial mutual entailment and transfer of function must be under contextual control, but if the relationship between the stimuli is arbitrarily defined the type of function which transfer must also be under contextual control."

"Arbitrary applicable relational responding can be brought to bear on any set of stimuli whenever appropriate contextual events bring the relevant history of relational responding to bear." (Hayes, 1991, p.25)

Summary of Hayes' relational frame theory

It is perhaps important to stress again that Hayes uses the term "relational frame", as a metaphor, as a convenient description of "arbitrary applicable relational responding under contextual control". The word "frame" is used to emphasise the idea that this type of responding is not based on the specific stimuli that are related; that the stimuli do not specify the relation.

According to Hayes responding in terms of a "relational frame" has the following characteristics:

i) Responding shows contextual controlled qualities of

a) mutual entailment (specifying relationship between A and B, also specifies relationship between B and A)

b) combinatorial mutual entailment (specifying A-B & B-C, may specify A-C & C-A, but it may not. We will always be able to tell whether it does or not).

c) transfer of function (given the above relationships, if we change the function of one stimulus we will also change the function of the other stimuli).

ii) Responding that is due to a history of relational responding relevant to the contextual cues, and

iii) is neither based on direct non-relational training with regard to the particular stimuli of interest, nor

iv) due to non-arbitrary characteristics of either the stimuli or the relation between them.

Hayes' has further clarified his stance by stressing that relational frames are relations in the environment/organism interaction. "If a relation is a pattern of mutual transformation of stimulus functions, a relational frame is the name for that particular pattern. It is a noun because the structure of English demands it, but it is a situated action. A relational frame is always 'framing relationally'." (Hayes & Hayes, 1992)

He also points out that arbitrarily applicable relational responding is not based on logic, but that this kind of responding "is due to a characteristic history, and is itself the substance of the kind of responding we call logical" (S. Hayes, 1991, p.35). Logic is the result of relational frames taught to us by the verbal community. Logic is not a thing in the non-social world, it is behaviour. Therefore it is up to behavioural scientists to explain logic, not appeal to it as an explanation of psychological events.

Describing stimulus equivalence in terms of relational frame theory

Hayes disagrees with Sidman's view of stimulus equivalence as a fundamental behaviour phenomenon, perhaps even a new behavioural principle, arguing instead that

"The relational control perspective suggests that stimulus equivalence can be interpreted as a special case of a network of relational frames. In this way of thinking equivalence is not a unique phenomenon -- only the most common and fundamental type of arbitrarily applicable relational responding. Equivalence is just the beginning." (ibid, p.17).

"Symmetry is viewed as fundamental to stimulus equivalence because mutual entailment is the basis for the other aspects of relational responding (combinatorial mutual entailment and transfer of functions). The kind of symmetry described in the equivalence literature is a specific instance of the generic quality of mutual entailment. Combinatorial mutual entailment is a more complex aspect of relational responding. It can be thought of as the generic case of transitivity."

Hayes uses the terms "synomy" and "coordination" to describe a relational frame where the specified relation is one of sameness or identity. This is the only type of relation where all the derived relations are the same as the ones specified. In other words, the frame of coordination describes equivalence relations; if A is the same as B, and B is the same as C then A is the same as C, and C is the same as A and B.

Hayes further suggests that a relational frame of coordination is probably the first to be abstracted sufficiently that its application becomes arbitrary and that this "basic frame" is established as the result of early language training. "With enough examples of specifically trained symmetrical responding, and transfer of function in terms of that, a general form of responding may occur". In other words, some kind of general relationship is learnt and word-object symmetry does not have to be trained for every new word. (Hayes, 1991, p.29)

"Suppose a child is shown a pea and told 'this is a pea'. An organism without established verbal abilities may have to learn explicitly that if this object is called a "pea", that a "pea" is also that object. There is nothing in normal processes of stimulus control which would dictate a symmetrical relation between the pea and the word "pea". The child told "this is a pea", however, does not arrive in this situation as a tabula rasa. Various contextual cues (e.g. the word "is", or pointing to an object and speaking) may indicate that this is situation in which responding in terms of the relation of sameness would be reinforced." (ibid, p.26)

Hayes has provided the most detailed theoretical discussion of stimulus equivalence available at present, but the relational frame account is, as he himself recognises, mainly descriptive. It may however facilitate further discussions about factors which influence equivalence responding, what the controlling variables are for this kind of responding.

According to the relational frame theory the exact type of the emergent responding on matching-to-sample tasks depends on cues present either during training or during testing *and* on available response patterns, i.e. it is generalised from past history of relational responding. Failure to show equivalence can either be because the subject is not able to respond in this way (absence of frame) or due to absence of cues indicating the applicability of the frame. Responding in terms of equivalence relation is not learnt during stimulus equivalence experiments, because the relation frame has already been formed prior to any trials. Experimental studies can provide information about possible contextual cues for equivalence responding, i.e. under what circumstances subject will engage in it. However, they cannot tell us anything about how this type of relational responding developed in the first place unless we study subjects who have not yet acquired this type of response pattern. To find out about how the 'basic type of relational responding' is initially learnt by humans, would require longitudinal, observational studies, starting with pre-verbal infants. This thesis is concerned with the circumstances under which children treat visual stimuli as equivalent during matching-to-sample tasks, rather than with the question of how the ability to respond in this way initially develops. The types of possible contextual cues for equivalence responding will therefore now be considered.

Contextual cues for equivalence responding

Equivalence classes emerge when the context for this type of responding is present and the cues could be present during either the training or testing phases. Sidman et al (1985) for example, suggested that as subjects' performance on equivalence tests often improve during repeated testing it is likely that the test itself can provide a context in which equivalence classes are formed.

It is important to point out here that a stimulus which functions as a cue for one subject does not necessarily do so for another. The experimenter may therefore not have much control over the presentation of context. The "context setting property" of contextual stimuli is not a function of any features of those stimuli, in the same way as the discriminative property of a discriminative stimulus is not the function of any stimuli features.

The argument put forward by the present author is that language can provide "generally applicable" cues. For example, if the experimenter gives explicit verbal instructions regarding the relationship between the samples and comparisons on a matching-to-sample task, using phrases such as "goes with", "with", or "same as", then it is likely that subjects will respond in accordance with these descriptions. In other words, experimental instructions given during training phase may provide cues to the relationship between the stimuli. This does not mean that such instructions are necessary for equivalence responding, but if they are given they may provide the appropriate contextual cues. If subjects are told that certain stimuli go together, it should come as no great surprise to find that they later treat those stimuli as belonging together. There seems to be little recognition in the equivalence literature of the possibility that what the experimenter tells the subjects may influence their performance and instructions describing the relationship between the stimuli (terms like "goes with") are extensively used (e.g. Catania et al 1990; Devany et al, 1986; Gatch & Osborne 1989; Spradlin et al, 1973; Wetherby et al 1983). In these studies subjects seem to have little difficulty learning the baseline task and most of them also pass symmetry or equivalence tests. Such linguistic cues are of course only effective providing that subjects understand language. Differences in the performances on equivalence tasks related to subjects' level of language development, such as those reported by e.g. Devaney et al (1986) may be due to differences in comprehension of the verbal instructions regarding the relationship between the stimuli.

Verbal instructions make the relationship between the stimuli obvious, but their are other, less obvious cues and common naming may be one such cue. The children studied by Dugdale and Lowe (1990) were not given any explicit verbal instructions about the sample - comparison relationship and most of them failed to learn the baseline A-B task after as many as 600-700 trials. As mentioned previously, after being taught common names for the stimuli the children were immediately able to carry out the conditional discrimination task and respond correctly on a symmetry test. In relational frame terminology these children were capable of responding according to synomy frame but did not do so until they had learnt common names for samples and corresponding comparisons.

Dugdale and Lowe (1990) suggested that common names had a mediating function because the names entered into a symmetrical relationship with the visual stimuli (see Figure 6 above). Their argument is based on a distinction between *labelling or tacting* and *naming.* A tact or label is defined in terms of a unidirectional relationship. Naming on the other hand involves a bi-directional relationship between a visual stimulus and a verbal response.

Naming is said to occur when a particular stimulus controls a subject's verbal response *and* the subject's verbal response also exert control over other behaviour (e.g. selection) with respect to that particular stimulus. The argument is that naming, defined as stimulus-response symmetry, can mediate stimulus-stimulus symmetry (ibid). They further suggested that whether verbal responses function as names rather than tacts may depend on contextual cues.

Children have an extensive history for responding as if words and objects are symmetrically related and as result they derive the general principle that words and their controlling stimuli are interchangable in particular contexts. They also learn contextual cues which indicate this naming context, cues such as the word "is" or pointing to an object while speaking. It is therefore possible that common verbal responses may lead to the emergence of new relations between visual stimuli more readily if the symmetrical relationship between the words and the visual stimuli is made explicit, i.e. in the presence of cues which indicate a naming context. Dugdale and Lowe taught the verbal responses by telling the children *"that is omni/that is Delta"*. They did in other words give explicit cues for the naming context. This raises the question of whether common labels would have the same function if there were no cues (phrases such as *That is*) to indicate naming context /word-stimuli symmetry. The main aim of this thesis has been to investigate this question further.

Summary

As discussed earlier (in chapter Three) equivalence studies have important theoretical implications as they can provide a methodology for a functional analysis of verbal behaviour and concept development. In addition, there are important practical implications for teaching linguistic skills, including reading and writing. Stimulus equivalence is a relatively new field of study and at present there is little understanding of the underlying explanatory principles, although several studies have been trying to establish how the ability to respond "equivalently" initially develops and under what circumstances organisms will later respond in terms of this ability. The latter question has been concerned to a large extent with the possible mediating function of verbal responses.

The equivalence literature provide three main explanatory frameworks, which may not be mutually exclusive:

i) Stimulus equivalence is a primitive which has emerged through evolution and that cannot be analysed further (Sidman, 1990). Sidman and his co-workers argue that verbal mediating is not necessary for, although it may facilitate, the emergence of equivalence. They acknowledge that their result indicate that a delay in the emergence of equivalence is more likely for purely visual than for auditory-visual relations (Sidman et al 1985).

ii) According to what is usually referred to as the "language hypothesis" stimulus equivalence emerges through verbal mediation; there is a causal relationship between language development and performance on equivalence tasks. Dugdale and Lowe who are proponents of this view have argued that common naming of stimuli (stimulus-response symmetry) can mediate the emergence of equivalence classes.

iii) Steven Hayes has attempted to explain stimulus equivalence in terms of relational responding in general. He agrees that there is a relationship between development of language and the ability to respond according to equivalence relations, but stresses that it is not causal. His argument is that equivalence and language are manifestations of the same response pattern, or "relational frame", and that this pattern of responding is learned during language development. Once this pattern (frame) is established different contextual cues can "activate" it.

There is no consensus on the origin of equivalence responding; Sidman argues in favour of biological determinism whereas Dugdale & Lowe and Hayes favour explanations in terms of a previous history of equivalence type responding, but all agree that at present there are not enough evidence for either view. These views are not necessarily mutually exclusive as it is possible that the ability to respond according to equivalence relations is the product of biological evolution, but that it will only emerge after an extensive reinforcement history.

There is agreement that equivalence responding depends on the presence of contextual cues for when it is appropriate to do so. Something in the procedure must "tell" the organism that equivalence relations are relevant. Hayes agrees with Dugdale and Lowe that early language training can provide the appropriate reinforcement history for learning to respond according to equivalence relations because children learn a general response pattern of word-object symmetry. They disagree on the question of how this pattern of responding generalises to matching-to-sample tasks with purely visual stimuli and in particularly about the role that language plays in this process.

Dugdale & Lowe (1990) have suggested that verbal responses can mediate the emergence of equivalence between visual stimuli if those responses enter into a symmetrical relationship with the stimuli. They have argued further that if the verbal responses do not function as names in the sense of being symmetrically related to the stimuli they are paired with, then those stimuli may not be treated as equivalent. The instructions used by Dugdale & Lowe made the naming context explicit, i.e. made it obvious that the vocal utterances were symmetrically related to the visual stimuli by the using relational terms "is".

The experiments reported in this thesis were intended to investigate if symmetry between visual stimuli would emerge as readily without such cues to the naming context. An additional aim was to compare the effects of verbal responses taught before acquisition of the baseline A-B tasks with those taught afterwards.

Prior to reporting on these studies (found in chapters 8-10) the discussion will turn to problems encountered when working with young children and how several adaptations to the standard Matching-to-sample procedure were made in order to overcome these problems.

CHAPTER FIVE

ADVANTAGES AND DISADVANTAGES OF WORKING WITH CHILDREN AND THE NEED FOR ADAPTING STANDARD PROCEDURES.

As explained in the previous chapter the main aim of the studies reported in this thesis was to investigate the conditions under which common naming promote emergent relational responding on matching-to-sample tasks, and specifically to test the following hypothesis:

Common verbal responses made to visual stimuli on a matching-to-sample task lead to the emergence of new relations between the visual stimuli more readily in the presence of cues which indicate a naming context, i.e. cues that make explicit the relationship between the words and the visual stimuli.

In addition the studies sought to test the hypothesis that the effect of verbal responses may differ depending on whether they are taught before or after the acquisition of the baseline conditional discrimination task.

The subjects participating in the studies were all children aged 3-5 years and this chapter is concerned with the advantages and disadvantages of choosing children as subjects. The final procedure was developed on the basis of preliminary studies and differed from standard procedures in several respects. This chapter provides a background discussion for the development of the experimental methodology and procedure which is described in detail in the subsequent chapters (6 and 7). The chapter focuses on discussing why standard matching-to-sample tasks were considered unsuitable for this population and the type of adaptations needed. An overview of the basic design is presented first in order to put this discussion in context.

The basic design

The design consisted of the following stages :

1. Attempt to train conditional discriminations between visual stimuli on a matching-to-sample task without giving any explicit instructions about the relationship between the stimuli. This was done to control for the possibility that such instructions may provide contextual cues for responding in terms of equivalence relations on subsequent tests.

If the conditional discrimination task was learnt, symmetry tests were carried out.

2. If the subjects did not learn the conditional discrimination task, or failed the symmetry test, subjects were taught vocal labels (Omni and Delta) in the presence of the visual stimuli. This was done using one of the following interventions:

a) Instruction including the relational term *That is* (*Omni/Delta*), i.e. including contextual cues for naming

b) Instruction without any such relational term. Attempts were made to train matching of visual stimuli with spoken words in the same way as visual-visual matching, i.e. without any explicit instructions about the relationship between the visual samples and the verbal comparisons.

c) If the children failed to learn the labels with intervention (b) the following cues for the naming context was introduced;

i) Pointing to the stimuli while saying the words. This was done as an attempt to increase attention to the visual stimuli while saying uttering the spoken label.

ii) If child still did not learn, instructions including the relational term *That is* was given.

3. Compare the different types of labelling interventions.

Comparisons were made regarding:

a) Effects on visual-visual matching-to-sample task; effects on baseline task and symmetry tests

b) Acquisition of labels; number of trials to learn.

4. Compare the effects of labels taught before and after the acquisition of the baseline conditional discrimination task, i.e. after failing baseline and after failing the symmetry test. The reasons for this is two fold:

   a) to investigate if the emergence of symmetry depended on how the baseline was acquired.

   b) to investigate if the stimulus labels had a direct or an indirect effect on performance on the symmetry test.

Advantages of working with children

There were several reasons for choosing to work with young children and these are outlined below.

This thesis is a continuation of work carried out by Dugdale & Lowe, and is based on the same basic assumption as their studies, i.e. that to further understand the equivalences phenomenon it is necessary to adopt a developmental perspective. This assumption is based on evidence for a developmental sequence of equivalence responding (Lowe & Beasty, 1987). Several studies indicate that young children and mentally handicapped people do not show equivalence responding as readily as normally developing adults (see Green et al 1990 for review).

It is also in line with a Vygotskian approach were the argument is that to fully understand any human activity we must study it as it develops, we must study processes rather than outcomes. Vygotsky argued that adult behaviour has become "fossilised" and that retrospective studies can tell us very little about its development, we should instead concentrate on those functions that:

"have not yet matured but are in the process of maturation, functions that will mature tomorrow bur are currently in the embryonic state. The functions could be termed the 'buds' or 'flowers' rather than then the 'fruits' of development" (Vygotsky, 1978, p.86)

A similar argument has been made elsewhere within the behavioural literature by authors highlighting the problem of potential uncontrolled variables within subjects' pre-experimental history. The suggestion has therefore been made, by for example Etzel (1987), that the effects of pre-experimental histories can be reduced by studying developmentally delayed or young normally developing populations.

The aim here was to study the effect of different interventions on matching-to-sample performance, which requires subjects who fail either baseline task or fail later tests for emergent relations. Normally developing adults rarely fail these tasks whereas children aged five and below often do (Green et al, 1990). However, although there are very good reasons for concentrating on children doing so also creates problems. The discussion will now turn to the special problems encountered when working with young children and how attempts were made to overcome these problems.

Disadvantages of working with children

There is agreement in the literature that young children are generally difficult to work with on any learning studies (see Etzel 1987 for review). In equivalence research the basic problem is that young normally developing children, like people with mental handicaps, often have great difficulty learning the baseline conditional discrimination task (Green et al, 1990; Greenfield, 1985; McIlvane, Kledara, Killory-Andersen & Sheiber, 1989; Osborne, Heaps & Phelps-Bowden, 1978; Saunders et al, 1988; Zygmont, Lazar, Dube & McIlvane, 1992), which means that these studies take a long time. This is particularly problematic when studying young children because developmental variables cannot be excluded. There are also problems with ensuring that the child is motivated to continue the task for extended periods of time. Related to this there are problems with finding suitable reinforcement, and ethical considerations. These and other potential problems specific to studies with children are discussed below. The awareness of these problems and the need to minimise them has been the result of a literature search of conditional discriminations tasks with children and initial pilot studies carried out for this thesis.

At present there is no clear understanding of why these studies take a long time, i.e. why children have problems learning baseline tasks (Soraci, Deckner, Baumeister & Carlin, 1990; Zygmont et al, 1992), but the need for extensive pre-testing and training is one factor (Dixon & Spradlin, 1976; Lazar, Davies-Lang & Sanchez, 1984). Identity matching has been used frequently as pre-training to teach general skills and to ensure that the child understands the requirements of the task. Although this can help in teaching prerequisite skills such as touching the relevant stimuli, waiting for stimuli to appear and scanning the display and searching for relevant stimuli (Sidman, 1977), it does result in a long baseline sequence. It is also possible that it may cause confusion when arbitrary matching is introduced and the sample and comparison are no longer identical as the child may treat arbitrary matching as a different kind of task.

Children show remarkable consistency in their performance even when their responses are incorrect, i.e. they often develop stimulus or response biases. Stimulus bias means that the child chooses the same comparison on all trials; response bias can manifest itself as consistently choosing the same comparison position or a preference for either the left or right side of the response panel. The development of such biases is well documented, as is the fact that they can be very difficult to rectify (Daehler & Bukatko, 1974; Dugdale, 1988; McIlvane, Dube, Klederas, Iennaco, & Stoddard, 1990; Sidman 1970) and hence add to the time span of the investigation.

Another problem is that it is difficult to maintain children's motivation, which may be either a consequence or a cause of long baselines and the frequency of errors. Compared with adults children have shorter concentration spans, are more easily distracted and get bored quicker. There are of course individual differences and some researchers (e.g. Dixon & Spradlin, 1976) have used screening tests to include only "suitable" subjects. This does however add to the length of the study, and may limit the value of the results.

Although equivalence studies originated within the behavioural analysis of human behaviour the procedures used do not differ in principle from those used in conditional discrimination studies with animals. Human subjects are required to indicate choices of stimuli by touching them which is analogous to e.g. pigeons' key pecks. Food is used as reinforcement in animal studies and in many child studies edible treats have been used, with M&Ms' being a particular favourite in the US. However, compared to animals children are studied in much less restricted environments, with a lot more available competing behaviours. Animals can be subjected to a lot more intensive training and are often food deprived prior to experimental sessions.

Finding suitable reinforcement is another important consideration that is more problematic for the researcher working with children, particularly as the task is repetitive and has very few intrinsic reinforcing properties. Normally developing children do not usually receive tangible reinforcers for learning. Their responses are usually maintained through social praise, or some intrinsic reinforcement in doing something right. Conversely making a large number of errors on a task often acts as punishment and leads to reluctance to continue that task.

Another problem with tangible reinforcers is that their effectiveness varies with individual children. This is true particularly with toys. The pilot studies carried out here indicated that toys may not always be effective, as the child may not like the toy or may already own one. Parents' advice can be sought, but it is possible that toys considered suitable by parents may be boring for the child, and parents may object to toys liked by the child. Parental objection is even more likely in the case of edibles, in particular sweets. Even if there are no objections edibles tend to be "messy" and child often reach satiation point.

The view of the present author is that although tangible reinforcers are important, social interaction, praise from adults and the nature of the task is equally important. The task must be perceived as a fun game rather than a test or a chore, otherwise lack of motivation will continue to be a problem. A child's unwillingness to continue on a task also has ethical implications, in terms of if and how the child is persuaded to continue.

The ethical considerations involved when working with young children are very important, particularly as it is doubtful that children are capable of giving informed consent to participate, but these issues are unfortunately rarely discussed in the literature.

Unlike animal research, there are no laws pertaining specifically to research with children. The British Psychological Society have issued guidelines, but these are very short and vague. If subjects are recruited through college nurseries or health authorities, monitoring is usually done by internal ethical committees. If the experiments are carried out in schools or the child's home it is often up to the integrity of the researcher to ensure that the study is ethical. Etzel (1987) has suggested that parents diligently monitor research procedures, but this is not necessarily the case. On the contrary, it is likely that many adults have faith in the integrity of the researcher (cf. Milgram, 1974).

It is good practice to obtain written consent from parents prior to any study, but there must be a balance between the amount and detail of information given to parents and experimental control. Giving full details can jeopardise the study as the parents may "prime" their children to respond correctly.

Young children are unlikely to be able to give informed consent prior to experimental sessions. According to the BPS guidelines unwillingness to participate should be considered as withdrawal of consent; "When testing children, avoidance of the testing situation may be taken as evidence of failure to consent to the procedure and should be acknowledged." (BPS , 1992, p.9). However, this may not always be as easy as it sounds. For example it is not unusual for a child to refuse to participate one day but be quite willing to continue the next. Another example is the child who refuses to continue after having acquired the baseline task, which may have taken several weeks to learn. This can create a dilemma regarding the amount and type of persuasion that is acceptable. Researchers must be aware of their potential role of authority, particularly when working in schools and nurseries, where children are used to obeying adults. Staff and parents may also try and persuade a reluctant child to continue. There are no universal solutions to these problems but researchers must be aware of them, and be sensitive to any changes in the child's attitudes and behaviour towards both task and experimenter.

There are also problems outside the researcher's control e.g. childhood illness, and school holidays, which need to be kept in mind when estimating the time span of any study.

Why the standard matching-to-sample task was considered unsuitable for this population and the type of adaptations needed.

The problem specific to this study was that it required subjects who passed as well as those who failed the A-B baseline task. The aim was therefore to develop a procedure where children would require only a small number of trials to reach criterion on the baseline task. If children who learn the task do so quickly this can justify an early introduction of interventions which reduces the time span of the study.

The previous discussion has made it clear that children's failure to learn conditional discrimination tasks is not necessarily an indication of lack of ability, but may be due to problems with ambiguously defined task goals, reinforcement or motivational variables or response factors. In order to develop a procedure suitable for this population these factors must therefore be considered. There is however a problem as equivalence studies with normally developing children often omit to report variables like number of trials required to teach baseline, type of instructions used, and basis for subject selection and subject attrition. In other words the problems involved in teaching matching-to-sample tasks is not recognised. Yet informal discussions with researchers in this field reveal that most investigators experience major problems when working with young children. Perhaps, as Green et al. (1990) suggest, training problems are bypassed by excluding subjects who do not learn readily. The aim here was to try and overcome the problems by concentrating on task rather than subject variables.

It is recognised that there are similar problems when studying people with mental handicaps, although the reasons for these problem are not well understood, as illustrated by the following quotes:

"Despite the procedure's empirical and practical importance, few studies have examined variables influencing the acquisition of conditional discrimination under matching-to-sample procedures. As a result, the literature does not contain a procedure that reliably teaches conditional discrimination to developmentally limited individuals" (Saunders, 1989, p.7).

"Despite research conducted over more than 40 years, there has yet to emerge a systematic set of procedures for teaching people with severe retardation and language deficiencies to respond to relations among stimuli" (Green et al. 1990, p. 255).

The authors quoted above and several other investigators (e.g. Greenfield, 1985; McIlvane et al., 1990; Saunders & Spradlin, 1990) have also suggested that there is a correlation between low-mental age scores (below 4-5 year) and difficulties with learning conditional discriminations on matching to sample tasks. The literature on matching-to-sample studies with mentally handicapped has therefore been consulted by the present author for ideas on how to develop a procedure suitable for young children.

Common methods

McIlvane et al. (1990), in reviewing the three dominant methods for teaching conditional discriminations to people with mental handicaps; trial-and-error with random presentation order, discrimination reversal learning and errorless learning procedures, concluded that :

"Where conditional discrimination is concerned many investigations have had inconsistent results with virtually every commonly used teaching method" (ibid, p.283).

Trial-and-error procedures are likely to result in position and stimulus preferences and so lead to frequent errors which leads to loss of motivation to continue. Discrimination reversal can be used to teach two sample-comparison combinations at a time. It involves three stages; first the same comparison is correct for a whole session and during the second session the other is correct. The third stage is trial-and-error. The method is successful in teaching comparison discriminations but performance in stage three is often at chance level (Devaney et al. 1986; Guess & Baer, 1973; Mackay, 1985, cited by Mackay & Ratti, 1990). Errorless learning procedures, such as stimulus shaping and fading (Terrace, 1963), are also often unsuccessful in that subjects make errors at the final stage. McIlvane et al. (1990) suggest that this may be because subjects do not observe the sample before responding.

Several authors have however argued that, as young children and mentally handicapped adults respond to actual stimuli rather than the relationship between them, sample observation is not sufficient for ensuring conditional discrimination (Dinsmoor, 1985; Saunders & Spradlin, 1990; Soraci et al., 1990). To increase success on MTS tasks we need to "enhance the salience of stimulus relations" (Soraci et al., 1990).

As discussed earlier (chapter 4) the procedure need to include a contextual cue for relational responding, something within the task must "tell" the subject that responding should be based on the relationship between stimuli. Verbal instructions is perhaps the most obvious clue as far as humans are concerned. The view taken here is that explicit instructions about the relationship between samples and comparisons may function as cues for responding in accordance with equivalence relations. In other words, it is difficult to give instructions that give clues to a uni-directional relationship; if A then B, without at the same time giving clues to a bi-directional relationship.

Role of instructions

Wulfert and Hayes (1988) have discussed pre-training as a possible cue for equivalence responding. It could however be argued that the most obvious cue in their studies was contained in the instructions given to the subjects. During the baseline conditional discrimination training subjects were told *"You have to figure out which of those at the bottom goes with the one at the top"*. The relational term "goes with" (as argued previously in chapter 4) is likely to result in subjects treating the stimuli as belonging together.

Wulfert and Hayes suggested that as we do not yet fully understand instructional control, we can't use instructional control as an explanation for our findings. They point out that shaping responses can also cause problems and conclude that "at the present time, it seems best to simply delineate the experimental procedures carefully and to be fully aware of the need to examine this issue theoretically and experimentally" (ibid, p. 140). Green, Sigurdadottir, & Saunders (1991), while recognising that instructions may contribute substantially to the outcomes of matching-to-sample tasks, agree that "almost nothing is known about the role of instructions in establishing equivalence relations, ordinal relations, or interactions between these types of stimulus relations." (ibid, p.288).

Verbal instructions were minimised in the present studies precisely because their effects are unclear and hence may be uncontrolled variables. The consequences of removing instructions is that methodological changes are required to assist the children in learning the baseline task. Several such changes were therefore instigated, the first being in the type of stimuli used.

Adaptations made

Most researchers have used two-dimensional stimuli, usually presented on a computer screen. The required response is touching or pressing a stimulus which can be done with little effort. The first adaptation made here was a move away from computer screen presentation and the introduction of 3-dimensional stimuli that the subjects had to pick up and place on the response panel. The assumption was that manipulation of the stimuli would increase attention to the sample stimuli and make the relationship between sample and comparison made more obvious. Attention to the sample is an important although not sufficient factor for enhancing the salience of the relationship between the stimuli. The samples are the critical stimuli that must control behaviour initially and throughout matching-to-sample performance. It is therefore necessary to encourage the subjects to observe relevant sample-stimulus features before responding (Zygmont et al. 1992).

It was also assumed that the placing of the 3-dimensional samples and comparisons together on the response panel may serve as a non-verbal cue for relational responding. As Stromer (1986) has argued it may be enough to simply see stimuli together, and if there are contextual cues indicating that they should be related in a particular way, "this kind of concurrent presentation may alone be enough to place them into a relational frame." (Hayes, 1989, p.21)

Another reason for choosing 3-dimensional stimuli was that children often find it easier to do tasks that are not completely outside their pre-experimental experiences (cf.

Donaldson, 1978 and discussions regarding children's performance on Piagetian tasks). The stimuli used here resemble building blocks commonly used by children.

Manual presentation of stimuli also made it easier to instigate steps to reduce stimuli and response biases. It is important to change presentation order of the stimuli when these biases develop so that biased responding is not reinforced. If computer presentation is used these changes can only be made between sessions, whereas with manual presentation changes can be instigated immediately a bias develops.

In addition, a very important consideration was that 3-dimensional stimuli made the non-relational naming instruction more feasible. It is more likely that children will learn the name for a stimulus, if they say the name while holding the stimulus, rather than just seeing it. In other words, holding the stimulus may function as a cue to the relationship between the visual stimulus and vocal comparison.

Summary

The main focus of this thesis was to investigate conditions under which naming promotes equivalence class formation in young children. However, procedures needed to be adapted to fit the subject population under study prior to carrying out these investigations. The change in the type of stimuli was not sufficient and further changes were made based on preliminary studies. These preliminary studies and the sequence of changes to the procedure are described in Chapter Six. The emphasis throughout has been on presenting the task as a game and on the importance of the social aspects of the task. It is difficult to devise a procedure that can compete with the toys, equipment and activities available in the home, school or nursery. The experimental situation does however provide an opportunity for a one-to-one interaction with an adult, which is rare in school and nurseries. It is therefore important to develop close inter-personal relationships with the children who participate. In other words, the children must enjoy carrying out the task and like being with the experimenter. Pilot studies indicated that this is facilitated by not seeing children every day.

CHAPTER SIX

DEVELOPMENT OF PROCEDURE.

PRELIMINARY STUDY I

A matching-to-sample procedure incorporating 3-dimensional stimuli was designed and the main aim of this preliminary study was to finalise this procedure. In other words, the study was carried out to investigate further children's performance on the baseline task. It was also intended to investigate the feasibility of teaching verbal labels without relational instructions, the effect of stimuli-labels on the A-B task and the emergence of symmetry. The study was unfortunately not successful regarding the latter aim as the school term ended before the children reached the testing stages. It did however provide useful information about performance on the conditional discrimination task and labelling training and thus facilitated final changes to the procedure.

SUBJECTS

The subjects were all pupils from a reception class in a local primary school. Written parental permission was obtained after giving the parents a brief outline of the procedure. There was no formal selection procedure and the children entered the study as soon as parental permission and the children's willingness to participate had been ascertained. (See Appendix 1 for specimen copy of letter sent to parents asking for their permission). Six children (four girls and two boys) aged between 4 years 3 months and 4 years 6 months, took part in an initial study, and their respective ages at the start of the study were as follows:

Subject	*Age (years : months)*
Mark	4:2
Glenn	4:2
Sian Lynne	4:3
Jenny	4:4
Lisa	4:4
Kimberley	4:6

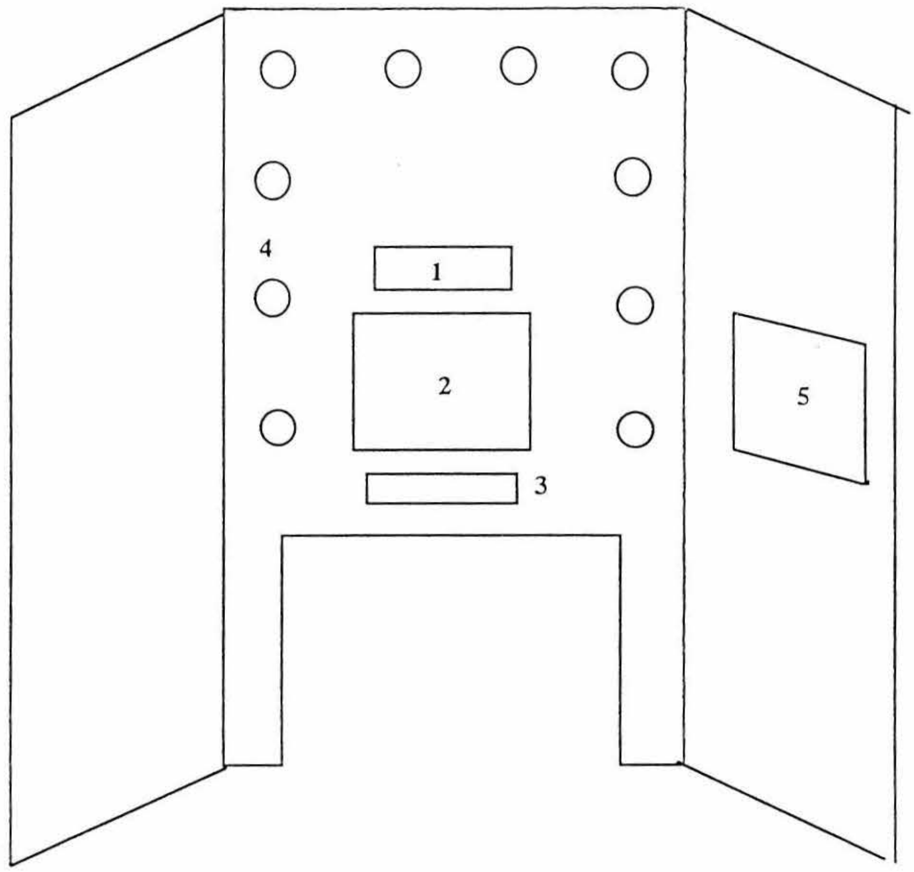
APPARATUS

Figure 7 shows a photograph and Figure 8 shows a schematic overhead view of the apparatus. The child was seated in front of a wooden panel, 105 cm high and 75 cm wide. In the middle of the panel was a hinged "door" (30 cm x 25 cm) which opened inwards, i.e. away from the subject. On the two vertical edges of the "door" were grooves into which a metal plate (20 cm x 25 cm) could be inserted. This metal plate served as the response panel.

Figure 7

Photograph of apparatus.

Figure 8



Schematic diagram of apparatus.

Key

1 - Window for delivery of boxes as part of reinforcement set-up

2 - Door on which the metal response panels were placed

3 - Drawer for presentation of the stimuli

4 - Lights

5 - Connect Four matrix

Underneath the response panel "door" was a drawer for presentation of the stimuli. The drawer was 4 cm high, 22 cm wide and situated 4 cm below the "door". The bottom of the drawer was 40 cm above the floor and the subject and experimenter sat on child size chairs. Above the response panel "door" was a perspex window, 30 cm high and 10 cm wide.

Around the edges of the wooden panel were differently coloured lights spaced 16 cm apart. These lights, together with a tape recorder, a glove puppet, tokens and a matrix from a "Connect Four" game, formed part of the reinforcement set-up.

To either side of the wooden panel was another panel which separated the subject from the experimenter. Situated behind the panels were the tape recorder and a TV monitor which was linked to the video camera. The "Connect Four" matrix was mounted in the side panel to the right of the child.

A-4 papers were printed with the order of stimuli presentation and these forms were also used to score each trial for correct or incorrect response. In addition, all the sessions were video-taped in order to record objectively the children's performances.

Stimuli

These consisted of three-dimensional wooden shapes, approximately 6 cm x 6 cm x 1 cm. Both sets of stimuli are pictured in Figure 9. The shapes were painted yellow on the top and bottom surfaces, and the sides and edges were painted blue to emphasize the individual shapes. Inserted in the underside of each shape was a magnet.

Figure 9

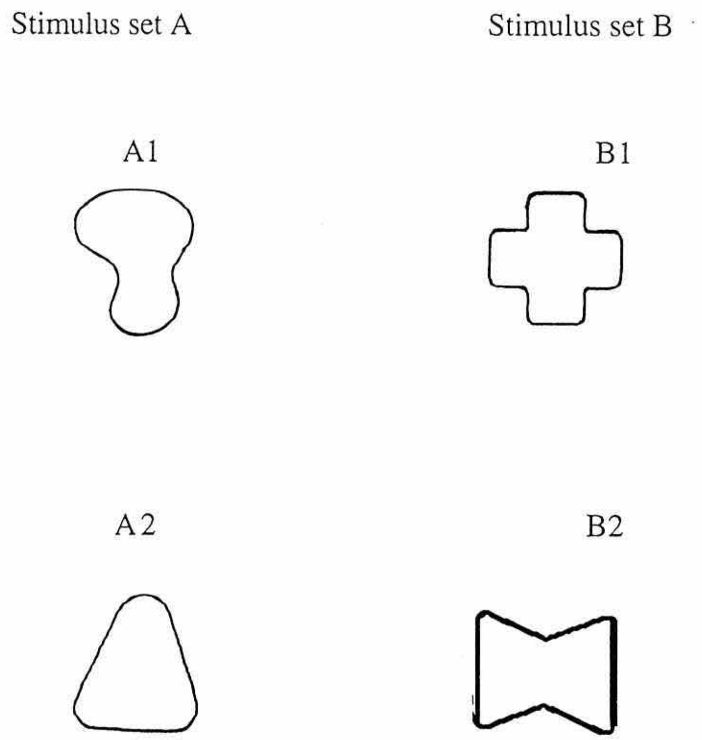


Figure 9 shows the visual stimuli used in this study. The stimuli denoted as set-A served as samples during the baseline training phase and those denoted as set-B served as comparisons.

Reinforcement set-up

During training and teaching trials correct choices resulted in 10 seconds of flashing lights and tape recorded music plus a token. The music and lights were controlled by a foot button and a timer, so that both were started by E pressing the foot button and ceased after the set time. Following a correct response the "door" with the response panel opened and the puppet appeared giving verbal praise like *"Well done"*, *"That was right"* and removing the response panel. The experimenter also placed a token into the Connect Four matrix. Every sixth token resulted in the presentation of a small box in the window above the response panel. Each box contained either a small toy or a star, which were given to the child at the end of the session. The stars were glued into a book and when the child had ten stars s/he received a bigger toy.

Incorrect choices were followed by a buzzer which was also controlled by a foot button. After incorrect responses the response panel was removed by the experimenter, i.e. the puppet did not appear, and no tokens were delivered.

DESIGN AND PROCEDURE

The procedure varied according to the children's performance as the aim was to finalise the experimental procedure and to find out more about children's learning on conditional discrimination tasks.

Figure 10 shows a summary of the general plan and Figure 11 contains a diagram of all the sample-comparison relations trained and tested for. The general plan was to train baseline conditional discrimination between the set-A and set-B visual stimuli, using a matching-to-sample procedure. Children who failed to learn the matching task were taught to apply verbal labels to the stimuli. A multiple baseline across subjects design was employed. In other words, the number of sessions on the baseline task varied between subjects, to ensure that any changes in performance after the labelling interventions were a result of those interventions and not a function of time.

Figure 10

Summary of the general plan showing sequence of training and testing stages.

The identifiers A-B, A-X etc. refer to the sample-comparison relations pictured in Figure 11.

1 Baseline matching-to-sample task : Train A-B.

If subject learns A-B then proceed to 4

If subject fails to learn A-B then proceed to 2

2 Teach A-X: Subjects required to say "Omni" in the presence of A1 and "Delta" in the presence of A2. Subjects given one of the following instructions.

2a Non-relational instruction - *Say Omni/Delta.*

2b Relational instruction - *This is Omni/Delta.*

3 Return to baseline A-B trials.

If subject learns A-B then proceed to 4.

If subjects do not learn A-B teach B-X: Subjects required to say *Omni* in the in the presence of B1 and *Delta* in the presence of B2. Subjects given the same instructions as used for A-X teaching.

4 Reduce reinforcement probability

5 Test A-B and B-A

Figure 11

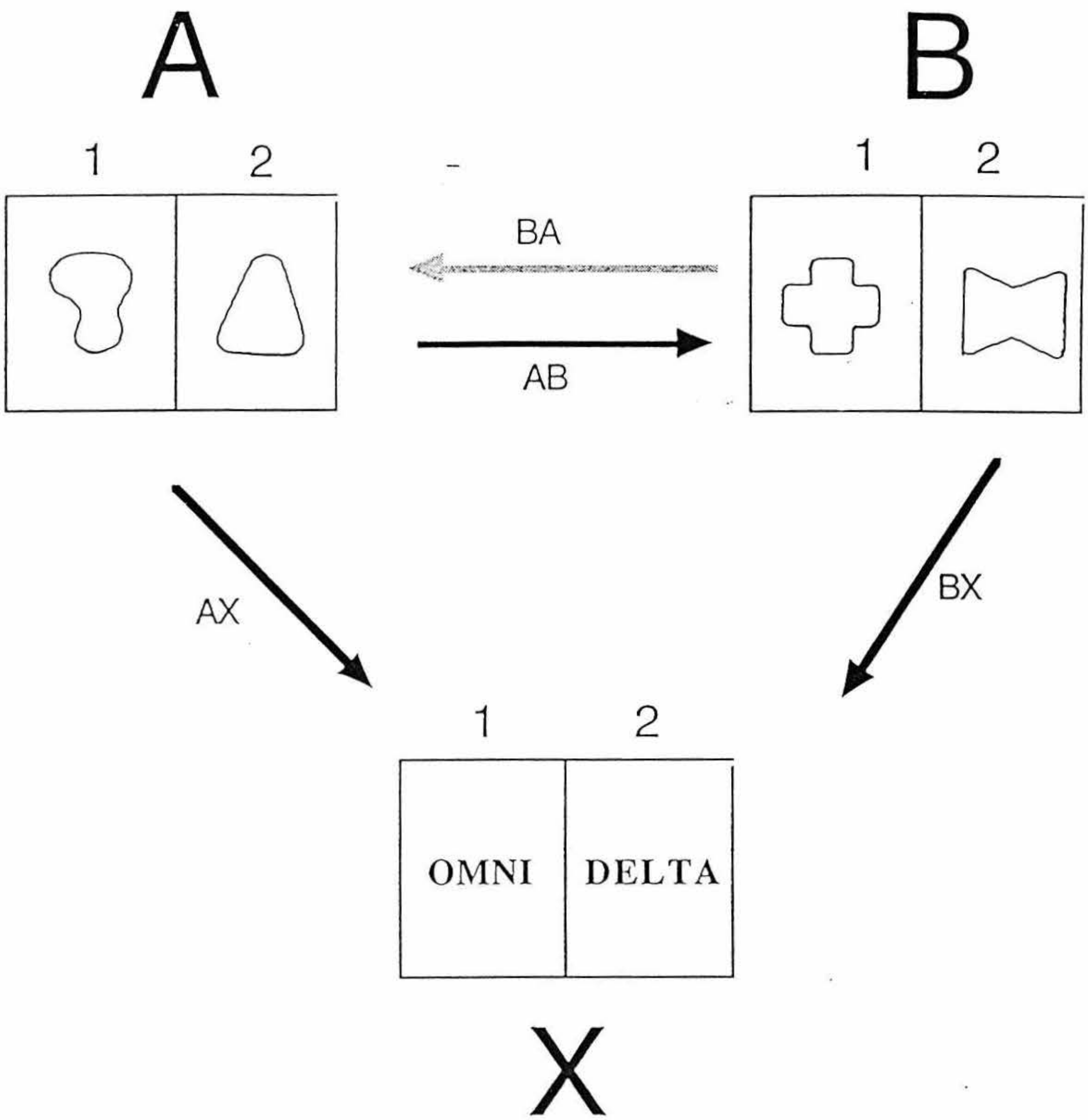


Figure 11 gives a schematic description of the design used in the studies reported in this thesis. The black arrows represent relationships that were explicitly trained and the grey arrow shows the relationship that was tested for.

The kind of stimuli used in this study differed from those normally employed in that three-dimensional wooden blocks were used and the children were able to manipulate the stimuli.

The relationship between the visual stimuli was arbitrary in the sense that there were no physical similarities between them. It was also highly unlikely that the subjects had any previous experience of a conditional relationship between the stimuli. The words "Omni" and "Delta" were chosen on the assumption that the children were unfamiliar with these words. This was confirmed by their initial difficulties in pronouncing the words.

Trials were initially presented in a random order but when this did not lead to success on the task a "blocked-trial procedure" (cf Saunders & Spradlin, 1990) was introduced. Each of the two sample-comparison combinations was presented in blocks of trials within a session, i.e. this was a discrimination reversal procedure where one comparison was correct for a block of trials, then the other was correct. Initially each sample-comparison combination was presented in blocks of ten or eight trials, this was then reduced to six trials prior to random presentation. The initial session consisted of blocks of eight trials if the children made no errors during these trials. If they made errors the blocks were increased to ten trials. The block sizes were then decreased as soon as errors were confined to the first two trials in each block as these were regarded as information trials.

This intervention was introduced because it was felt that it would be easier for the children to learn one sample-comparison combination at a time. In other words, that it would be easier to learn A1-B1 and A2-B2 if each trial type was presented in a sequence of several trials. The study by Saunders and Spradlin (1990) referred to above also provides experimental support for the assumption that blocking trials enhance baseline performance on matching-to-sample tasks as it ensures discrimination between comparisons.

Details of procedure

The general plan (Figure 10) was followed for all subjects. The exact procedure for each child did however vary depending on the child's performance, therefore these deviations are noted in the Results section.

The apparatus was set up in a small room which was normally only used for storage of teaching materials. All the staff and children in the school were aware of its new usage as an experimental room and were very co-operative in ensuring minimum disturbance by only entering the room during break times.

The experimenter spent a couple of days with the children in the class room prior to introducing them, one at the time, to the experimental room. Their first session in the room consisted of the experimenter generally chatting to and getting acquainted with the children. During the second session the children were acquainted with the procedure, general instructions (details given below) were given and the reinforcement set-up was briefly explained. Each child's ability to cope with the task was established during this session.

In line with the BPS ethics guidelines refusal to continue was seen as withdrawal of consent and therefore a minimum amount of persuasion was used if a child expressed a wish to stop. There was also a practical reason for this, apart from the ethical aspects, as preliminary studies had shown that persuasive attempts can adversely affect the relationship with the child and the child's willingness to continue to participate in the study. Each child was always asked prior to a session : *"Do you want to come and play the game today?"* Children who said *"No"* did not participate that day. This was however a rare occurrence, which usually coincided with some special activity in the class room, like the showing of a video.

The child sat in front of the panel and the experimenter sat next to the child until performance was stable. The experimenter then moved behind the panel and used the glove puppet to communicate with the child, which avoided any problems with inadvertent cueing. The child and the responses continued to be observed via the TV monitor.

Each session lasted 15-20 minutes but the number of trials during a session varied between 16 and 32, depending on the child's willingness to carry out the task and the outcome. The set-A stimuli were the samples and the set-B stimuli the comparisons (see Figure 8). Each trial type (A1-B1 and A2-B2) was presented on an equal number of trials during all sessions except those consisting of blocks of trials of only one type.

All visual-visual matching trials began with presentation of the sample stimulus in the drawer underneath the response panel. When the child had picked up the sample and placed it on the panel, the two comparisons were presented in the drawer and the child was required to choose one and place it on the response panel. The consequences for correct or incorrect choice of comparison were delivered as soon as the comparison stimulus was placed on the response panel. No scheduled consequences were delivered if subjects picked up both the comparisons. When this happened the trial was discounted and the subject was told: *"No, it won't work if you pick up both"*.

The left-right position of correct and incorrect comparisons was randomly determined with the following provisos. The correct comparison never appeared in the same position for more than three consecutive trials. Each comparison appeared in the left and the right position on an equal number of trials in each session. During trials with random presentation order the same comparison was correct on no more than three consecutive trials.

Instructions

The children were asked if they wanted to play a game and were given the following instruction when the sample stimulus appeared in the drawer:

"Do you see that there? (E pointing to stimulus) *I'd like you to pick it up and put it here. Like this.* (E puts the stimulus on the panel). *When you do that music comes on and the lights too. Let's see if you can do it."*

The contingency between the child placing the stimulus on the panel and start of the music and lights was emphasised by telling the child:

"You have to put it on there for the music to come on."

When the child reliably placed the sample on the panel as soon as it appeared they were required to choose a comparison before the delivery of scheduled consequences. They were told:

"Now there won't be any music yet, but there will be two more things in here. Do you see them? After you have put that one there (pointing to sample) *then you have to pick one of these, but only one at a time. Like this.* (Demonstrates correct choice) *If you get it right teddy will come out and he will also give you one of these* (token) *in here* (pointing to Connect Four matrix). *When they get to the top teddy will put a little box in here* (pointing to window) *with something in it for you. You can open the boxes later. Let's see if you can do it.*

Attempts were made to tell the children that there was a correct way of doing the task and that it was possible for them to get it right every time. The aim was also to try and make the uni-directional (if-then) relationship between sample and correct comparison obvious without using any instructions, like "goes with", that could be interpreted as describing a bi-directional relationship. During the first few matching trials the children were instructed as follows:

After placing sample stimulus on the panel: *Right, now let's see, if that one goes there, which one of these is the right one?*

After correct choice : *That was right, now you have to try and remember what you did so you can get it right again later.*

The following prompts were also given on subsequent trials : *"Which one was it? Do you remember? You got it right before, didn't you? Try to remember."*

Labelling training.

Subjects who failed to learn the baseline task were taught the labels for the set-A stimuli and then returned to baseline trials. If these labels did not assist learning of the A-B task, the plan was to teach the subjects to apply the same labels to the corresponding set-B stimuli. There were two labelling conditions. After picking up a stimulus subjects were either told : *"That is an Omni/Delta"*, or the experimenter simply said *"Say Omni/Delta"*. The latter instruction was used in an attempt to train word-object pairing without explicitly telling the children anything about the relationship between the words and the objects. If the children did not make the appropriate verbal response they were prompted to do so by the experimenter saying: *Is it Omni or Delta* (relational instruction) or*"Can you say Omni/Delta"* (non-relational instruction).

RESULTS

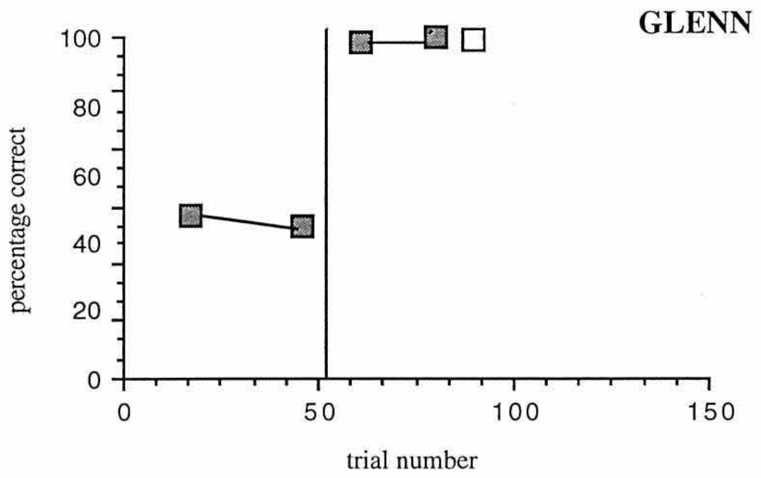
A-B training Two of the children, Glenn and Mark, learnt the A-B task without any interventions involving the teaching of labels, although neither learnt through a trial-and-error random presentation task. Their results are summarised in Figures 12 and 13.

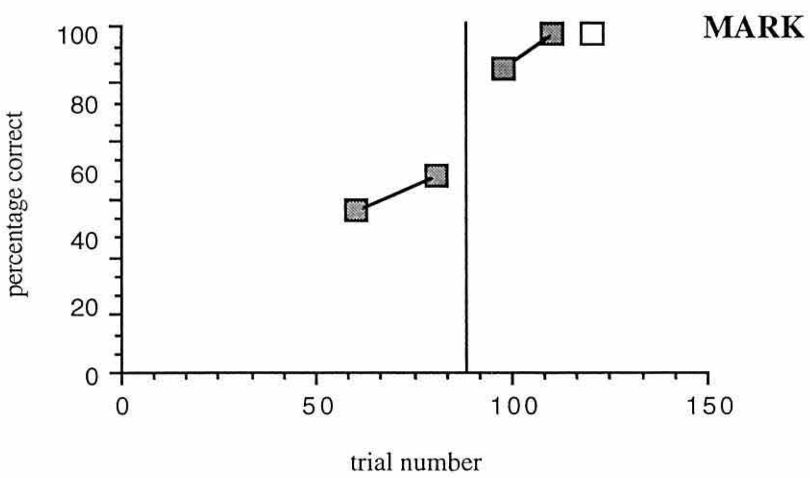
Glenn did not attend to the sample stimulus initially and was therefore (after 48 randomly presented trials) shown the two samples simultaneously and told : *"These two look quite different don't they? You must look at them, to see which one it is."* On the subsequent trial he said (after putting the sample on the panel) *"When you take this one, then it's ...* (waiting for the comparisons to appear) *this one, isn't it?"* From then on his performance was 100% correct including a session without contingent reinforcement. He also made the following comment:

" I know how to play this game now. You always have to pick the same shape."

Mark developed a stimulus bias where he chose the same comparison (B2) on all trials. This stimulus preference was corrected by introducing the blocked trial presentation order in the fourth session (after 82 trials). Mark started responding correctly following the introduction of blocked trials and performance was maintained at 100% correct after the removal of the scheduled consequences.

Figure 12
Graph showing percentage correct responding for **Glenn** and **Mark**





KEY

TEACH A-B

A-B TEST

Introduction of interventions
Glenn: told to look at stimuli
Mark: blocked trial procedure

The other four children failed to learn the baseline A-B task and attempts were then made to teach these children the verbal labels for the stimuli. The table in Figure 13 shows the number of trials carried out by each child prior to the introduction of labelling training. Details of their performances are given below.

Jenny failed to learn the A-B task despite carrying out a total of 236 trials (nine sessions). She developed a response bias during the second session when she started to alternate between the comparisons, chosing B1 and B2 on alternative trials. Attempts were made to rectify this bias by altering the presentation order so that she was always incorrect, but this had no effect on her performance. She was then told to look carefully at the sample before choosing the comparison in an attempt to increase her attention to the samples. Following this instruction Jenny started touching the A-stimuli, including tracing their shapes her finger. She also labelled the A1 stimulus *"round"* and *"duck"*. In other words, she did attend to the sample stimuli but this had no effect on her response pattern of alternating between the comparisons.

Jenny was able to describe the general requirements of the task, as shown by her reply when asked , prior to starting the third session the experimenter : *"Do you remember what we did yesterday?"* Jenny answered:

"You have to get the thing to put up on the metal, then you have to think which one. If it's right you get a button and a prize." There was however no evidence that the sample stimuli exerted any control over her choice of comparisons, either from this description or from her performance on the visual matching task.

The blocked trial procedure was introduced after Jenny had carried out 198 baseline trials. This rectified the previous response bias and she now started to switch her choice of comparison following no more than two initial errors in each block . Her responding did however deteriorate when the block sizes were reduced.

Figure 13

Summary table for Preliminary study 1, showing the number of trials carried out by each child at each stage of the procedure, and the outcome of each stage.

CHILD	AGE (Year:months)	A-B training	A-X teaching	Return to A-B training
Mark	4:2	118 Learnt		
Glenn	4:2	80 Learnt		
Jenny	4:4	236 Failed	(a) 220 Failed	
Kimberley	4:6	85 Failed	(a) 110 Learnt	22 Failed
Sian Lynne	4:3	120 Failed	(b) 50 Learnt	32 Learnt
Lisa	4:4	152 Failed	(b) 50 Learnt	142 Failed

The letters in the brackets in the A-X teaching column refer to the instructions during the label training: (a) = non-relational instruction, (b) = relational instruction.

Kimberley carried out a total of 85 trials over five sessions but failed to learn the baseline task. There was no detectable pattern to her responding which remained around 50% correct throughout. She was reluctant to continue the task after the five sessions and it was therefore decided to introduce labelling training without any further baseline task interventions such as blocked trial presentation.

Sian Lynne carried out a total of 120 trials (six sessions) on the baseline task without learning. The blocked trial presentation was introduced in the third session (after 70 trials). It was however unsuccessful as she did not switch her choice of comparison after making an error. Instead she developed a preference for the B1 stimulus, which continued throughout the subsequent sessions.

Lisa carried out 152 trials over six sessions. During the second session she developed a left side response bias, i.e. always chose the comparison on the left. This was corrected by presenting the correct comparison on the right throughout the session. Her responding did however remain around 50% correct on the subsequent sessions.

A-X teaching

Attempts were made to teach labels for the A-stimuli in accordance with the procedure described earlier. Sian and Lisa were given the relational instruction; *"That is an Omni/Delta "*. Kimberley and Jenny were told to *"Say Omni/Delta"* in presence of the corresponding stimulus, i.e. given the non-relational instruction. A blocked trial procedure was used with all four subjects, starting with blocks of eight followed by blocks of four (8 - 8 - 4 - 4) prior to random presentation.

a) Relational instruction

Sian Lynne and Lisa learnt the labels over two sessions (50 trials). They had no problems saying the words and errors were restricted to the beginning of the first session.

b) Non-relational instruction

Kimberley required 110 trials before she labelled the A-stimuli correctly. She was initially very reluctant to make any verbal response and required a great deal of prompting.

Jenny carried out a total of 220 trials without learning the labels. She was told to point to the stimulus while making verbal response after 154 trials, but this had no effect on her labelling performance. She became increasingly reluctant to respond, saying *"I don't know what to say"* on several trials.

Return to A-B baseline task

The children who had learnt the labels for the A-stimuli were returned to the baseline task with blocked trial presentation (8 - 8 - 4 - 4). They were now required to name the samples prior to the presentation of the comparisons.

Sian Lynne responded correctly on the A-B task as soon as it was re-introduced. She carried out a total of 52 trials (32 with and 20 without contingent reinforcement) and performance was 100% correct throughout.

Lisa responded according to a "win-stay, loose-shift" pattern, i.e. she switched her choice of comparison following an error and did not learn the baseline task despite carrying out 142 trials with sample naming.

Kimberley failed to learn the A-B task , but she did only carry out 22 trials before the study ended.

The children did not progress further through the procedure as the study came to a premature halt with the start of the school holidays.

CONCLUSION

The end of the study was determined by the end of the school term rather than by the stage in the procedure reached by the children. Although none of the children reached the stage of learning common labels or were tested for symmetry, the study was successful in providing useful information about children's performance on conditional discrimination tasks and the feasibility of teaching verbal labels without relational instructions. The discussion below deals with the findings in the same order as the results section, i.e. baseline A-B training; labelling teaching; effect of A-labels on the A-B task. These findings formed the basis for changes to the procedure, particularly in relation to the teaching of labels and in ensuring attention to the sample stimuli, which were adopted in the next phase.

The procedure was successful in that it did not require any pre-training and all the children learnt the basic requirements of the task immediately, i.e. it seemed to have the potential for short baselines. Placing the sample and comparison stimuli together was however not sufficient for everyone to learn the visual matching task as only two children learnt the task.

The two who learnt the baseline task prior to labelling interventions did so very rapidly. Mark's performance did initially show a stimulus preference, which was corrected by the introduction of the blocked trial procedure, and he subsequently learnt the task. During random presentation 50% of reinforcers are received even if the subject always chooses the same comparison or the same position, i.e. biased responding is reinforced. One advantage of the blocked trial presentation is that it counteracts such biases. It also ensures comparison discrimination. If subjects continue to choose the same comparison until they make an error and then change to the other comparison, we know that they are discriminating between the stimuli. Failure on the matching-to-sample may be a failure to remember which two stimuli go together rather then failure to treat the task as a conditional discrimination one and a blocked trial presentation may aid memory. However, this method of trial presentation did not result in acquisition of the A-B task for Jenny or Sian Lynne.

The success of the blocked trial procedure depends on subjects switching their choice of comparisons after making initial errors when the blocks change. Jenny seemed to be responding in this way, but it is not clear that her responding was controlled by the errors, as illustrated by the following comment made by Jenny at the end of the first session with blocked trial presentation :

"You choose the same one until it's at the top, then you have to try and guess which one it is".

This is a good example of how the analysis of subjects' verbal behaviour during the task can give important clues to what is and is not controlling their non-verbal responding.

It is difficult to make any firm conclusions regarding the reasons for why the blocked trial procedure did not lead to acquisition of the baseline task with these children, but it may have been due to lack of attention to the sample stimuli.

This interpretation is supported by work by Saunders & Spradlin (1989, 1990) which showed success with teaching methods that explicitly require discriminations between the sample stimuli as well as the comparisons. In the present experiment the latter was achieved by following the above authors' procedure and presenting each sample-comparison combination in blocks of trials. Continuing to choose the same comparison was seen as evidence of discrimination between the two.

In the first of their studies (Saunders and Spradlin, 1989) sample discrimination was established by teaching subjects differential responding (the subjects were required to press buttons according to different schedules of reinforcement) in the presence of different sample stimuli. The authors discussed the possible role of the differential schedules in relation to two reasons for why sample specific responding may result in acquisition of the conditional discrimination task:

a) it ensures successive discrimination between the sample stimuli, or

b) the response "exerts stimulus functions controlling comparison selection", i.e. mediates comparison selection.

Saunders and Spradlin argued that accuracy of responding which is maintained after the removal of the sample-specific behaviour suggests that option (a) above is correct. In other words, if behaviour is no longer required and accuracy drops this suggests that the differential responses to sample control the choice of comparison. They found the former to be the case and therefore dismissed the mediation theory. This explanation does however not take into consideration the possibility of covert self-instructions (cf Lowe, 1979). The maintenance of accuracy could be the result of mediation, because the subjects may have labelled their responses (different speed of button pressing) to the different samples, e.g. DRL 3 - "slow", FR 8 - "quick". The sample stimuli may then have continued to control these verbal responses after the removal of the schedules for button pressing and the verbal responses may have come to control comparison selection.

In a second study Saunders and Spradlin (1990) used stimulus naming in order to achieve sample discriminations. In the studies reported in this thesis stimuli naming could obviously not be used to ensure sample discrimination as naming was part of the planned interventions. As argued above it is also possible that sample naming may do more than just simply ensure sample discrimination, and that it may have a mediating function. It was therefore necessary to device a procedure that would ensure sample discrimination without teaching subjects to name the stimuli. This was achieved by incorporating a identity matching task with the sample stimuli into the procedure. This meant that subjects were required to carry out an identity matching task with the sample stimuli prior to choosing a comparison.

The results from the preliminary study showed a clear difference in terms of ease of acquisition between the different types of instructions used during labelling training. The children who were told *"It is an Omni"* learnt the corresponding words fairly quickly. However, the children who were not supplied with such relational terms required many more trials before learning the labels, with one child failing to learn. The study was terminated before the children were taught common labels and further studies were therefore required to determine the feasibility and effects of these interventions. This study did however provide evidence that teaching children to match visual stimuli with spoken words without any explicit instructions about the relationship between the visual samples and the verbal comparisons, may be different from teaching visual-vocal such explicit instructions. The results therefore encouraged further investigations into the effects of the different types of instructions.

Only child responded correctly on the A-B task following the acquisition of the labels for the A-stimuli. It is possible, that the A-labels led to success on the A-B task because the verbal responses ensured discrimination between the sample stimuli (see discussion above). The results from one of the other children, Glenn, who was explicitly told to attend to the differences between the sample stimuli, further support the view that interventions to ensure sample discriminations can facilitate correct responding on conditional discrimination tasks. As explained above, the next phase in this study included a non-vocal method for ensuring sample discriminations. A second study, reported in Chapter 7, was then carried out to test this adapted procedure.

CHAPTER SEVEN

DEVELOPMENT OF PROCEDURE
PRELIMINARY STUDY II

The aim of this study was to finalise the procedure and standardise the blocked trial presentation by implementing the changes to the procedure described in Chapter Six. It was also intended to investigate further children's performance on the baseline task and during labelling training, plus the effect of stimuli-labels on the visual-visual matching task and the emergence of symmetry.

An identity matching task with the sample stimulus was incorporated into every trial to ensure that the children were discriminating between the samples. This task consisted of fitting the appropriate sample stimulus into a wooden "frame" which corresponded to the stimulus shape (see Figure 9, Chapter 6 for drawing of stimuli). The frame was fixed to the top of the response panel and resembled the kind of form board puzzles young children play with. The frames also ensured that the sample always appeared in the same place on the response panel, unlike in the previous study where the child could place the stimuli anywhere. An additional advantage of fixing the sample in the same position on the panel each time was that the children couldn't move the stimulus around on the panel. It also meant that the sample now always looked the same. It is possible that perceptual differences may previously have resulted in the children perceiving the same shape as different depending on its position.

SUBJECTS

Seven children participated in this study and their ages ranged between 4 years 1 month and 5 years 3 months. They were recruited from the same primary school class as the children in study I. However, as study II was conducted during the subsequent term the children in this study were slighter older. Yasmin was the exception as she had not started school but attended a play group attached to the school. Each child's age at the start of the study was as follows:

Subject	*Age (year : month)*	*Subject*	*Age (year : month)*
Yasmin	4:1	Samantha	5:2
Michelle	4:8	Natalie	5:3
Paul	4:8	Steven	5:2
Ali	4:11		

APPARATUS

The apparatus was the same as that used in preliminary study I except that the metal response panel was altered. There were now four such response panels in all, each with a wooden cut out frame fixed to the top. Each of these frames corresponded to one of the four stimuli used. Figure 14 shows a drawing of one of the response panels.

Stimuli

They stimuli consisted of the three-dimensional wooden blocks used in the previous study (Figure 9, Chapter 6). The top of each stimulus was fitted with a small round, wooden handle, to make it easier for the experimenter to remove the stimuli at the end of a trial.

Reinforcement set-up

The same set-up of music, lights and toys was used. The puppet was again used to provide social reinforcement for correct responding. No reinforcements were delivered during test trials.

Figure 14

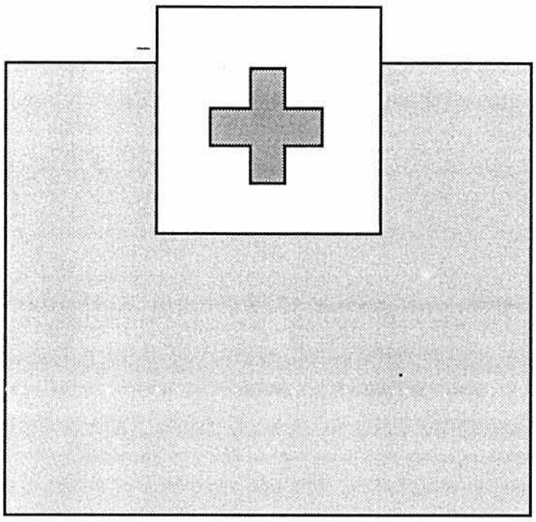


Figure 14 shows a drawing of one of the metal response panels with a cut out shape into which the sample stimulus was placed on each trial. All visual-visual matching trials began with the insertion of a metal response panel into the grooves on the "door" of the apparatus. There was one metal response panel for each stimulus.

DESIGN AND PROCEDURE

The same experimental room was used and the experimenter did again get acquainted with the children in the class room prior to commencing the study.

The general plan outlined in chapter Six (p.103) was followed. In this study the children who learnt the baseline A-B task were given a symmetry test. The basic procedure described in study I was followed with the addition of the identity matching task with the sample stimuli (see below for details). Again the exact procedure varied between the children depending on their performance and these deviations are noted in the result section.

All visual-visual matching trials began with the insertion of a metal response panel into the grooves on the "door". Two stimuli were then presented in the drawer underneath and the subject's task was to pick up the stimulus that corresponded to the cut out shape (frame) on the response panel and fit it into the frame. In other words, subjects carried out an identity matching task. The stimulus in the frame then served as a sample for that trial.

The identity matching task with sample stimuli was incorporated into each matching trial to ensure that the child was discriminating between the samples. After the sample had been placed in the frame the two comparisons were presented in the drawer and the child was required to choose one and place it on the response panel. The consequences for correct or incorrect choice of comparison were delivered as soon as the comparison was placed on the response panel.

The criterion for moving on to a subsequent stage in the procedure was 90% correct responding per trial type during one session. Sidman (1987) has argued that two-choice matching-to-sample tasks are prone to artefacts that can produce false positives. This criticisms is however only valid if overall performance is considered. In this study the response criterion was set high and applied to each sample-comparison combination.

Attempts were made to tell the children about the uni-directional relationship between the samples and comparisons without giving any clues to a symmetrical relationship using the same instructions as reported in Study I. As before, labelling training was introduced after these types of instructions had been unsuccessful.

Labelling training.

Subjects who failed to learn the baseline task were taught the labels for the set-A stimuli and then returned to baseline trials. The two labelling conditions *"That is Omni/Delta"* and *"Say Omni/Delta* were employed.

Symmetry test

A symmetry test was administered after a subject's performance had reached criterion on the A-B task. The test consisted of a 24 trial session (16 presentations of A-B and 8 presentations of B-A trials). The reinforcement probability was reduced during the session immediately prior to the test in order to only change one variable at the time.

Details of stages 1-5 of the procedure

(See summary of general plan in Figure 10, p.102, chapter 6)

1. A-B training

Each session during the training phase consisted of 16 to 32 trials. A blocked trial procedure was used throughout (details below).

The first session began with identity matching trials with the sample stimuli. The response panel was put in place, the two stimuli presented in the drawer underneath and the child was given the following **Instructions :**

"Pick up the one that fits in there. (E pointing to the frame on response panel) After a correct choice: *"When you get it right, you get some music and you get one of these buttons in here.* (Pointing to Connect Four matrix) *When the buttons get to the top you get a little present in there.* (Pointing to window). *And teddy comes out to take it away, and now you can try again"*

These trials were repeated until the child reliably chose the correct stimulus on each trial, i.e. the stimulus that matched the frame. The child then carried out eight A-B matching trials where the same stimulus served as the sample, i.e. a block of eight trials with each of the sample-comparison combinations.

During the initial AB matching trials the child, after having placed the appropriate sample stimulus on response panel, was told:

"That's right, but this time you have to do a little bit more before the music comes on. Teddy will show how to do it. See, those (comparisons) *come out here and you pick one up and put it on here.* (Demonstrates correct choice) *Then you get the music to come on. See if you can do that now?*

(Child makes correct choice) *That's was right. Now you get a button in here. Let's try again.*

(Child makes incorrect choice) *That wasn't the right one, so no music or lights. Let's try again.*

The block sizes were decreased as soon as errors occurred only during the first two trials in each block, i.e. when the child switched choice of comparison after two initial errors. The blocks were first decreased to six and then to four and two trials. Finally the children carried out a minimum of 40 trials with random trial presentation prior to withdrawal of the scheduled consequences to ensure that performance remained stable. The minimum number of trials for the procedure for the A-B training stage was 96, i.e. even children who made no errors during this stage needed to carry out 92 trials before proceeding to the testing stage.

2. A-X teaching

Each session consisted of 16 trials and the experimenter sat behind the panel during all the sessions. A blocked trial procedure was used and the subjects were given reinforcement contingent on saying *"Omni"* after having picked up A1 and *"Delta"* after choosing A2.

The sequence of training was as follows :

A response panel was inserted into the "door" and both the set-A stimuli were presented in the drawer. Subjects were required to put the correct stimulus into the frame on the panel, i.e. to carry out identity matching as described above. During the initial trials the experimenter gave the following instructions immediately after a stimulus was placed on the panel:

The experimenter said *"Say Omni/Delta"* if subjects were taught with the non-relational instruction and "*That is Omni/Delta*" when the relational instruction was used.

If the child did not repeat the label spontaneously s/he was prompted with *"Can you say Omni/Delta?"* On subsequent trials the following prompts were used:

2a Non-relational instruction:

"What do you say?" If still no reply: *Omni or Delta?*

2b Relational instructions:

"What is it?" If still no reply: *"Is it Omni or Delta?"*

The criterion for successful teaching was 14 correct responses during one session of 16 randomly presented trials.

Subjects who learnt the labels were then returned to baseline A-B matching, stage 3.

3. Return to A-B trials

The procedure was the same as for the initial A-B training (stage 1) except that subjects were now required to label the samples before the comparisons would appear. If they did not label the stimuli they were prompted as described above. The trial presentation was carried out according to the blocked trials procedure described above.

4. Reduction of reinforcement probability

Prior to the test in stage 5 all the subjects carried out a 16 trial session without contingent reinforcements. This was done in order to only change one variable at a time. Testing the A-B and B-A relations immediately after the A-B trials would have involved a change in two variables; the absence of reinforcement and the appearance of the set-B stimuli as samples in a visual-visual matching task.

During trials without contingent reinforcement both correct and incorrect choices were followed by the removal of the response panel but not by any sounds or tokens. The subjects were however given non-contingent feedback, to avoid the possibility of the children becoming reluctant to continue the task or not try "their best" on later sessions. They were therefore given tokens and boxes at the end of each session, when they always received three boxes regardless of their performance.

Identity matching trials with set-B stimuli were also intermixed with the A-B trials. This ensured that the children had experience, prior to testing, with the task of putting the set-B stimuli into the frames on the response panels.

In sum, the sessions in stage 4 ensured that the only variable altered during the testing stage was the appearance of set-B stimuli as samples and Set-A as comparisons.

The following instructions were given immediately prior to the withdrawal of scheduled consequences;

"Now the music and lights won't come on any more when you get it right. There won't be any noise to tell you if you are wrong either. And you won't get any buttons in here even if you are right. But teddy will keep the buttons for you behind here and he will give them to you at the end. You will also get boxes at the end. But you won't know until the end how many you have got. I am sure you can do it right every time even though there won't be any music, lights or buttons. Just try and do your best like you have done before."

When a subject's performance was stable during sessions without reinforcement s/he was given a A-B/B-A test.

5. A-B and B-A test

The final stage was a symmetry test, where A-B and B-A trials were presented together in random order at a ratio of 2:1, with a total of 24 trials (16 A-B and 8 B-A). The provisos for random presentation order described in Chapter Six applied here as well, namely : the correct comparison never appeared in the same position for more than three consecutive trials; the same stimulus was correct on no more than three consecutive trials; each comparison appeared in the left and the right position on an equal number of trials. The subjects were given non-contingent feedback as described above (stage 4).

RESULTS

Figure 15 below contains a summary table showing the number of trials carried out by each child at each stage of the procedure, the outcome of each stage, and the number of overall sessions.

A-B task

Four of the seven children, Steven, Ali, Michelle and Yasmin, learnt the A-B matching task without any verbal interventions. Three of them (Steven, Ali, Michelle) learnt the task quickly, making only a small number of errors; Steven made one, Ali five, and Michelle two errors. The youngest child, Yasmin, made more errors during the initial sessions and hence carried out more trials before learning the task. See Figure 15 for number of trials carried out by each child.

All the children continued to respond correctly in the absence of contingent consequences.

A-B/B-A test

Steven, Ali, Michelle subsequently passed a symmetry test, during which they responded correctly on all A-B and B-A trials.

Yasmin failed the symmetry test, during which the baseline performance also broke down. The test was therefore repeated during the following session, where her performance deteriorated further, dropping to chance level. Yasmin's responding, expressed as percentage correct responding for each test, was as follows:

Test 1.	A-B trials - 75%	B-A trials - 63%
Test 2.	A-B trials - 60 %	B-A trials - 50%

She became very restless and reluctant to carry out the task during the testing sessions and then refused to participate in further sessions.

Figure 15

Summary table for Preliminary study 1, showing the number of trials carried out by each child at each stage of the procedure, the outcome of each stage, and the number of overall sessions.

CHILD	**AGE**	**A-B[1] training**	**A-B & B-A test**	**A- X[2] teaching**	**Return to A-B**	**Total number of sessions**
Steven	5 : 2	98 Learnt	24 Passed	-	-	6
Ali	4 : 11	120 Learnt	24 Passed	-	-	7
Michelle	4 : 8	98 Learnt	24 Passed	-	-	7
Yasmin	4 : 1	152 Learnt	48 Failed	-	-	13
Natalie	5 : 3	344 Failed 44[3] Learnt	24 Passed	-	-	19
Samantha	5 : 2	340 Failed	-	(b) 38 Learnt	48 Failed	20
Paul	4 : 8	330 Failed	-	(a) 64 Failed (b) 32 Learnt	40 Failed	25

1 Minimum number of trials for procedure = 92

2 The letters in the brackets refer to the instructions during the label training:
(a) = non-relational instruction, (b) = relational instruction.

3 After instruction *The right one changes sometimes*

Natalie, Paul and Samantha did not learn the A-B task and where therefore told to *"Look at that one* (sample) *before you choose one of these* (comparisons)." This instruction was intended to make the relationship between sample and comparison more obvious, and was repeated on every trial. It did not however have any effect on the children's performances. See table in Figure 15 for number of trials carried out by each child, and Figures 16 and 17 for graphs of their performances.

Natalie (See Figure 16) was given a further instruction after she had carried out 344 trials without learning the A-B task, when she was told *"the right one changes sometimes, and you have to try and find out when it has changed"* after which she started to respond correctly. Correct responding was maintained after withdrawal of contingent consequences and she then went on to pass a symmetry test.

Samantha and Paul carried out 340 and 330 trials (15 sessions) respectively without learning the A-B task. They both made comments about the task and the stimuli during these sessions and these are reported below.

Samantha did not continue choosing the same comparison stimulus during the initial sessions where the trials were presented in blocks of eight. The size of the blocks were therefore increased to 16 trials. Following the first session with a block of 16 trials of the same sample-comparison combination Samantha commented:

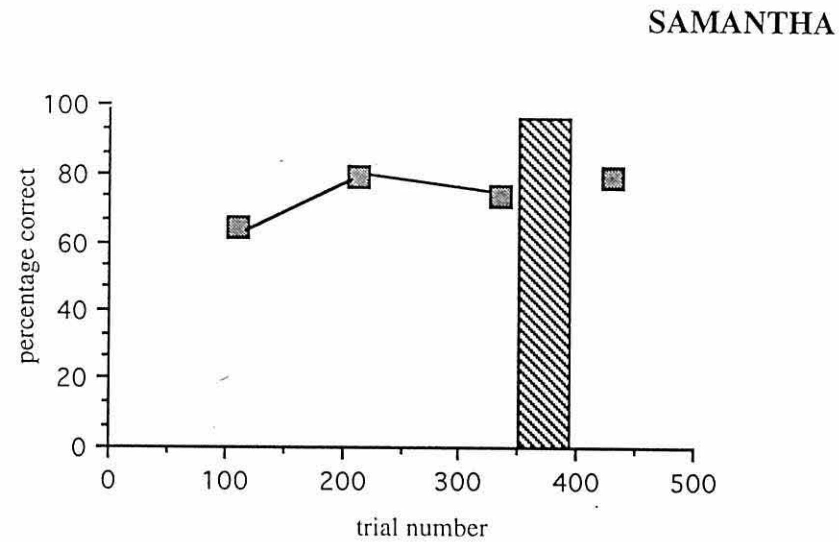
"Ah, it's always this one isn't it""

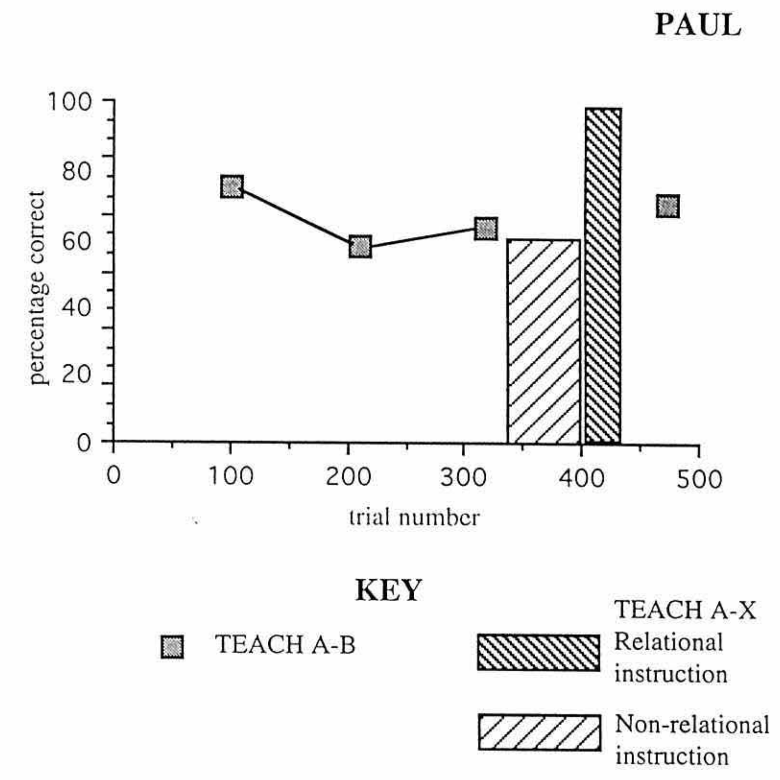
She subsequently started to switch her choice of comparison following an error when the block sizes were reduced to eight and then six trials. Further reduction did however lead to a deterioration in her performance, which decreased to chance level during blocks of four.

Samantha named the comparison stimuli *"Square"* (B1) and *"Bow"* (B2) during the fifth and sixth sessions. On several trials she made these vocal responses after putting the sample onto the response panel but prior to the appearance of the comparisons. In other words, she said *"That's a square"* after putting the A1 sample on the panel, and *"That's a bow"* in the presence of the A2 sample stimulus. No further verbalisations in relation to the task or stimuli where made during any of the subsequent trials.

Figure 16

Graph showing percentage correct responding for **Samantha** and **Paul**

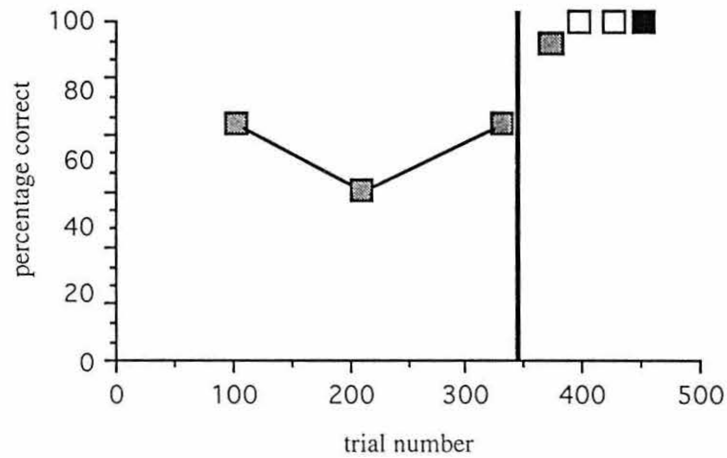




Visual-visual matching is represented as scatter plots and labelling trials as bar-charts. The width of each bar corresponds to the number of trials carried out by the child.

Figure 17

Graph showing percentage correct responding for **Natalie**



KEY

TEACH A-B

A-B TEST

B-A TEST

Instruction : "The right one changes sometimes and you have to try and find out when it has changed

Visual-visual matching trials are represented in a scatter plot. The vertical line represents the introduction of the verbal instruction.

Paul pointed to the stimuli during the eight session saying:

"Those things, I don't know what they are called".

The following dialogue took place between Paul and the experimenter at the start of the eleventh session:

Paul: *"Why don't you write on it so I know which one's the right one?"*

E : *"What do you mean?"*

Paul: *"You could write a number on it so I know which one is right"*

E : *"But it is not always the same one that is right, so you would have to have a number on both, and then you still wouldn't know which one is right"*

Paul : *"But you would write a number on one and then rub it out, and then write it on the other one."*

A-X teaching

Paul and Samantha (See figure 17) were given labelling training; Samantha was given the relational and Paul the non-relational instruction. Samantha learnt the labels within 46 trials. She also described the relationship between the words and the stimuli (while pointing to the stimulus) during all the sessions, making comments like: *"What do I say for that one? Is it Omni or Delta?"*

Paul carried out 72 trials without learning the labels. He was then told: *"That is Omni/Delta"* and proceeded to learn the appropriate labels within 32 trials.

Return to A-B task

Paul and Samantha then returned to the baseline task, where they continued to label the samples but neither of them learnt the A-B task. They were both very reluctant to continue the sessions. They seemed less attentive than the other children and needed more encouragement to finish each session. They tended to wander around the room, talked a lot about events unrelated to the task and usually wanted to leave after ten trials. Paul even said on a few occasions *"I don't want to do this any longer and that is why I* *keep getting it wrong."* It was therefore decided not to carry out any further trials with these two children.

SUMMARY

Of the seven children who participated, four learnt the A-B task prior to any interventions and three of these passed a symmetry test. One child, Yasmin, failed the test. Her reluctance to carry out the task in the absences of reinforcement may have had an adverse effect on her performance, or, conversely, her reluctance may have been the result of failure on the test.

One child, Natalie, learnt the A-B task and passed the symmetry test after the relationship between the sample and comparison had been made more explicit by telling her to try and find out when the correct comparison changed. It could be argued that this instruction may have been successful because it brought about attention to the sample. However, as the identity matching procedure already assured this, it would appear that the instruction added more information, perhaps by providing a clue to the relationship between sample and comparison.

The two remaining children were taught to label the samples. The different instructions resulted in different outcomes. The child (Samantha) who was given the relational instruction learning the labels within two sessions whereas Paul who was given the non-relational instruction did not learn. He did however learn the labels after the introduction of the relational instruction. Neither of these children subsequently learnt the A-B task and were then excluded from the study, as was Yasmin who, having learnt A-B, failed a symmetry test. To be more precise they excluded themselves by making it clear that they did not want to continue.

DISCUSSION OF BOTH PRELIMINARY STUDIES

A major advantages of the procedure which encouraged further studies was that no pre-training was required to teach the basic skills required and that the children who learnt without interventions did so very quickly. In other words, they showed a very rapid acquisition of the baseline task, which justified short baselines in future studies. Two children in the second preliminary study were kept on the baseline task for over 300 trials which was more than three times the average number of trials for the children who learnt the task. These two did however still fail. They did also become bored and reluctant to continue the task prior to finishing all the planned stages. It was therefore decided that subsequent studies would have a reduced number of baseline trials.

Around half of the children learnt the baseline task, two out of six in the first study and four out of seven in the second, i.e. a total of six children of thirteen studied learnt the task. This was encouraging as the intended investigations depended on some children learning and others failing the base line task. They also required children who learnt the baseline (A-B) tasks but failed symmetry (B-A) tests, which one child did in the second preliminary study.

During labelling training there was a clear difference between "straight" object-word matching and matching when the relationships between the objects and the words were made obvious. Six children who had previously failed the A-B task were given labelling (A-X) training; three with the relational instruction and three with the non-relational instruction. The former three learnt the labels relatively quickly (around 50 trials) whereas only one of those given the non-relational instruction learnt A-X. This indicates that visual-visual and visual-verbal matching may not differ, in terms of ease of acquisition, if there are no cues to the relationship between samples and comparisons. The studies planned for this thesis did however depend on teaching A-X matching without such cues to children who had previously failed the A-B task. In other words, it would not be possible to compare the effects of different labelling interventions on visual-visual matching task if the children would only learn the labels in one condition.

The failure to acquire the labels in this study may have been due to the actual instruction used. It is possible that the non-relational instruction was unsuccessful because the instruction *"Say"* was confusing and prevented attention to the visual stimulus. There is no obvious reason why a child on being told to say a strange word should connect that word to any particular object. On the other hand, it seems that this is just how language acquisition occurs during infancy, i.e. word-object pairing leads to learning of names for objects. Infants do however not learn names without clues to the relationship between the words and the objects nor are they asked to repeat words out of context. Their care-givers engage in non-verbal communication, they make obvious the relationship between the words and the objects, e.g. through pointing to and looking at objects, while talking about those objects. (Clark & Clark, 1977). In this study attempts were made to teach stimulus labels (object-word matching) without explicitly telling the children about the relationship between the labels and the stimuli, but unfortunately the procedure was not adequate at this stage. Further changes were therefore needed, and these are described below.

The comments made by Paul and Samantha suggest that the children's verbal behaviour can provide clues to the controlling variables for their non-verbal performance. Both children appeared to treat the task as a problem to be solved. Samantha asked questions and made comments about the task and she also seemed to use common names for the stimuli. She still failed to learn the AB task, possibly because she did not use the names consistently.

The role of private speech has received much attention since Vygotsky (1978, 1984) and Luria (1961) first suggested that it serves to regulate and control non-verbal behaviours. There is a large body of evidence which support their view that spontaneous private speech serves a function of self-guidance and self-direction and that it tends to increase with task difficulty and errors (Berk, 1985; Berk & Garvin, 1984; Frauenglass, Marni, & Rafael, 1985; Goodman, 1981, 1984; Pellegrine, 1980). It was therefore decided to include an analysis of the children's spontaneous verbalisations in the next stage of the study.

Changes made to the final procedure

The following changes were instigated on the basis of the two preliminary studies.

The use of 3-dimensional stimuli was not enough to ensure acquisition of matching-to-sample. It did however facilitate the development of a non-verbal method for increasing discrimination between the sample stimuli. It also made it possible for the experimenter to say the word as the child held the a stimulus and thus facilitated attempts to teach words in some sort of context. In the final procedure the word *"Say"* was omitted when teaching labels without relational instructions and the experimenter merely said the word *"Omni"* or *"Delta"* as soon as the child picked up a stimulus. The alteration to say the word while the child was holding the stimulus was made in an attempt to increase the probability of the child attending to the stimulus while the word was spoken. The word *"Say"* was omitted in order to decrease possible confusions and misunderstandings. The general instructions about the task were simplified by using the glove puppet to model correct responding for the same reason.

The use of the glove puppet had additional advantages. As mentioned earlier it ensured continued social interaction with the children after the experimenter had moved behind the response panel. It was also explained that the glove puppet, known as "Teddy", had defined which stimuli were relevant and that the experimenter did not know. It was hoped that this would emphasise that there was something about the stimuli that was important (Daehler & Bukatko, 1974). In addition it reduced the problem of the child asking the experimenter's advice.

The number of trials per training session was standardised to 16, which, based on the pilot studies, appeared to be the maximum for maintaining the children's motivation.

It was decided to make the size of the blocks of sample-comparison combinations irregular to avoid possible problems with subjects counting trials between reinforcement deliveries. The success of the blocked trial procedure depends on subjects switching choice of comparison in relation to change of sample stimulus. If all blocks consist of the same number of trials it is possible that the children would learn to switch after a certain number of trials which would reduce their chances of learning the relationship between samples and comparisons.

The position of the Connect Four matrix was altered and it was now placed on a chair next to the child. The tokens were now delivered to the child by the glove puppet and the child then placed the tokens into the matrix. This was done to make the contingency between a correct response and the delivery of a token more obvious and to prevent boredom.

It was decided to repeat the final test session due to the small number of B-A trials and calculate the percentage of correct responses across the two sessions.

The various instructions used in the preliminary studies to emphasise the relationship between sample and comparison had little effect on the children's performance. Further studies are needed to investigate the effect of these kind of instructions. However as the aim here was to study effects of stimuli naming these instruction were omitted in the final procedure in order to simplify it.

CHAPTER EIGHT

INTRODUCTION TO EXPERIMENTS 1 - 3.

EXPERIMENT 1: Baseline training and symmetry test.

General background and hypotheses

These experiments are a continuation of studies by Dugdale and Lowe (1990), who have argued that naming, defined in terms of stimulus-response symmetry, may have a mediating role in the emergence of stimulus-stimulus symmetry. However, it is not clear *how* vocal responses come to function as mediating names during matching-to-sample tasks.

The aim of the experiments reported in this thesis was to use the procedure developed during the preliminary studies to investigate further the conditions under which naming promotes stimulus equivalence and in particular to determine the effects of instructions used during naming training. These aims are set out in more detail below.

Hypotheses

The main hypotheses tested in the present studies were:

* Vocal responses made to stimuli during a conditional discrimination task may have a mediating role in the emergence of stimulus-stimulus symmetry.

* Vocal responses may come to function as mediating names during matching-to-sample tasks more readily if the relationship between the vocal response and the visual stimulus is made explicit by the use of relational instructions (e.g. "that is") during naming training.

The following hypotheses were also tested :

* Performance on visual-visual matching and visual-verbal matching tasks may differ within the same procedure. In the study by Dugdale & Lowe (1990) the children who

had previously failed stimulus-stimulus matching tasks had no problems learning to label the stimuli (stimulus-word matching). It is possible that learning names is easier because it involves inter-modality matching, or it may because stimulus-word matching is part of child's previous history. The present study allowed a better comparison between the two types of matching than Dugdale & Lowe's study, as both visual-visual matching and visual-verbal matching were trained using a procedure which was designed to minimise experimenter clues to the relationship between the samples and comparisons.

* The effect of verbal labels may differ depending on whether they are taught before or after the acquisition of the baseline task. Common names taught prior to the acquisition of the baseline task may have a mediating function in learning A-B matching. It is however possible that B-A could emerge without any mediation; symmetry may simply be an automatic result of learning the baseline task which does not require verbal mediation. In other words, verbal mediation may only have an indirect effect on the emergence of untaught relations. The direct effect of verbal mediation was tested here by teaching labels after success on the baseline task but following failure on a symmetry test. The performance of these children was then compared with those who were taught labels after having initially failed the baseline task

* Performance on matching-to-sample tasks may differ depending on the child's age or level of language development. Several investigators (Beasty, 1987; Devany et al, 1986) have suggested that age and linguistic ability are important variables for success on these tasks and the present studies provided an opportunity to investigate this further.

OUTLINE OF THE PROCEDURE

1. Attempt to train conditional discriminations between visual stimuli, without telling the subjects anything about the relationship between the stimuli. If subjects learn, test for symmetry.

2. If subjects do not learn or symmetry is absent, teach vocal labels in the presence of the stimuli. There are three reasons for this intervention:

   i) To compare the effect of labels taught when the experimenter attempts to make explicit the relationship between the visual stimuli and the words, by telling the subjects *"That is Omni/Delta"*, and labels taught by the experimenter simply saying the words in the presence of a stimulus.

   ii) To investigate if the acquisition of labels differs depending on how they are taught.

   iii) To compare object-object matching with object-word matching, particularly in terms of ease of acquisition.

3. Compare the effects of labels taught before and after the acquisition of the baseline conditional discrimination task (i.e. after failing the baseline A-B task and after the failing B-A test) in order to investigate if the emergence of symmetry differs depending on how the baseline is acquired.

4. Compare the above interventions across different age groups and level of language development.

DETAILS OF GENERAL PLAN AND PROCEDURE

The basic method used throughout all three experiments was the same as that described for the preliminary study II (chapter 7) unless otherwise stated. The following chapters therefore only contain details about the method which are necessary to facilitate the "flow" of the account of the experiments.

A schematic summary of the general plan showing the sequence of training and testing stages is provided in Figure 18.

The blocking procedure described previously (chapter 6) was used throughout, with a block consisting of a set number of trials with the same sample-comparison combination, i.e. the same comparison being the correct choice for a set number of trials. This will from now on be referred to as "a block of " followed by the number of trials. The size of the blocks was gradually decreased until presentation order was random. This reduction in block sizes occurred as soon as errors were confined to the first trial within each block.

Although this study could be regarded as one experiment the different stages will be treated as separate experiments to enhance the clarity of the report and facilitate discussion of the results.

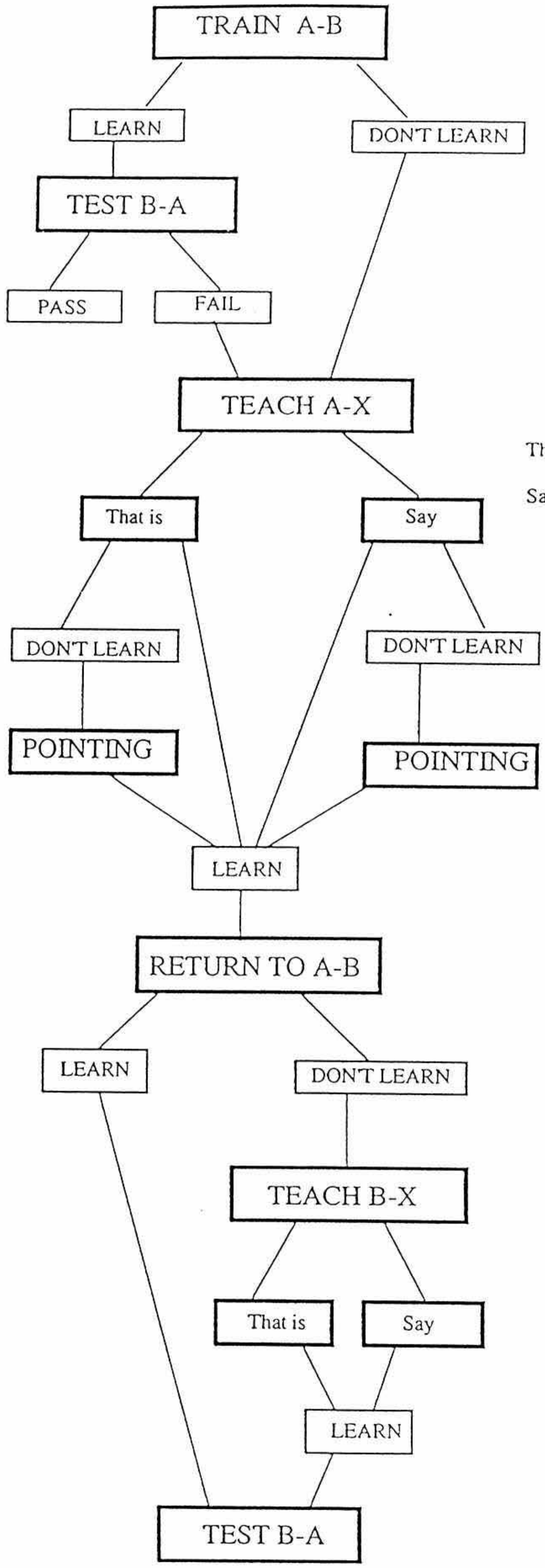
Experiment 1 consisted of two phases; A-B training and symmetry test, which were carried out to select subjects for further experiments. Possible differences in performance related to age and level of language development were also tested for.

Experiment 2 included three children who had previously failed to learn the A-B baseline task and three children who had learnt the baseline task but failed a symmetry test. These children were then taught to label the stimuli and the effects on the A-B task and a subsequent B-A test were investigated.

Five children who had learnt the baseline task and passed a symmetry test without any experimental interventions took part in a further experiment to test for emergence of equivalence responding. This is reported as Experiment 3.

Figure 18 overleaf shows a schematic overview of the experimental training and testing stages.

The boxes with the wide borders show the training and testing stages, and the boxes with the lighter borders show the possible outcomes.



That is = Relational instruction

Say = Non-relational instruction

EXPERIMENT 1: Baseline training and symmetry test

INTRODUCTION

There were two aims for his stage:

1. To select subjects for further studies
2. To test the hypothesis that performance on matching-to-sample tasks may be related to children's age and linguistic ability.

The number and type of relevant spontaneous utterances made during the experimental sessions were also analysed in order to determine any relationship between the production of private speech and the children's success or failure on the matching task.

SUBJECTS

An initial subject pool of 20 children (12 boys and eight girls) aged between 3 years 3 months and 4 years 11 months were recruited from a local primary school reception class and a university run day nursery.

The level of each child's language development was assessed with the Reynell Developmental Language Scales (Reynell, 1977), but no other formal assessments were carried out. Informal inquiries made to parents and staff supported the conclusion that all the children were normally developing without any known problems regarding vision or hearing.

The younger children required more pre-experimental time to get acquainted with the experimenter who therefore spent three weeks in nursery playing with children prior to introducing them to the experimental task.

METHOD

The apparatus, stimuli, and reinforcement set-up were the same as those used in preliminary study II, with the introduction of the changes described at the end of chapter 7. The glove puppet was used to model correct responding and to give the plastic tokens to the children who put them into the matrix. At the end of each session the tokens were removed from the matrix and exchanged for the little boxes that had been placed behind the perspex window above the response panel.

The children who learnt the A-B task and passed the symmetry test also took part in a post-experimental task designed to elicit verbalisation about the task and the stimuli. As before all sessions were video recorded.

Spearman's correlation coefficients were calculated to test for associations between the children's performance on the A-B task and their ages and scores on the Reynell test.

Procedure

A-B training

Figure 19 shows an overview of the training sequence for the minimum number of sessions required prior to symmetry testing, and details, including instructions given, are provided below. There were 16 A-B matching trials within each session. The criterion for moving on in the sequence was 90% correct responding. Children who continued to make errors were returned to a previous stage in the sequence.

Figure 19

Overview of the training sequence for the minimum number of baseline sessions required prior to symmetry testing

Stage in sequence		Matching task and block size
1	a)	Identity trials with one A-stimulus as correct choice
	b)	A-B matching: block of 8 trials if errors confined to initial trials, otherwise continue for another 8 trials = block of 16.
	c)	Identity trials with the other A-stimulus
	d)	A-B matching : block of 8 trials
2		A-B matching: four blocks of unequal size, 5 - 4 - 3 - 4 If no errors - go to stage 3. If errors are made repeat session. E goes behind the screen
3		Random presentation order for two sessions if criterion reached. If criterion not reached carry out at least four sessions before returning to stage 2.
4		Reduce reinforcement probability 8 A-B trials (random presentation) + 4 identity matching trials with B-stimuli = 12 trials with contingent reinforcement Followed by 8 A-B trials (random presentation) + 4 identity matching trials with B-stimuli = 12 trials without contingent reinforcement
5		b) 16 A-B trials (random presentation) + 8 identity matching trials with B-stimuli = 24 trials without contingent reinforcement.

Stage 1

The first session started with a minimum of four identity trials with one A-stimulus being correct. The next step was a block of eight A-B trials where this A-stimulus served as sample. The order of the identity matching trials was counterbalanced so that half of the children started with the A1 stimulus and the other half started with A2. If the child chose the correct comparison on the last six trials in the A-B block it was followed by identity trials with the other A-stimulus and a block of eight A-B trials with its corresponding comparison being correct.

If the child did not consistently choose the correct B-comparison in the initial block this was extended to 16 trials. The next session then consist of 16 trials where the other comparison was correct and block sizes were then reduced to eight trials in the subsequent session.

Instructions

a) Identity matching with the first A-stimulus

The child sat in front of the response panel with the experimenter to the right, which meant that the experimenter was able to operate the glove puppet both in front and behind the panel. The Connect Four matrix was placed on a chair next to the child.

A metal response panel was put in place, the glove puppet was introduced to the child and the following instructions were given:

"This is Teddy and he will show you how to play the game. Watch Teddy."

The two A-stimuli were presented in the drawer underneath the response panel and teddy demonstrated a correct choice, which resulted in music and lights. The child was told: "*Listen to that, Teddy made the music come on. Watch Teddy again.*"

(Teddy demonstrated another correct choice) "*Can you see the lights around here? They come on with the music. Now you try to get the music and lights to come.*"

The child was then required to respond. If the child made a correct choice, the experimenter said: *"That's right. When you get it right Teddy comes out and gives you* *one of these buttons. You put them in here . Lets see if you can get some more buttons up to the top."*

If the child made an incorrect choice the experimenter said: *"No, that was wrong. That noise comes on when you are wrong. Try again."*

b) A-B matching with one sample-comparison combination

The child was told prior to the next trial: *"Don't do anything, just watch Teddy.* Teddy picked up the appropriate A-stimulus and placed it on the panel, and the B-stimuli were presented:

"This time you have to pick up one of these. Like this. (Correct comparison choice demonstrated)

"Teddy will do it again, just watch" (Another demonstration).

On the subsequent trial : *"Now you try it."*

After the sixth correct choice the child was told: *"Now you are at the top and look what happens in here when you get to the top, there's a little present in here for you. You can have a look in the box later. Now lets see if you can do another row of buttons to the top and get another box in here."*

c) Identity matching with the second A-stimulus

The child was told *"Look up here before you choose"* (experimenter pointing to the frame on response panel).

d) A-B matching with the other sample-comparison combination

After presentation of the B-comparisons the child was told : *"Now you have to find the right one of these. Watch teddy first"* (Teddy demonstrated correct choice). On the subsequent trial : *"Now you try it"*

Stage 2

In this stage there were four blocks of 5, 4, 3 and 4 trials respectively. Children who made no errors in this stage were given random presentation next (stage 3). If children made more than one error in this stage it was repeated during the subsequent session and the order of the correct comparisons was reversed. In other words, if the previous session had started with five A1-B1 trials the next one started with five A2-B2 trials.

When this stage was repeated the children were also given the following instruction after fitting the sample stimulus on the panel and before the presentation of the comparisons:

Look at that one (E points to sample) before choosing.

This was done in order to emphasis the importance of the sample stimuli without using instructions that may give clues to a symmetrical relationship between the samples and the comparisons.

After two sessions with this block size the children who only made errors on the first trial following the change of correct comparison moved on to stage 3. In other words, children who changed their choice after making an error and then chose the same comparison until making another error (win-stay; loose-shift strategy) went on to stage 3. Children who did not respond consistently in this way were moved back to stage 1.

Stage 3

The experimenter now went behind the screen. This stage consisted of a minimum of two 16 trial-sessions with random presentation order, i.e. the criterion for continuing to the next stage was 90% correct responding during two sessions. Children who did not reach criterion returned to stage 2. The number of sessions depended on the children's performance, as they were not returned to the previous stage if their performance showed an upward trend.

Stages 4 and 5

The aim here was to withdraw gradually the contingent reinforcement and to increase the number of trials in a session. The symmetry test consisted of 24 trials without reinforcement. The number of trials was therefore increased to this number prior to the test to assess the child's ability to cope with a longer session. Identity matching with set B-stimuli were also intermixed with the A-B trials. As explained in chapter 7, the gradual introduction of these changes ensured that the only variable altered during the symmetry testing stage was the appearance of the B-stimuli as samples and the A-stimuli as comparisons.

In stage 4 the children carried out eight A-B trials (random presentation) which were intermixed with four identity matching trials with the B-stimuli. They were given contingent reinforcement during these trials and at the end of the 12 trials the tokens were exchanged for the little boxes. The children then carried out a further 12 trials (eight A-B and 4 identity matching with B-stimuli) without contingent consequences. The sequence of training meant that the minimum number of trials carried out prior to withdrawal of reinforcement was 72. In other words, even children who made no errors carried out 72 reinforced A-B trials over five sessions

Prior to the withdrawal of the contingent consequence the following instruction was given:

"Now the music and lights won't come on any more when you get it right. There won't be any noise to tell you if you are wrong either. And you won't get any buttons in here even if you are right. But teddy will keep the buttons for you behind here and he will give them to you at the end. You will also get boxes at the end. But you won't know until the end how many you have got. I am sure you can do it right every time even though there won't be any music, lights or buttons. Just try and do your best like you have done before."

At the end of these trials the children were given further tokens and one box. These non-contingent consequences were given to enhance the child's motivation to continue with further sessions.

Stage 5 consisted of 16 A-B trials and eight identity matching trials with set -B stimuli with non-contingent consequences as before. The children were given two boxes at the end regardless of their performance. If performance broke down at this stage contingent reinforcement was reintroduced, if not the next stage was a symmetry test.

Symmetry test

A symmetry test was administered after the children's performances had reached criterion on the A-B task in stage 5. The test consisted of two sessions each with 16 A-B and 8 B-A trials which were presented in random order without contingent consequences. The rationale for having the B-A trials intermixed with A-B trials is to exclude the possibility that failure on the symmetry test is due to breakdown of the baseline.

Post-experimental task

The children who passed the symmetry test were given a post-experimental task to elicit verbalisation about the task and the stimuli. Another glove puppet, called "Spot the dog" was introduced for this, and the children were told that Spot didn't know how to play the game and asked to tell him how it was done. This was done to make the task seem less of a test.

The child was seated by a TV monitor on which the response panel and the dog puppet could be seen but the child not was able to see the response panel directly. This meant that the child could not point directly to the stimuli and it was hoped this would encourage talk about them.

The stimuli were presented as before and the child asked to tell Spot which stimulus to choose on each trial. Children who merely said *"That one"* while pointing to the monitor were told that Spot couldn't see the TV and that they had to say which one they meant.

After two trials of each A-B combination the children were asked to predict the correct stimulus by asking them: *"Tell Spot which one is going to be the right one this* *time"* before the stimuli appeared. This meant that the children could not point to the stimuli and that any answer had to be vocal.

RESULTS

See Figure 20 for a table showing the number of trials on the A-B task, the outcome of the B-A test, the chronological ages of the children and their scores on the Reynell test.

Seventeen (81%) of the 20 children learnt the A-B baseline. Fourteen (82%) of these 17 then passed the B-A test. The six children who failed either the A-B training phase or the B-A test went on to participate in the next experiment and details about their performance will therefore be discussed in relation to experiment 2 (Chapter nine).

The children who learnt the A-B task did so quickly with the exception of Richard and Megan. Richard was a reluctant participant and refused to complete a full session of 16 trials on several occasions. He was not given a Reynell test because he was absent from school for a prolonged period and then refused to come into the experimental room.

Megan switched her choice of comparison after making one initial error during the second stage (blocks of 5 - 4 - 3 - 4) but alternated between comparisons when random presentation was introduced. She went through the sequence of training again starting at stage two and then learned the baseline task.

Megan was the youngest child and required the highest number of trials to learn the baseline task, but a Spearman's test showed no significant correlation between the number of trials required to learn the task and chronological age ($r_s = .148$; $p = .575$).

The Spearman's correlation coefficients calculated to test for associations between the number of trials on the baseline task and the scores on the comprehension and expression components of the Reynell test were respectively -.532 ($p = .0395$) and -.229 ($p = .376$). In the case of the comprehension score the coefficient was inflated by the presence of a single outlier with a score of 3.42 and 232 trials (Megan). As three coefficients were calculated it was necessary to correct the value of alpha to allow for the corresponding inflation of type I error. The value corresponding to an alpha of .05 under these circumstances is .017 and using this criterion none of the correlations obtained was significant.

Age did not appear to be related to success on either the baseline task or the symmetry test (see Figure 20). The four youngest children learnt the A-B task, whereas two of the oldest (Rhys and David) didn't. Two of the children who failed the symmetry test (Daniel and Joseph) were also among the oldest whereas the four youngest passed the test.

The scores on the Reynell language test did not appear to be related to success on either task. One child with low scores, Rhys, failed to learn the baseline task. However, the other two children who failed to learn A-B task did not have low scores and Laura who had scores similar to Rhys's learnt the baseline task. Laura failed the symmetry test, but the other two children who failed the test (Joseph and Daniel) had high scores on the Reynell test.

Figure 20

Table showing the number of trials on the A-B task, the outcome of the B-A test, the chronological ages of the children and their scores on the Reynell test

NAME	RESULTS Number of reinforced A-B trials	Passed BA	AGE at testing	EQUIVALENT AGE SCORES Compre- hension	Expression
Daniel	136	**No**	5:0	5:07	4:11
Matthew	104	Yes	5:0	6:03	> 7:00
Joseph	72	**No**	5:0	> 7:00	4:07
Rhys	**Failed** (128)		4:11	3:03	3:05
Michael	104	Yes	4:11	4:03	3:10
Andrew	72	Yes	4:11	4:09	4:03
Stephanie S.	72	Yes	4:11	5:01	> 7:00
Erin	104	Yes	4:11	4:09	4:05
David	**Failed** (174)		4.11	5:05	4:00
Stephanie J.	72	Yes	4:10	5:08	6:11
Kate	72	Yes	4:10	6:09	> 7:00
Luke	88	Yes	4:10	4:07	3:04
Richard	200	Yes	4:09	Not tested	
Laura	128	**No**	4:06	3:05	2:09
Melanie	72	Yes	4:05	4:07	3:09
Carlie	**Failed** (192)		4:05	4:03	4:06
William	72	Yes	4:00	4:09	4:10
Jonathan	72	Yes	3:10	5:08	6:08
Justin	72	Yes	3:07	>7:00	3:09
Megan	232	Yes	3:05	3:05	4:06

The figures in the column headed "Number of reinforced A-B trials" refer to the number of trials carried out on the A-B task prior to the withdrawal of the reinforcement (the minimum for the sequence of training was 72 trials) or the number of trials prior to the introduction of the labelling intervention (for those children who did not learn the A-B task).

The children's spontaneous verbalisations during training and testing sessions were analysed. In addition, the children who learnt the AB task and passed the symmetry test carried out a post-experimental task designed to elicit verbalisations about the task and the stimuli. Appendix 2 contain a list of all the comments made about the stimuli (both during and after the matching-to-sample sessions) by these children. The table in Figures 21 show the number and types of spontaneous verbalisations made during the experimental sessions.

The majority of the children's comments were made either about the individual stimuli or about the relationship between them. One child, Michael, commented on having made an incorrect choice prior to receiving feedback during the second training session.

None of the children used common names for a sample and its corresponding comparison during the experiment. Only one child, Michael, used common names during the post-experimental task where he said The *"other letter"* to both the A-stimuli and *"The other square "* in the presence the two B-stimuli. Matthew used a common label, *"the wiggly one",* for the A1-sample and the B2-comparison during the post-experimental task. In other words, he used a common name for two stimuli which he had not previously matched together.

Figure 21

Table showing the number and type of spontaneous verbalisations made during the experimental sessions.

Child	Individual stimuli	Relationship between stimuli
Learnt AB & passed BA		
Matthew		3 (II)
Michael	1 (II)	
Stephanie S.	4 (I, II, III, IV) 10 (test sessions)	
Stephanie J.	1 (I)	
Richard		2 (XI)
Jonathan	1 (I)	
Justin	1 (I)	1 (I)
Megan	2 (X)	
Learn AB, failed BA		
Daniel		1 (test session)
Joseph	3 (II, IV) 1 (test session)	
Laura	20 (test sessions)	4 (test sessions)

The table shows the number of verbalisations made about the individual stimuli and about the relationship between the stimuli. The Arabic numerals refer to the number of utterances, the Roman numerals in the brackets refer to the numerical order of the experimental sessions during which the utterances were made.

The utterances made about the individual stimuli took the form of descriptive labels. For example A1 was referred to as *Snowman, Hammer, Foot shape;* A2 as *triangle, Arrow;* B1 as *Cross, Sword, X;* B2 as *Bow, Bow tie, Cube* (see Appendix 2).

Nine of 14 children how were successful in both the training and testing stages produced spontaneous utterances about the task, but, with the exception of Stephanie S., they only did so for one session. Six of these children used at least one descriptive label during the experimental sessions, but none labelled all four stimuli spontaneously. During the post-experimental session eleven of these children labelled at least two of the stimuli and seven labelled all four stimuli. Two children (Megan & Jonathan) who had used labels during the experiment did not do so afterwards, and one child (William) made no verbalisations about the stimuli in either condition.

Two of the children who failed the symmetry test labelled the stimuli during the test sessions. None of the three children who failed to learn the baseline task produced any spontaneous utterances related to either the stimuli or the task.

Four children verbalised about the relationship between the stimuli. Matthew described the relationship between the samples and comparisons during his second session saying *"The cross (B1) goes with the wiggly one (A1) and the triangle (A2) goes with the one like this"* (traced the shape of B2 in the air).

Justin asked at the end of the first block of eight A1-B1 trials: *"Why isn't there one for this one?"* (pointing to the A2 stimulus).

Richard verbalised the contingency between sample and comparison during his eleventh session, when he said *"I know which one goes with this one"* after putting the sample in the frame and prior to the appearance of the comparison stimuli.

Daniel was reluctant to respond on first BA trial saying *"I don't know which one"*. On the second BA trial he commented on the position of A and B stimuli being reversed saying *"That was a funny one"*. The experimenter asked why and Daniel responded: *"Because that (B1) is there* (pointing to sample frame) *and that* (A1) *is there"* (pointing to response panel).

Five of the children (Justin, Jonathan, Richard, Stephanie J.) traced the outline of the stimulus shapes in the air during the post-experimental task. One of these children, Justin, also described the shapes verbally when asked to predict the correct comparisons. Justin on one trial, where the B1 stimulus was the correct choice, drew the shape of a cross in the air and said *"It is going to be one like that and one across"*. On a later trial when the correct comparison was the A2 stimulus he said *"The line to there and then to there"* while drawing the shape of a triangle in the air. When experimenter asked *"Could you tell doggy without using your hands"* Justin said *"The triangle"*.

CONCLUSION

The analysis of the results did not reveal any obvious explanations for the differences in the children's performance on the task, which was not related to either their ages or the scores on the language development test.

The attempt to provide further information about a possible relationship between verbal and non-verbal behaviour by analysing the children's spontaneous utterances was not very successful as the children tended to say very little. There were no evidence of common names being used for the stimuli, supporting the view that this is not a necessary requirement for the emergence of new relations.

There was some evidence for the Vygotskian view that private speech increases with task difficulty as two of the children (Stephanie S. & Laura) showed an increase of speech during the testing sessions. On the other hand, the children who failed to learn the A-B did not show any evidence of private speech. This indicates that verbalisations may have been related to the absence of contingent feedback rather than errors made on the task, i.e. verbalisations didn't increase as a result of making errors but as a result of not knowing whether or not errors had been made.

However, as the data in relation to the children's utterances are spare the experiment does not allow any firm conclusions about the possible role of private speech nor was its primary aim to investigate this question.

The main aims were

i) to select subjects for further experiments designed to investigate the effect of different types of naming interventions, and

ii) to test the hypothesis that children's performance on the matching-to-sample tasks may be related to their age or level of language development. The fact that no such relationships were demonstrated does not allow us to completely dismiss the hypothesis. It is possible that the Reynell test did not give a very accurate measure of the children's linguistic abilities. This is particularly true for the tasks used to measure expressive language, where the outcome depends on the child's willingness to talk. Here the test was given after the experiment when the children had carried out at least seven experimental sessions and the experimenter had spent several weeks playing with the children outside the experimental set-up. The test was carried out as a game, again using the glove puppet dog to make the task less of a test. Despite this many children, who had previously been very talkative, said very little during the Reynell test.

As discussed in Chapter Seven the procedure used was developed to ensure rapid acquisition of the baseline task to justify a short baseline prior to the introduction of the experimental interventions. In this respect the procedure was almost too successful in that only three subjects failed the baseline task. Thirteen of the children learnt the task in 100 trials or less, which would appear to be a small number of trials, but comparisons of the present results with other studies with normally developing children is difficult as the number of trials required to learn the baseline task is rarely reported. Devaney et al. (1986), de Rose et al. (1988) and Boelens & Smeets (1990) have reported rapid acquisition with children aged between 2 and 6 years, but their subjects were all given the instruction that included the relational term "goes with". A study by Catania et al. (1990) showed a clear effect of such relational instructions. The subject, a child aged 5 1/2, carried out 400 trials without learning. The experimenter then asked, while pointing to sample *"Which one goes with this one?*, following which the child immediately responded 100% correctly. The only available child studies which have reported not using such instructions and which have reported the number of trials during baseline phase are Beasty (1987) and Dugdale (1988). In Beasty's study the children all carried out identity matching trials prior to the arbitrary matching task and some needed as many as 1650 trials to learn the task. In Dugdale's study the majority of the children failed to learn the baseline despite having carried out between 600-700 trials. In other words, the number of trials carried out prior to learning the baseline task in the present study was between six and sixteen times lower than numbers reported in the previous comparative studies.

The three children who learnt the baseline task but failed the symmetry test and the three who had failed the AB task took and part in a further experiment to assess the effects of naming interventions. These experiments are reported in Chapter 9.

CHAPTER NINE

EXPERIMENT 2: Naming interventions

Comparison of the effect on matching performance of relational and non-relational instructions used during naming training.

This experiment was designed

a) to compare the effects of relational and non-relational instructions during stimulus labelling training and in particular to compare any effects on a subsequent symmetry test.

b) to compare the effects on the symmetry tests of labels taught prior to the acquisition of the baseline task with those taught after the baseline task had been learnt.

c) to compare performance on visual-visual matching with that on visual-verbal matching

The procedure was the same throughout, but to facilitate reporting and subsequent discussion the results are divided into two sub-sections. Experiment 2a contains the results of naming training given to children who had previously failed to learn the A-B baseline task. Naming training given to children who had initially learnt the baseline task but failed a symmetry test is reported as Experiment 2b.

Both sets of results are then discussed in relation to:

i) ease of acquisition of stimulus labels,

ii) the effects of learning sample labels, and

iii) the effects of common labels.

METHOD

SUBJECTS

Six children participated in this experiment and they were selected based on their performance during the training procedure described in Experiment 1 (Chapter 9). There were two girls and four boys aged between 4 years 5 months and 5 years. Three of the children had previously failed to learn the A-B baseline task (Experiment 2a) and three had failed a symmetry test (Experiment 2b). Details of their previous matching performances are given in the appropriate sub-section below.

APPARATUS

The apparatus, stimuli, and reinforcement set-up were the same as those used in experiment 1.

Reliability checks

Reliability checks were carried out on the performance of all six subjects who received naming training with at least one session from each phase being checked. The checks were carried out on video recorded sessions by an independent observer, who was a psychology graduate involved in a different research project. She had some knowledge of matching-to-sample procedures, but was naive about the aims of the study. Using a form identical to that used by the experimenter she recorded each response as correct or incorrect and the positions of stimuli on each trial.

Experiments 2a and 2b consisted of a total of 52 baseline training sessions, 16 baseline sessions with sample naming, 40 stimulus labelling sessions and 22 test session, making a total of 130 sessions. Reliability checks were carried out on 33 (25%) sessions; 6 (12%) baseline training sessions, 3 (19%) baseline sessions with naming, 10 (25%) labelling sessions and 14 (64%) test sessions.

Inter-observer agreement was 100% for matching responses (choice of comparison or spoken label) on 29 of the sessions checked. There was disagreement on five trials (total of 640 checked); one baseline training trial, three labelling trials, and one test trial. Formal calculations were considered unnecessary as disagreement was so small.

Agreement ratio for positions of stimuli ranged between 85 and 100%. However, the positions recorded by the observer did not violate the general proviso of the correct stimulus never appearing in the same position for more than three consecutive trials.

GENERAL PLAN AND PROCEDURE

The schematic overview of the training and testing sequence presented as Figure 18 in Chapter 8 is reproduced here as Figure 22 to aid the description of the procedure used in this experiment. The set-A and set-B visual stimuli and the set-X vocal (*Omni* (X1) and *Delta* (X2)) are pictured in Figure 23, which shows a diagram of the relations taught during the A-X and B-X training phases. Figure 24 shows a summary of the general plan for teaching stimulus labels and testing for their effect on visual-visual matching tasks. Details of the procedure are given on the subsequent pages.

Figure 22

A flow diagram of training and testing sequences during Experiment 2

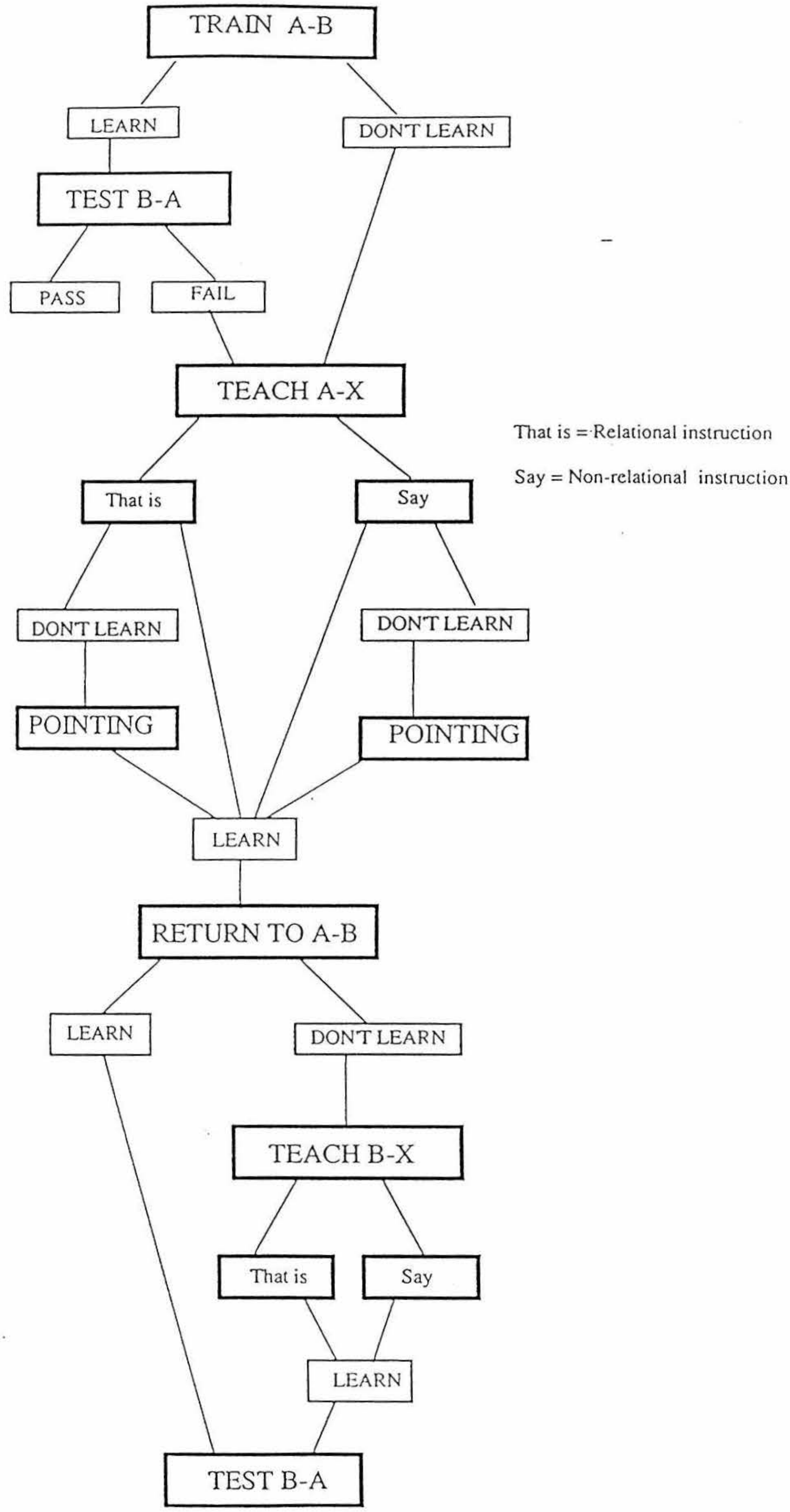


Figure 23 overleaf shows a schematic description of the relations between the visual stimuli (set-A and set-B) and the verbal labels (set-X) taught during labelling training. The arrows on the left hand side indicate the A-X relations and the arrows on the right hand side indicate the B-X relations.

Figure 23

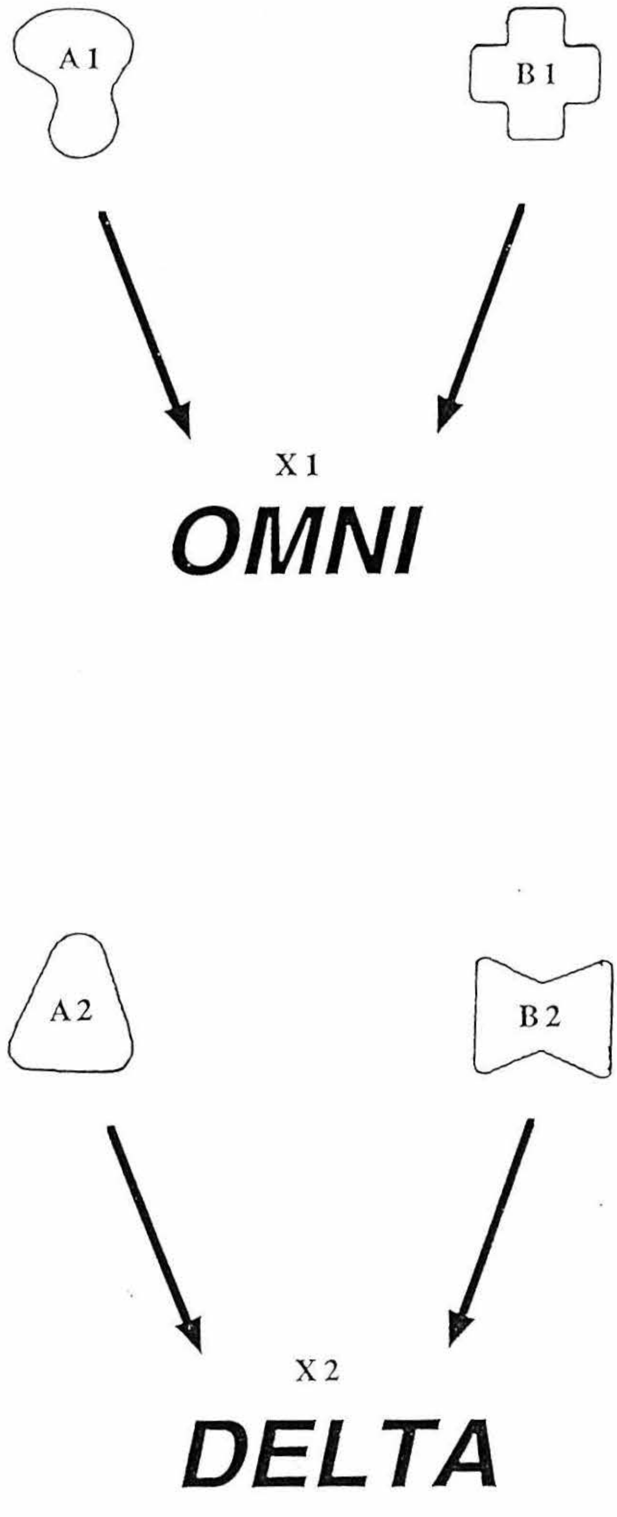


Figure 24

Summary of the planned sequence for teaching stimulus labels and testing for effects of labels on visual-visual matching tasks.

1. **Teach A-X** matching, i.e. teach labels for set-A stimuli. Children are required to say *Omni* in the presence of stimulus A1 and to say *Delta* in the presence of A2.

   Instructions:
   a) including relational phrase: *That is Omni/Delta*
   b) without relational phrase: Experimenter merely says *Omni/Delta*
   c) Pointing: The children are taught to point to the stimulus while saying *Omni/Delta* if the labels are not learnt with the above instruction

2. **Return to baseline A-B trials.**
   Children who respond correctly on A-B task proceed to stage 4.
   Children who fail to learn A-B proceed to stage 3.

3. **Teach B-X** matching, i.e. teach labels for set-B stimuli.
   Children are required to say *Omni* in the presence of stimulus B1 and to say *Delta* in the presence of B2. Instructions given as described in stage 1.

4. Reduce reinforcement probability

5. **Test A-B and B-A.**

   Children who fail the test are returned to training sequence:
   Those who have not previously been taught labels for set-B stimuli return to stage 3 for B-X training.
   Children who learnt common labels (A-X and B-X) through non-relational instructions are now given relational (*That is*) instruction during labelling trials.

Details of procedure

The general procedure followed for experiment 2 is outlined below. There were some minor variations to the procedure based on the children's performance and these deviations are noted in the result section.

A-X training

The procedure for the A-X phase was the same as that for the A-B baseline trials described in chapter 6, with the set-X vocal responses now being matched to the set-A visual stimuli.. The child sat in front of the panel and the experimenter sat next to the child until performance was stable and then moved behind the panel. The glove puppet was again used for communicating with the children. In other words, the aim was to train visual-vocal matching following the same procedure as used during the previous visual-visual matching stage, with the exception of an instruction (*That is*) that made explicit the relationship between the visual sample and vocal comparison.

All A-X trials began with the insertion of a metal response panel with a cut out shape corresponding to one of the A-stimuli. Both the A-stimuli were then presented in the drawer underneath the response panel. As soon as the child picked up the correct A-stimulus the experimenter said either:

a) *That is Omni/Delta* (relational instruction) or

b) *Omni/Delta* (non-relational instruction)

The first three trials during the first session were modelling trials where the child was not required to omit a vocal response, and scheduled consequences were delivered as before following the insertion of the visual stimulus into the frame on the response panel. If the child had not said the appropriate word by the fourth trial the experimenter gave the prompt:

Can you say Omni/Delta?

On subsequent trials the following prompts were used:

a) Relational instruction - *What is it?* If the child did not respond the experimenter asked

Is it Omni or Delta? or

b) Non-relational instruction - *What do you say?* If the child did not respond the experimenter asked *Omni or Delta?*

Scheduled consequences were then only delivered contingent on the vocal responses *Omni* or *Delta.*

A blocked trial procedure was implemented where the sizes of the blocks were reduced gradually as described for the A-B training in Chapter 9. The initial session consisted of two blocks of eight trials if errors were confined to the initial trials, otherwise the first block was extended to 16 trials. After eight trials with the same A-stimulus as sample, the response panel was changed and the other A-stimulus served as sample. The first three trials again consisted of modelling trials and the prompts described above were used on the fourth and subsequent trials if necessary. The modelling trials were not counted as part of the block of eight trials.

The sizes of the blocks were reduced from eight trials to blocks of 5, 4, 3 and 4 trials respectively. When children reliably changed their vocal response following the change of the visual stimulus (errors being confined to the initial trial in each block) a random presentation order was introduced.

The A-B baseline trials were re-introduced when performance on the A-X task reached the criterion of 90% correct responding during sessions with random presentation order.

Children who failed to learn the labels were given further cues in the form of pointing.

c) Pointing

Pointing was introduced to give further cues to the relationship between the visual stimuli and the responses, i.e. pointing, like the non-relational instruction, was an attempt to direct the child's attention to the stimuli without giving vocal cues to the naming context. This intervention was used because both relational and non-relational instructions may fail if the child is not attending to the stimulus while making the verbal response. The use of 3-dimensional stimuli made it possible for the children to make the appropriate verbal response while holding a stimulus, and was thus an attempt to increase their attention to the stimuli. However, although the child always heard the words while holding on to a stimulus it was very difficult to control when the children themselves said the words. They had all been trained to choose the appropriate stimulus and immediately put it on the response panel, which meant that they often made the verbal response after placing the stimulus on the panel. In other words, the sequence of events during labelling trials was often:

Pick up the stimulus - hear *Omni/Delta* - place the stimulus on the panel - say *Omni/Delta*..

The children where therefore taught to point to the stimulus while saying the word. The required response was first modelled by the experimenter and the child was instructed to *"Keep your finger on it while you say the word.* The sequence was now: Pick up stimulus - hear *Omni/Delta* - place the stimulus on the panel - point to the stimulus - say *Omni/Delta*..

Return to A-B baseline task

The children returned to the blocked trial stage which they had reached prior to learning A-labels. The children were now required to label the sample stimulus prior to the presentation of the visual comparison stimuli. The prompts *What is it?* (relational instruction) or *What do you say?* (non-relational instruction) were used if the children did not make the appropriate vocal responses to the sample stimuli.

In this experiment all the children responded correctly on the A-B task after learning labels for the set-A stimuli. The reinforcement probability was therefore reduced when performance reached criterion.

Reduction of reinforcement probability

The aim of this stage was withdraw the contingent consequences and increase the number of trials per session prior to the testing stage. This was done in the same way as described in experiment 1, chapter 9, including the same instructions. There was however a slight variation between the children who had learnt the A-B task prior to labelling interventions (experiment 2a) and those that had not (experiment 2b). The children in experiment 2a carried out eight A-B trials intermixed with four identity matching trials with the set-B stimuli during which contingent reinforcement was given. This was followed by a further 12 trials (eight A-B and four identity matching with the B-stimuli) without contingent consequences. The following session consisted of 16 A-B trials and eight identity trials with the set-B stimuli without reinforcement.

The three children in experiment 2b already had experience of 24-trial sessions without reinforcement as they had previously carried out and failed the symmetry test. The first session of reinforcement withdrawal was therefore omitted and they carried out 16 A-B trials and eight identity trials with the set-B stimuli without reinforcement.

Contingent consequences were re-introduced if performance broke down at this stage, otherwise the children went on to a symmetry test.

A-B and B-A test

As before (experiment 1) this consisted of two sessions of 16 A-B and eight B-A trials each. No contingent consequences were delivered during testing. The children were required to label the sample stimuli in accordance with their previous labelling training.

Children who failed the test returned to the training sequence, the exact stage being determined by their previous training history. The children who had not been taught B-labels went on to B-X training.

Children who failed the symmetry test after being taught common stimulus labels (A-X and B-X) via the non-relational instruction were given the relational instruction, *That is Omni/Delta*, during a combined A-X and B-X session.

B-X training

This was carried out in the same way as the A-X training and the children were now taught to say *Omni* in the presence of B1 and *Delta* in the presence of B2, using the same instructions and prompts as described above for A-X training. The first session consisted of four blocks of uneven size (5-4-3-4 trials) unless the children made errors, in which case the session consisted of two blocks of eight trials.

The children's ability to label both the set-A and the set-B stimuli was then tested. without contingent reinforcement. No further reinforced A-B trials were carried out after acquisition of B-labels, i.e. the next stage was the A-B / B-A test (described above).

RESULTS

EXPERIMENT 2A

Effect of name training given to children who had previously failed to learn the A-B baseline task.

The subjects in experiment 2a were the three children who had previously failed to learn the A-B baseline task through the training procedure described in Chapter 9. The results are represented in graphical form in Figures 26 and 27 and details of each child's performance are given below followed by a summary of the results. The ages of the children and their matching performances prior to the introduction of naming interventions are described before the result of the naming interventions. Figure 25 contains a table showing the number of trials carried out at each stage in the training and testing sequence.

Figure 25

Summary table for Experiment 2a, showing the number of trials carried out at each stage of the training and testing sequence.

CHILD	A-B training	A-X teaching	Return to A-B training	A-B and B-A test	B-X teaching	A-B and B-A test
Rhys (a)	128	96	72	Failed B-A	16	Passed
David (a)	186	32	56 + 20[1]	Failed B-A	16	Passed
Carlie (b)	192	96 + 96[2]	56 + 24[1]	Passed		

The letters in the brackets refer to type of instruction during naming training:
(a) = relational instruction (b) = Non-relational instruction

1 Reinforcement reintroduced when performance broke down after its initial withdrawal
2 A-X trials with pointing

Previous performance on the A-B task

i) **Rhys**, aged 4 years 11 months, carried out 128 A-B trials prior to labelling interventions but never proceeded beyond sample-comparison presentation in blocks of eight trials. During the first session Rhys responded correctly during the first block of trials (A1-B1), but he continued choosing the same comparison (B1) on all eight trials in the second block. In other words, he persevered with the same comparison for eight trials although this was incorrect every time. Rhys was the only child who, during presentation of blocks of eight trials, failed to switch choice of comparison after an error.

When the block size was increased to 16 trials Rhys started to alternate between the comparisons, for example if he chose B1 on one trial, he would choose B2 on the next, regardless of whether the first choice was correct or not. He carried out two sessions with blocks of 16 trials (one of each combination) and in each session he alternated the choice of comparison in this way in a sequence of ten trials. He also expressed a dislike of the buzzer used to indicate incorrect choice, which was therefore replaced with the phrase *"No, that was wrong"* spoken by the experimenter.

During the two subsequent sessions with blocks of 16 trials he made 13 and 15 correct choices. However, when block sizes were reduced to eight trials, he first alternated between the comparisons as before and during the last session he once again persevered with the same comparison throughout the session.

ii) **David,** aged 4 years 11 months, developed a response bias during the baseline task and this persisted despite measures to correct it.

During blocked trial presentation he initially switched choice of comparison after each error. On the subsequent session with random presentation he made 13/16 correct choices. However, during the following session he only made 10 out of 16 correct responses and he subsequently started alternating between comparisons, in the same way as Rhys did. This response bias persisted after the reintroduction of the blocked trial presentation. The stimulus presentation was then arranged so that David was incorrect on every trial, i.e. as he was alternating his choice of comparison on every trial it was possible to predicted which stimulus he was going to choose and then alternate the trials so that he received no reinforcement . So for example, if he chose B1 on the first trial, this stimulus was again the correct comparison on the next trial, when he chose B2, which would then be correct comparison on the subsequent trial. This had no effect on his response pattern and he continued to alternate between the stimuli.

Identity trials with the A-stimuli were then introduced in an attempt to disrupt the bias. The rationale for this was that identity trials might make it more difficult for David to remember which comparison he had chosen on the previous A-B trial, but they had no effect on David's response pattern.

He was then told that *"swapping doesn't work"*, with the result that he developed a right hand position preference. However, this did not carry over to the following session, where he continued to alternate between the comparisons regardless of their position. He carried out a total of 186 trials; 96 trials prior to the development of the bias and 90 trials afterwards.

iii) **Carlie**, aged 4 years 5 months, had carried out 192 A-B trials. During the blocked trial presentations she switched her choice of comparison after making one error, but performance broke down when random presentation was introduced. During the first session with random presentation Carlie repeated the experimental instruction to look at the sample and during subsequent sessions she often touched the sample before choosing the comparison, tracing the outline with her finger, i.e. she pointed to the sample before choosing the comparison. On the re-introduction of blocked trial presentations she did not always switch choice after an error, nor continue with the same comparison until it was incorrect.

Summary of A-B performance

Choice of comparisons during A-B matching trials was not controlled by the sample nor by errors made on previous trials for any of these three children. However, unlike Rhys and David, whose performances showed clear biases, there was no obvious pattern to Carlie's performance.

Figures 26 and 27 contain graphs showing Rhys's, David's and Carlie's performances at all training and testing stages. To distinguish between visual-visual matching and labelling trials the former is represented as scatter plots and labelling trials as bar-charts. Each square on the scatter plot represent 16 trials and trials of the same type are joined with lines. The width of the bars correspond to the number of trials carried out by the child. Two bars for the same trial type indicate that the percentage correct responding changed after a certain number of trials. In the case of Rhys, for example, his responding was 85% correct on the first 64 labelling trials and 100% correct on the last 32.

Figure 26

Graphs showing percentage correct responding at all training and testing stages for **Rhys** and **David**

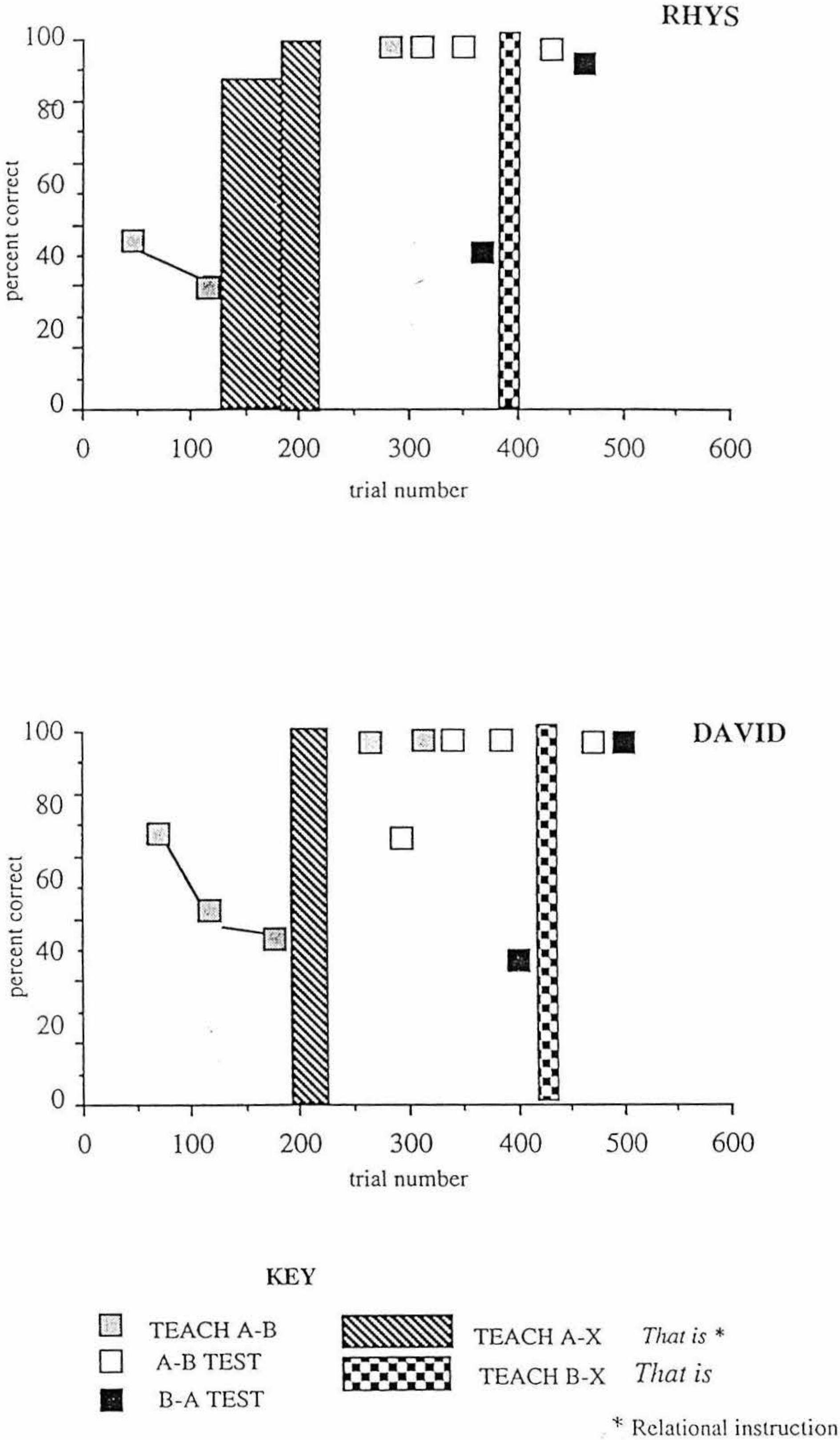
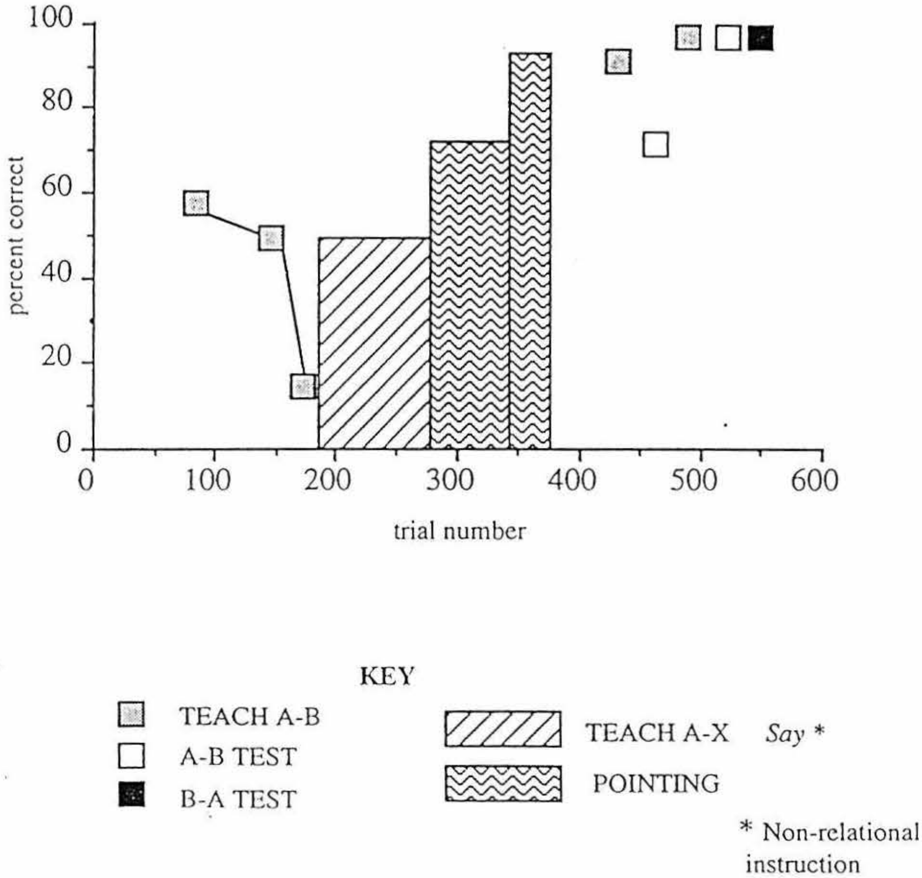


Figure 27

Graph showing percentage correct responding at all training and testing stages for **Carlie**



Naming Interventions

Labelling training was introduced after the following number of baseline trials: Rhys - 128; David - 186; Carlie - 192, as none of the children was making any progress on the A-B task and they all seemed to be losing interest in continuing the task.

The procedure for labelling training described above was followed. David and Rhys were given the relational instruction *That is Omni/Delta* during labelling training and the plan was to compare their subsequent matching performance with that of Carlie, who was given the non-relational instruction.

A-X training

a) Relational instruction : Rhys and David (Figure 26)

Rhys had problems saying *Omni*, so it was changed to *Om.* He responded correctly on all eight trials in the first block and after two modelling trials in the second block, although prompting was necessary. The initial reduction to blocks of unequal size (5-4-3-4) led to errors, but after reintroduction of blocks of eight trials his responding was 100% correct. He carried out a total of 96 A-X trials and responded 100% correctly on the last 32 trials.

David learnt the labels within 32 trials, he had no problems pronouncing the words and needed no prompting after the first five trials.

b) Non-relational instruction: Carlie (Figure 27)

The third child in this experiment, Carlie, was given the non-relational instruction.

Carlie carried out a total of 192 labelling trials; 96 trials with the non-relational instruction and 96 trials with pointing. During the first A-X session with unequally sized blocks (5-4-3-4) errors where restricted to the first trial in each block. However during subsequent sessions Carlie made errors throughout each block and when blocks of eight trials were re-introduced she started alternating between the verbal responses (saying *Omni/Delta* on alternative trials). In other words, Carlie's choice of verbal responses was not controlled by the sample stimuli nor by errors made on the previous trial. She was then taught to point to the stimulus while saying *Omni/Delta.*

On the introduction of pointing (blocked trials) she immediately started switching her vocal response after making an error, continuing with the same label until it was wrong and then switching to the other label on the subsequent trial. Her performance reached criterion after 48 trials with random presentation order.

Return to A-B baseline task

The children were now required to label the set-A sample stimulus prior to the presentation of the comparisons.

<u>a) Relational instruction : Rhys and David</u> (Figure 26)

Rhys started with blocks of eight trials. His performance reached criterion within 72 trials, i.e. the minimum number of trials required for the sequence of A-B, and he only made two errors during these 72 trials.

David started with four unequal blocks (4-5-3-5) and carried out a total 56 trials which was the minimum number for a sequence of training starting with unequal blocks. He made no errors during these A-B trials.

<u>b) Non-relational instruction: Carlie</u> (Figure 27)

Carlie started with four unequal blocks (4-5-3-5) and carried out a total 56 trials prior to the withdrawal of the reinforcement probability. The percentage of correct responding calculated over the two sessions with random presentation order was 88% (13/16 during the first session; 15/16 during the second), which meant that Carlie's performance had not reached the criterion of 90%. However, it was decided to move her on to the next stage as she showed signs of getting bored with the task.

Reduction of reinforcement probability

a) Relational instruction : Rhys and David (Figure 26)

Rhys was very reluctant to carry out the task without the scheduled consequences and was therefore given a token after every sixth trial during the first session. During the following session reinforcement was delivered at a ratio of 1 (reinforced) to 4 (unreinforced) trials. The reinforced trials were however distributed unevenly throughout the session.

David's baseline performance broke down after the withdrawal of the contingent reinforcement. A further three sessions were therefore carried out where the scheduled consequences were reintroduced and then withdrawn more gradually, by increasing the number of unreinforced trials in increments of two, four and six. David was then able to carry out a session of 16 A-B and 8 B-B trials without contingent consequences.

b) Non-relational instruction: Carlie (Figure 27)

Carlie started making errors when the scheduled consequences were withdrawn and contingent reinforcement was therefore reintroduced for 24 trials. She subsequently responded 100% correctly on a session of 16 trials without reinforcement.

A-B and B-A test

a) Relational instruction Rhys and David (Figure 26)

Rhys received reinforcement on the AB trials at a ratio of 1/4, but the B-A trials were never followed by scheduled consequences. Rhys was very reluctant to carry out the B-A trials and on the third B-A trial during the second testing session said: *I can't do it* ; the experimenter asked *Why?* and Rhys answered *Because there is no music.* He refused to continue after 18 trials (12 A-B and 6 B-A). His baseline performance remained at 100% correct Throughout the testing sessions but responding on the B-A test was only correct on 6 (42%) of the 14 trials. He continued to label the set-A stimuli correctly when they occurred as samples, but did not use the labels during the B-A trials.

David continued to respond correctly on the A-B test but failed the B-A symmetry test, responding correctly on six (37%) of the 16 B-A trials. He started alternating between the set-A comparisons during the B-A trials during the second session. He correctly labelled the set-A stimuli during the A-B trials.

Rhys and David were then taught the labels for the set-B stimuli; B-X training.

c) Non-relational instruction: Carlie (Figure 27)

Carlie passed the test although she chose the wrong comparison on one of the B-A trials

(B2-A2). On placing the A-stimulus on the panel she commented:

No, that was wrong.

The experimenter asked: *How do you know?*

and Carlie responded: *That one* (B2) *doesn't go with that one* (A1), *it goes with the triangle* (A2).

B-X training

Rhys and David both learnt the labels for the set B-stimuli within 16 trials and continued to label correctly both sets of stimuli in the absence of contingent consequences.

A-B and B-A test

Rhys was again reluctant to carry out the task, but did pass the test, i.e. responded correctly on both A-B and B-A trials. He continued to label all the sample stimuli correctly as *Omni* and *Delta*.

David also labelled the stimuli correctly and responded 100% correctly on both the A-B and the B-A trials.

Summary of results from experiment 2a

The table in Figure 25 (p.174) gives a summary of the number of trials in each stage.

The children who were given the relational instruction learnt the labels for the set-A stimuli quickly. The non-relational instruction was unsuccessful in that A-X was not learnt until the introduction of pointing.

The acquisition of set-A labels was followed by the immediate acquisition of A-B matching for all three children. Carlie not only learnt the A-B matching but she also passed a symmetry test after she had acquired the set-A stimuli labels. She did however use the relational term *"goes with"* to describe the relationship between the visual stimuli.

Learning common names for the set-A and set-B visual stimuli had a clear effect on David's and Rhys's symmetry performance. They had failed a symmetry test prior to learning common names but passed as soon as they learnt B-X.

These results are discussed further at the end of this chapter where the results are compared with the performances of the children who were taught stimuli names after having learnt A-B and failed the B-A test, i.e. the results of Experiment 2b, which are reported below.

EXPERIMENT 2b

Effect of name training given to children who had previously learnt the A-B baseline task but failed a symmetry test.

The subjects in experiment 2b were the three children who had previously learnt the A-B baseline task through the training procedure described in Chapter 9, but who had failed a symmetry test. The results are represented in graphical form in Figures 28-30 and details of each child's performance are given below. Their ages and matching performance prior to the introduction of naming interventions are described first followed by the results of the naming interventions.

Previous performance on A-B task and B-A test

i) Daniel (Figure 28) aged 5 years, responded at 50% correct during the first A-B session with random presentation, but the number of errors per session was then gradually reduced and his performance reached the criterion for the withdrawal of scheduled consequences after 136 trials.

Daniel's baseline performance remained at 100% correct during the A-B / B-A test but he chose the same set-A stimulus (A1) on all B-A trials.

ii) Joseph (Figure 29) aged 5 years, had carried out 72 A-B matching trials, which was the minimum required for the sequence of training with the blocked trial procedure. He responded 100% correctly as soon as random presentation order was introduced and carried on doing so after the reinforcement was withdrawn.

On the A-B / B-A test he responded correctly on the A-B trials but chose the same set-A comparison (A2) on all B-A trials.

ii) Laura (Figure 30) aged 4 years and 6 months, carried out a total of 128 A-B trials. She made errors during the first A-B session with random presentation order but then responded 100% correctly on all A-B trials both with and without contingent reinforcement.

During the second B-A test she consistently matched B1 with A2 and B2 with A1. She also consistently labelled A2 *Cross,* B1 *Bow*, and B2 as *Little one.*

Summary of A-B and B-A performance

All three children learnt the A-B task quickly having carried out the following number of baseline trials prior to the withdrawal of the reinforcement: Daniel - 136; Joseph - 72 and Laura - 128. They continued to respond correctly after the scheduled consequences were withdrawn. They all "failed" the B-A test but responded consistently during the testing stage.

Figures 28, 29 and 30 contain graphs showing Daniel's, Joseph's, and Laura's performances at all training and testing stages. To distinguish between visual-visual matching and labelling trials the former is represented as scatter plots and labelling trials as bar-charts. Each square on the scatter plot represent 16 trials and trials of the same type are joined with lines. The width of the bars correspond to the number of trials carried out by the child.

Figure 28

Graph showing percentage correct responding at all training and testing stages for **Daniel**

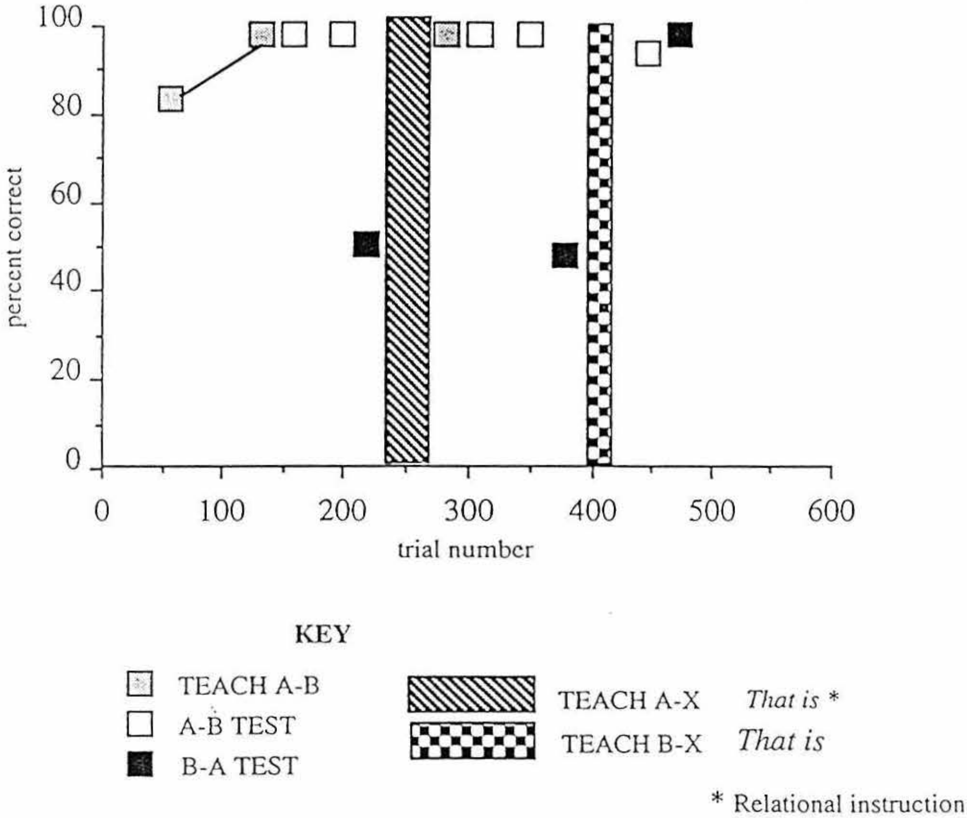


Figure 29

FIGURE

Graph showing percentage correct responding at all training and testing stages for **Joseph**

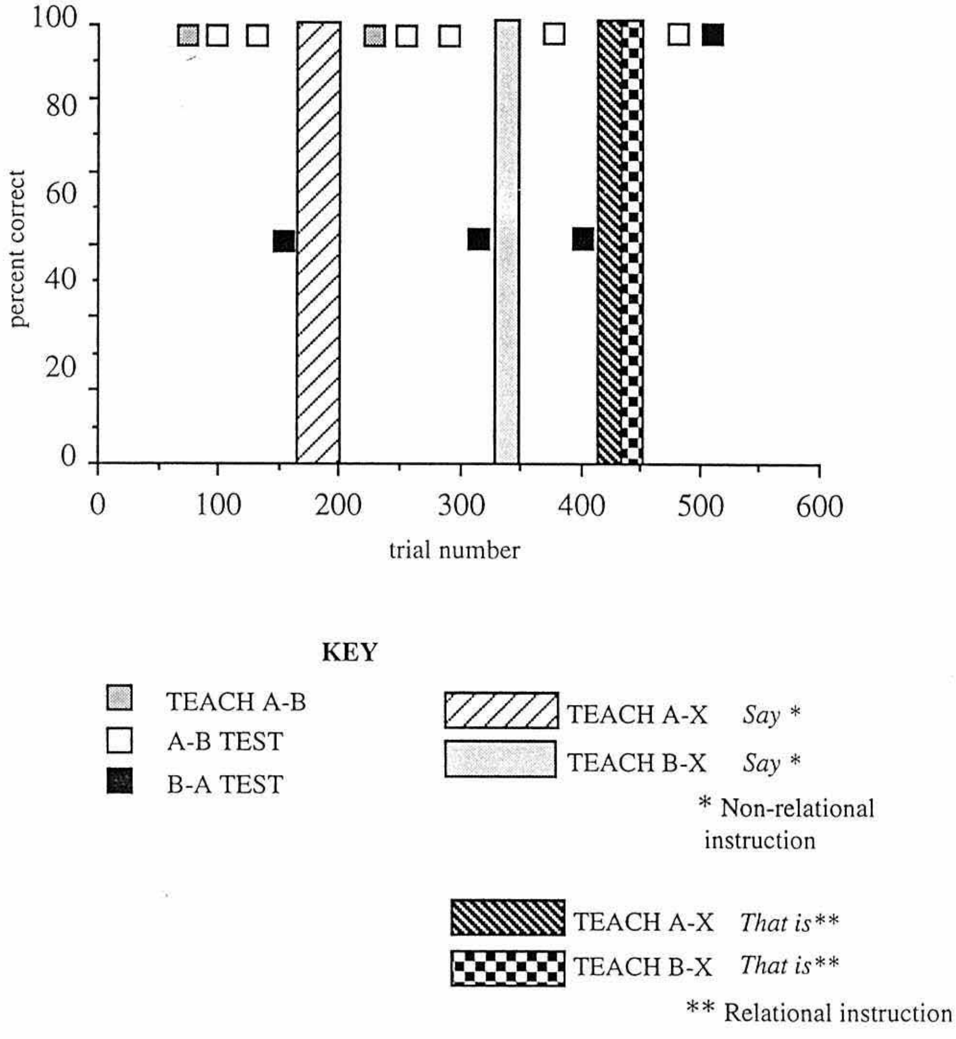
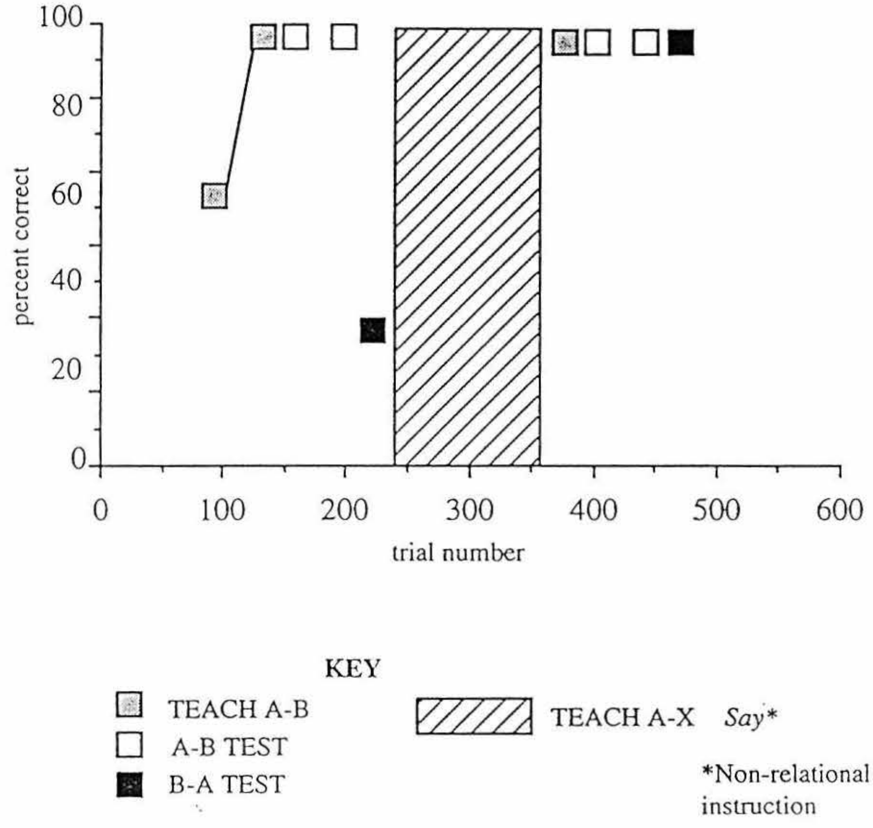


Figure 30

Graph showing percentage correct responding at all training and testing stages for **Laura**



Naming interventions

Labelling training was introduced after testing stage in accordance with the procedure described above. Daniel was given the relational instruction, Joseph and Laura the non-relational instruction.

A-X training -

a) Relational instruction : Daniel (See Figure 28)

Daniel learnt the A-labels within 32 trials having only made one error.

b) Non-relational instruction : Joseph and Laura (See Figures 29 and 30)

Joseph required 48 trials to learn the labels for the set-A stimuli.

Laura was initially reluctant to make any verbal response and needed prompting on most trials. She started making spontaneous responses after 48 trials but then made them as soon as the response panel appeared, i.e. prior to the appearance of the visual stimuli. She was taught to wait for the appearance of the stimuli during the subsequent 32 trials and her performance reached the criterion for the A-X stage after a total of 128 trials.

Return to A-B baseline task

The children were now required to label the set-A samples prior to the presentation of the comparisons. All three children continued to respond correctly on the baseline task, both with and without contingent reinforcement.

Joseph spontaneously labelled all the set-B stimuli *Omni* and *Delta* during the A-B task and Laura labelled the B2 stimulus *Delta* on one trial.

A-B and B-A test

a) Relational instruction : Daniel (Figure 28)

Daniel responded exactly the same as he had done on the previous test; 100% correctly on the A-B baseline task but chose the same set-A stimulus (A1) on all B-A trials. He was then taught to label the set-B stimuli; B-X training.

b) Non-relational instruction : Joseph and Laura (Figures 29 and 30)

Joseph responded correctly on the A-B trials but chose the same set-A comparison (A2) on all B-A trials, i.e. exactly like he had responded on the previous test. He did not label the set-B stimuli during the test, although he had previously done so during the A-B task. He also went on to the B-X training stage.

Laura continued to label the set-A stimuli appropriately when they appeared as samples and also labelled the B-stimuli on some trials. In addition she spontaneously used the relational term *That is*. A summary of her verbal responses to the different stimuli is provided below. Laura now passed the test.

Summary of spontaneous verbal responses made by Laura during the testing phase. Each utterance was made once:

A1 as sample	*That is Omni*
A1 as comparison	*That is Omni*
A2 as sample	*That is Delta*
A2 as comparison	*That was Delta*
B1 as sample	*That Omni, that, yeah, Omni.*
	That is Omni , that one.
	Omni
B1 as comparison	*That is Omni .*
	Omni.
B2 as sample	*That was Delta.*
B2 as comparison	*This is Delta.*

B-X training

Daniel and Joseph learnt to label the set-B stimuli within 16 trials and continued to label both sets of stimuli correctly in the absence of scheduled consequences.

A-B and B-A test

a) Relational instruction : Daniel (Figure 28) –

Daniel responded correctly on the B-A test making only one error. However, during the first test session his performance on the A-B baseline task was only 80% correct. During this session he made errors in labelling the A1 and B2 stimuli and the errors on the visual matching task were associated with incorrect sample labelling, in that he always chose the comparison that corresponded with the labels he had used. For example, when he incorrectly labelled the B2-sample as *Omni,* he chose the A1-comparison which he had correctly labelled *Omni.* During the subsequent testing sessions he labelled all the stimuli correctly and responded correctly on the A-B trials.

b) Non-relational instruction : Joseph (Figure 29)

Joseph continued to respond like he had on the previous tests; 100% correctly on the A-B trials but choosing the A2 stimulus on all B-A trials. He labelled all the set-A stimuli correctly but labelled the B-stimuli incorrectly on four B-A trials during the first testing session. On two of the four trials were B1 served as sample he labelled it *Omni* and on the other two trials he labelled it *Delta.*, but each time he chose the A2 comparison. The same was true for the B2 stimulus. He made no labelling errors on subsequent sessions where he continued to respond correctly on the A-B trials and to choose the A2 stimulus on all B-A trials.

He was the returned to the labelling training stage and given the relational *That is* instruction following which he responded 100% correctly on the A-B / B-A test.

Summary of results from experiment 2b

The table in Figure 31 shows a summary of the number of trials in each stage of the training and testing sequence.

All three children learnt the labels for the set-A stimuli without additional interventions, i.e. Daniel was only given the relational and Joseph and Laura the non-relational instruction. Laura did however spontaneously use the relational term *That is* thereby transferring herself to the relational instruction group.

Learning to label the set-A sample stimuli had no effect on Daniel's and Joseph's performances on the symmetry test, where they both continued to chose the same A-stimulus on all B-A trials. Laura passed the symmetry test after the A-X training stage but she labelled the B-stimuli correctly both during reinforced A-B trials and the test. In other words, common labelling of the set-A and the set-B stimuli emerged following the A-X training stage.

Common names for the stimuli led to success on the B-A test for Laura and Daniel, who used the relational term *That is*. Joseph, who had been taught common names through the non-relational instruction, still failed the test. He was then given the relational instruction and passed the test immediately.

Figure 31

Summary table for Experiment 2b, showing the number of trials carried out at each stage of the training and testing sequence.

CHILD	A-B training	A-B and B-A test	A-X teaching	Return to A-B training	A-B and B-A test	B-X teaching	A-B and B-A test
Daniel (a)	136	Failed B-A	32	16	Failed B-A	16	Passed
Joseph (b)	72	Failed B-A	48	32	Failed B-A	16	Failed BA
(a)			16			16	Passed
Laura (b)	128	Failed B-A	128	16	Passed		

The letters in the brackets refer to type of instruction during naming training:
(a) = relational instruction, (b) = Non-relational instruction.

Comparisons between the two sets of results

The results from Experiments 2a and 2b are summarised in the table in Figure 32. The results are then discussed in terms of the aims of the experiment set out in Chapter 8.

Figure 32

Summary table of results of Experiment 2

The table shows the number of trials to acquire set-A labels (A-X) , and consequent performance on matching task.

Performance prior to naming intervention	**Non-relational instruction**	**Relational instruction**
FAILED AB	**Carlie** A-X learnt after pointing -192 trials Learnt AB & passed BA test	**Rhys** A-X - 96 trials Learnt AB but failed BA. Passed BA after learning common labels **David** A-X -32 trials Learnt AB but failed BA. Passed BA after learning common labels.
LEARNT AB, FAILED BA	**Joseph** A-X - 48 trials. Failed BA, still failed after common labels. Passed BA after relational instruction **Laura** A-X - 128 trials Relational instruction used spontaneously on A-B and B-A trials, also labelled B-stimuli. i.e. used common labels. Passed BA.	**Daniel** A-X - 32 trials. Failed BA. Passed BA after learning common labels

The graphs presented in the result sections above show the number of trials and percentage correct responding for each stage in the training and testing sequence. However, it is not enough to merely compare number of trials in each phase. To make sense of these data we must carry out a detailed analysis of the children's response patterns and their verbal comments during the task. This section will centre on trends in the children's response patterns, starting with the acquisition of stimuli labels. Comparisons will then be made between acquisition of visual-visual matching on the baseline task (A-B) and visual-verbal matching A-X. The discussion will then turn to comparing the effects of the stimulus labels in relation to the type of instruction used for teaching the labels.

Performance on A-B task

The children who initially failed the A-B task persisted with the same response pattern even when it lead to a large number of errors. In the case of Carlie, it is possible that she received enough contingent reinforcers to maintain her incorrect response pattern. Rhys and David, however, persisted with inappropriate responding even when they received no contingent reinforcers. There are no age or language development variables to account for why these three children failed the A-B task. It is interesting that David's identical twin brother Luke learnt the A-B task quickly and passed B-A immediately.

The same is true for the children who learnt A-B but failed B-A. Joseph had one of the highest Reynell scores, and Laura had one of the lowest. Daniel was one of the oldest children.

Acquisition of stimuli labels (A-X training)

The relational instruction resulted in quick acquisition of stimuli labels for all three children regardless of their previous performances on the baseline task. The children given the non-relational instruction took longer to learn A-X and there may have been a difference based on previous baseline performance. Joseph and Laura had both learnt A-B prior to labelling training; Joseph learnt the labels immediately and Laura required 128 trials but she did learn the labels without further experimental interventions although she spontaneously formulated the relational instruction. Carlie who had previously failed to acquire the A-B task only learnt the A-X task after a total of nearly 200 trials and additional intervention in the form of pointing.

It is possible that previous success on object-object matching was related to success on object-word matching, and that there may be an interaction between previous performance and type of instruction during A-X training. The small number of subjects does however mean that this remains highly speculative.

Effects of stimuli labels

a) The effect on the A-B task

The acquisition of A-labels resulted in immediate correct responding on the A-B baseline task. This suggests that labelling does something more than merely ensuring sample discrimination, as this was already achieved by the identity matching task with the sample stimuli. Rhys's results are particularly interesting because, prior to learning the A-labels, he did not stick to choosing the same comparison during A-B sessions with 16 trials of the same combination, i.e. he did not continue choosing the same comparison until he made an error. Rhys was the only child that did not change the choice of comparison following errors on blocks sized 16 and 8. Carlie and David initially switched on error until presentation was randomised, after which their performances become more erratic. As soon as Rhys had learnt A-labels he did not only start to respond consistently but also 100% correctly.

b) The effect of labels on the B-A test

The non-relational instruction was used with three subjects; Joseph, Carlie, and Laura. Carlie and Laura were only taught to label the samples (set-A stimuli), i.e. were not taught common labels by the experimenter. Carlie passed the B-A test after learning A-labels, but she also described the relationship between the set-A and set-B stimuli using the relational term "with", for example saying *That one goes with the triangle*. Laura spontaneously labelled the B-stimuli as well and passed the B-A test.

All subjects who were taught common labels via the relational (*That is*) instruction passed a symmetry test immediately, regardless of previous experimental history. Laura also passed after learning to say *"That is Omni/Delta"*, although she had formulated that instruction herself.

Joseph, who learnt labels through the non-relational instruction, failed the B-A test despite using common labels. Learning common labels with the non-relational instruction did not alter Joseph's pattern of always choosing the same A-stimulus on B-A tests. However, after he had learnt common labels he did hesitate before choosing A-stimuli. He passed the symmetry test after being given the relational instruction.

Conclusion

Four children, who had previously failed the symmetry test, passed it after having learnt common labels, showing that common labelling is sufficient in some cases. One child, Joseph, did however still fail the symmetry test after having learnt common labels with the non-relational instruction. These results do therefore provide evidence that the instructions used for teaching the labels may influence their effect on subsequent matching performance. Joseph was subsequently given the relational instruction following which he passed the symmetry test, which further strengthens the conclusion that vocal responses may come to function as mediating names during matching-to-sample tasks more readily if the relationship between the vocal response and the visual stimulus is made explicit.

A comparison were made between the visual-visual (A-B) and visual-verbal (A-X) matching performance when the A-X task was performed under the same conditions as the A-B task, i.e. during the non-relational instruction condition where visual-verbal matching was trained using a procedure which was designed like the visual-visual task to minimise experimenter clues to the relationship between the samples and comparisons. The results suggest that there might have been an interaction between the type of instruction and previous performance on the A-B task.

The acquisition of sample labels had an immediate effect on the performance on the A-B task regardless of the type of instructions used during name training.

These results are discussed further in chapter 11, where they are considered in relation to theoretical implications and the issues raised in the introductory chapters. Chapter 10 contains a report of the third experiment, which consisted of an investigation into performance on equivalence tests.

CHAPTER TEN

EXPERIMENT 3: Equivalence testing and the effect of common naming on the performance of one child who failed the test.

The experiments reported on so far were aimed primarily at studying performance on symmetry tests. The main conclusion of these experiments was that stimuli labels can facilitate the emergence of stimulus-stimulus symmetry but that the type of instructions used for teaching the labels can influence their effect. The studies also showed the new procedure to be successful for teaching the baseline A-B task and testing for symmetry. Much of the debate around the role of naming in the emergence of new stimulus relations has however centred on equivalence rather than symmetry tests. It was therefore decided to extend the study to include equivalence testing. Experiment three was designed to:

a) test the suitability of procedure for equivalence testing, and

b) investigate if the different types of instructions used for teaching stimuli labels would have differential effects on equivalence test performance

Five of the children who had previously learnt the A-B task and passed a symmetry test without experimental instructions were taught a new stimulus relationship, B-C, and were then given a combined equivalence test, i.e. tested for the A-C and C-A relations. This chapter contains a report on their performance and on the effect of common naming on the performance of one child who failed the equivalence test.

METHOD

SUBJECTS

The subjects were selected from the initial pool of children who, having been taught A-B matching, passed a symmetry test (experiment 1, chapter 9). There were three boys and two girls and their ages at the start of experiment 3 were as follows: Kate (4:10), William (4:00), Jonathan (3:10), Justin (3:7), and Megan (3:05).

APPARATUS

The apparatus, stimuli and reinforcement set-up were the same as those used previously in experiments 1 and 2, with the addition of a new stimulus set, set-C. All the stimuli used in this experiment are pictured in Figure 33.

Figure 33

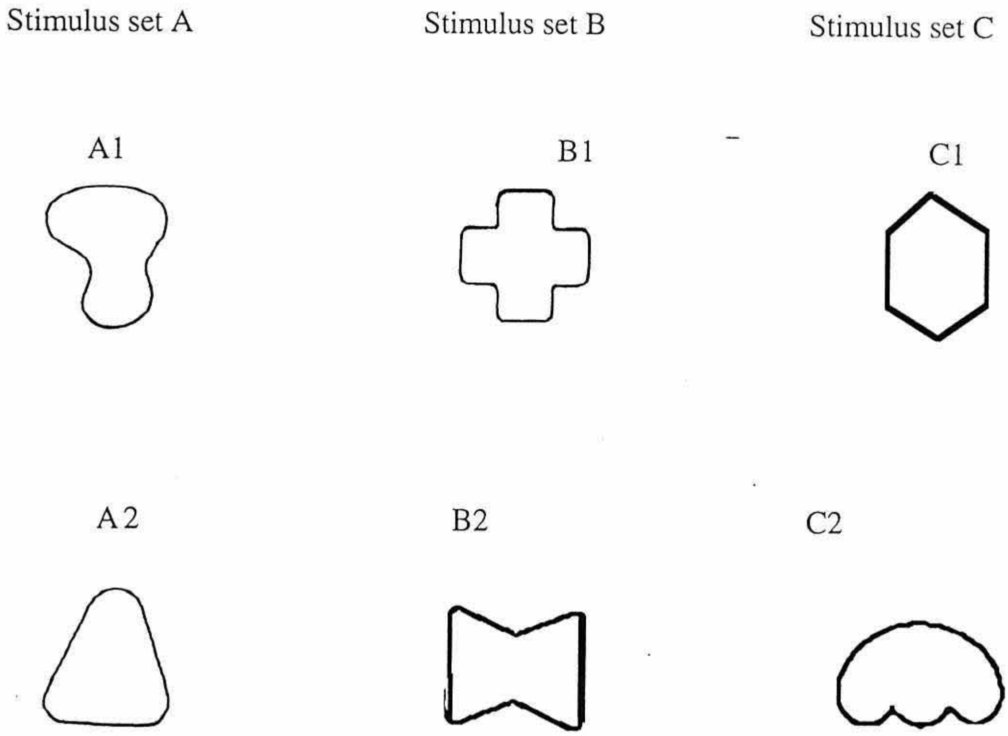


Figure showing the visual stimuli employed in Experiment 3.

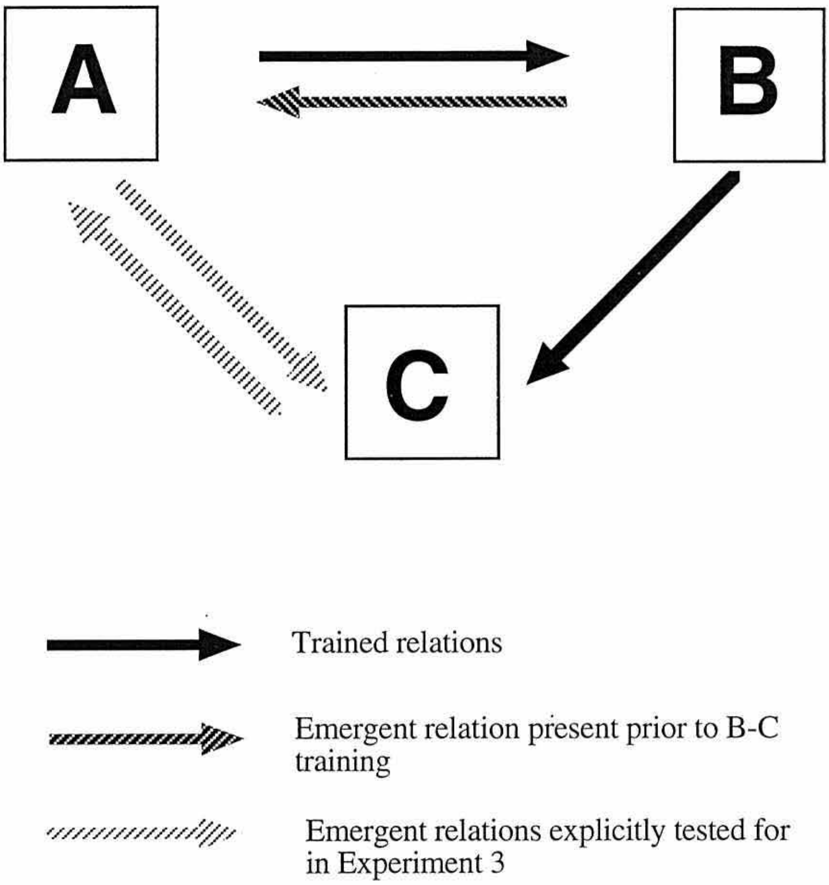
GENERAL PLAN AND PROCEDURE

The children had already learned A-B and had responded correctly on a B-A test (experiment 1). They were now taught to match two new stimuli, set-C, to the set-B stimuli (B1 - C1 and B2 - C2), and were then tested for A-C and C-A. Figure 34 shows a diagram of the taught and tested relations and Figure 35 shows a summary of the planned sequence for training and testing stages.

Children who failed the equivalence test were taught the common label Omni for the A1, B1, and C1 stimuli and *Delta* for A2, B2, and C2. The blocked trial procedure previously described was used throughout this experiment and as before each training session consisted of 16 trials.

Figure 34

Schematic diagram showing the relations taught and tested for in Experiment 3.



The letters A, B, and C refer to the stimuli sets pictured in Figure 27. The children had previously learnt the A-B relations and had responded correctly on a test for the emergence of the B-A relations. They were now trained on B-C relations and then tested for A-C and C-A.

Figure 35

Summary of planned sequence for training new stimulus relationships and testing for the emergence of equivalence relations.

1. B-C training: four blocks of unequal size, 5-4-3-4. If no errors go to stage 2. If errors are made repeat session.

2 16 B-C trials; random presentation order.

3. Combined test for A-B and B-C without contingent reinforcement, 8 A-B and 8 B-C trials

4. Test C-A and A-C.

Details of procedure

The general procedure is outlined below. There were some variations to the procedure based on the children's performance and these deviations are reported in the results section.

B-C training

Stage 1 - Four blocks of unequal size

The procedure for the B-C stage was the same as the one previously employed for teaching baseline A-B matching in Experiment 1 (described in chapter 8) with the exception that the B-C training started with four blocks of unequal size. The aim throughout all these studies was to keep the number of sessions to a minimum in order to maintain the children's interest. However, this had to be balanced against the need to ensure that the children carried out enough trials to learn the task. All the children responded correctly on the first five trials of the first B-C session and it was therefore decided to start with the unequal block size stimulus presentation rather than two blocks of eight trials in order to decrease the total number of sessions required prior to testing.

The experimenter sat next to the child during the first session and the glove puppet was used to model correct choice on four trials, two of each stimulus combination, prior to requiring the child to respond. The children were given the following initial instruction:

"Teddy is going to show you what to do. Just watch Teddy first and then see if you can do it."

After four modelling trials the child was told:

"Now you try it".

The experimenter did not make any comments about the new stimulus set or give any other instructions about the task.

If the children made more than one error during stage 1 it was repeated, otherwise random presentation order was introduced during the next session.

Stage 2 - Random presentation order

The experimenter now went behind the screen and the children carried out a 16 trial session with random presentation order. The criterion for continuing to the next stage was 14 correct choices (88%). Children whose responding did not reach the criterion repeated the session.

A-B and B-C test

The children carried out eight A-B and eight B-C trials, presented in random order, without contingent consequences to test the stability of their performance on the baseline trials prior to the equivalence test. The instructions given were the same as those used in experiments 1 and 2 prior to the withdrawal of consequences. If performance broke down at this stage the contingent consequences were re-introduced, otherwise the children went on to an equivalence test.

Equivalence testing

The test consisted of two 24 trial sessions, each with 8 A-B, 8 B-C, 4 A-C and 4 C-A trials presented in random order without consequences. In other words, the equivalence test consisted of a total of 16 A-B, 16 B-C, 8 A-C and 8 C-A trials. The criterion for passing the test was 88% correct responding, which meant more than one error on the A-C and C-A trials and no more than two errors on the A-B and B-C trials respectively.

RESULTS

The summary table in Figure 36 shows the number of trials carried out at each stage of the training and testing sequence prior to the equivalences test.

Figure 36

CHILD	A-B training	B-C training	A-B & B-C test	Equivalence test
William	72	32	16	Passed
Justin	72	32	16	Passed
Kate	72	32	16	Failed
Jonathan	72	104	16	Failed
Megan	232	32	16	Failed

Two of the children, William and Justin passed the test and the other three failed. Both William and Justin responded 100% correctly on all components of the test. William was however initially reluctant to choose a comparison on the trial types that were new to the test. The fourth trial during the first test session was a C-A trial , which was abandoned because William refused to choose a comparison and the experimenter's attempts to persuade him to do so failed. The trial was reintroduced after three A-B trials and this time William did choose the correct comparison, albeit reluctantly. Appendix 3 contains a transcript of the dialogue between the experimenter and William during these two A-C trials. William carried out the rest of the session without any comments, choosing the correct comparison on all trials, and continued to do so during the subsequent testing session.

The results of the children who failed the test are discussed in more detail below, including a report of subsequent interventions.

i) Kate

B-C training

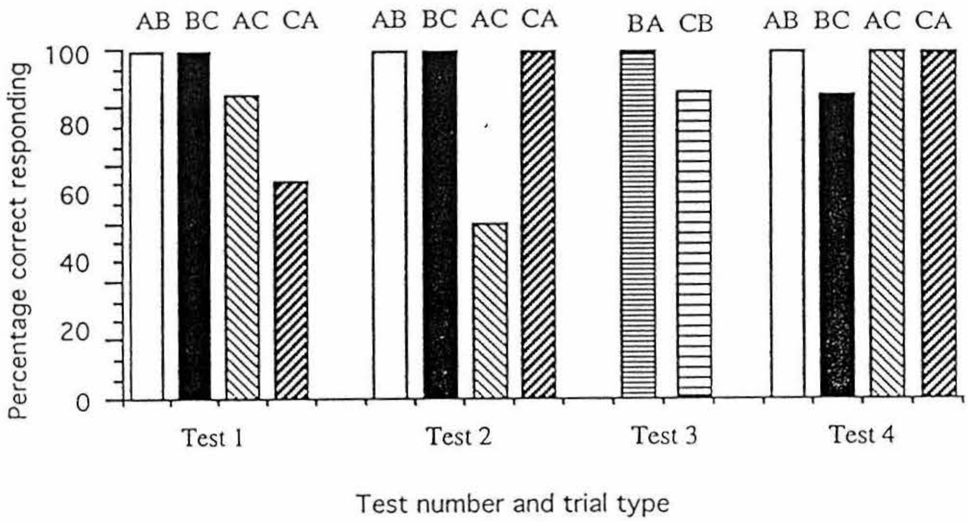
Kate made no errors on the B-C matching trials and reached the criterion for learning within 32 trials.

Equivalence test

The graph in Figure 37 below shows Kate's performance during equivalence testing stages.

She carried out a total of three equivalence tests (six sessions) and the baseline A-B and B-C performance was maintained at 100% throughout the testing stages. During the first test session she responded correctly on the first four equivalence test trials (A-C & C-A) and incorrectly on the last four. During the second test session she responded correctly on all trials. A further test session was carried out as Kate's responding had not reached criterion on the first test, but had been 100% correct during the second part of the test. The results were then analysed for each trial type and these are depicted in Figure 35.

Figure 37



The graph in Figure 37 shows the number of correct responses made by Kate on all trial types during the testing stage. Each test for the emergent relations A-C and C-A consisted of two sessions with a total of eight trials of each trial type. Each trial type is represented as a bar, with the trial type denoted above it.

The overall result of the first two tests was 11 correct responses on the A-C trials (69%) and 13 correct responses on the C-A trials (81%). As the graph in Figure 37 shows there was a difference in the pattern of responding on the different trial types. Kate made errors on the A-C trials during all the sessions whereas the three errors on the C-A trials were confined to the first session. During the second test Kate responded 100% correctly on the C-A trials, whereas responding on the A-C trials was chance level of 50% correct.

Because Kate responded correctly on the C-A trials but not on the symmetrical counterpart, A-C, it was decided to test for the symmetrical counterparts of the previously taught relations, i.e. to test B-A and C-B. She therefore carried out a test session where eight B-A and eight C-B trials were randomly presented. She made no errors during this session and proceeded to pass a subsequent equivalence test (see graph in Figure 37 for results and Figure 38 for a diagram of all trained and tested relations)

Figure 38

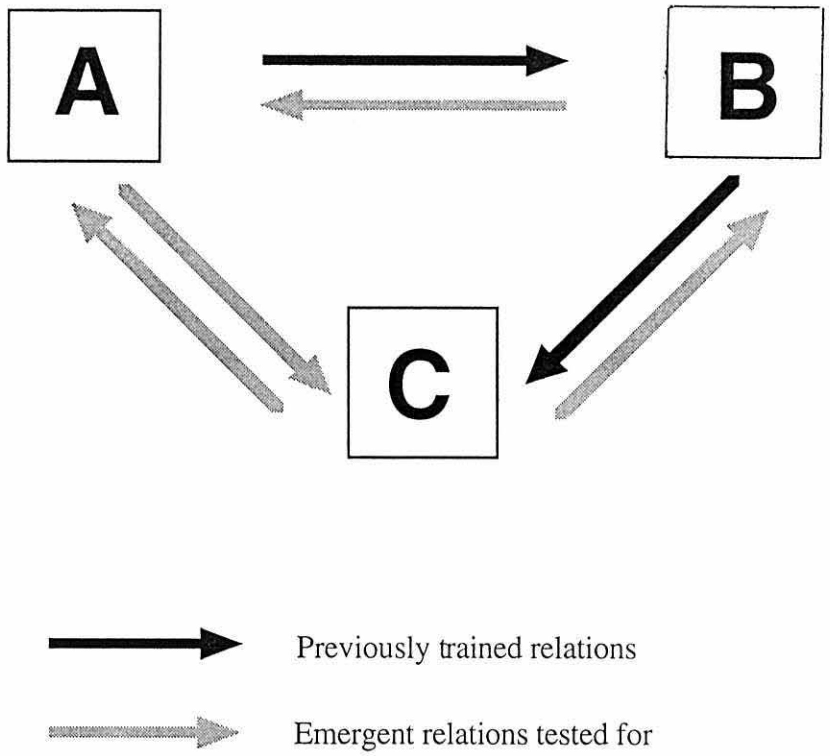


Diagram showing all the trained and tested relations for the three children who initially failed the equivalence test.

ii) Jonathan

B-C training

Jonathan needed more trials to learn B-C than he had previously needed to learn A-B matching (see table in Figure 36 above), requiring 104 trials to learn B-C compared to 72 for learning A-B. The first four B-C sessions consisted of blocks of unequal size and Jonathan changed his choice of comparison after making an initial error after the sample changed. He took a long time choosing a comparison on most trials, often asking

Is it that one or that one?

He also made several comments regarding the task throughout the training sessions. After the last trial in the second session he said:

That has to be on that side (pointing to the right side of the drawer) *and that has to be on that side* (pointing to the left side of the drawer)

However it is not clear what *That* referred to.

During the third session, having responded incorrectly on the first trial and correctly on the second, he pointed to the sample and said:

If you put this every time I get it right

On a later trial he picked up both the comparisons and changed their position, saying:

You've put it in the wrong place.

He was told that *It doesn't matter where they are* and then chose the right comparison when the trial was repeated.

At the start of the fifth session, prior to choosing a comparison on the first trial, he said:

Which is the same?

He then picked up the correct comparison and held it up against the sample saying:

This is the same

He proceeded to respond correctly throughout the session and continued to do so when the presentation order was randomised.

Equivalence testing

The graph in Figure 39 shows Jonathan's performance during the testing stages.

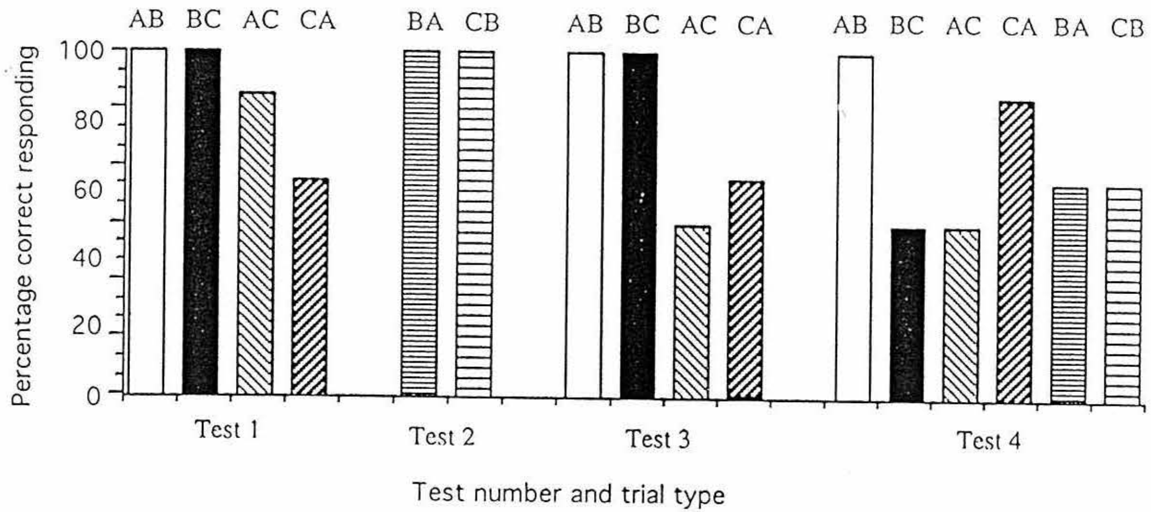
Jonathan carried out repeated tests because initially he responded correctly on the A-C but not on the C-A trials, carrying out a total of three equivalence tests (six sessions). The baseline performance (A-B & B-C) was maintained at correct responding during the first test. Jonathan also responded correctly on a combined test for B-A and C-B relations carried out after the first equivalence test.

Responding on the A-C trials broke down during the first part of the second test where Jonathan chose the C1 stimulus on all A-C trials and this preference for C1 continued throughout all subsequent A-C test trials. The C1 preference manifested itself on B-C trials during the third test , in which C1 was chosen on all trials where it occurred as a comparison (A-C & B-C).

The third test included B-A and C-B trials with Jonathan responding correctly on five out of eight trials of each type (63%). Responding on B-C and A-C remained at 50% (choosing C1 on all trials), A-B baseline responding continued at 100% correct and only one error was made on C-A trials (88% correct). See Figure 36 for a diagram of all trained and tested relations.

The graph in Figure 39 overleaf shows the number of correct responses made by Jonathan on all trial types during the testing stage. Each test for the emergent relations A-C and C-A consisted of two sessions with a total of eight trials of each trial type. Each trial type is represented as a bar, with the trial type denoted above it.

Figure 39



Graph showing percentage correct responses made by Jonathan on test trials.

iii) Megan

B-C training

Megan reached criterion for the B-C stage after 32 trials, which was 200 trials less than she had needed to learn A-B matching (see table in Figure 36).

Equivalence test

The graph in Figure 40 shows Megan's performance during the equivalence testing stages. Megan was also given tests for C-B and B-A relations as well as the A-C and C-A tests (see Figure 38 for a diagram of all trained and tested relations).

She carried out one test (two sessions) and responded correctly on the A-B and B-C baseline trials throughout. She did however respond in the "opposite way" on all A-C (A1-C2 & A2-C1) and on six of the eight C-A trials. This pattern was repeated during a combined B-A and C- B test where she responded the opposite way on the C-B trials but correctly on all the B-A trials. Her performance on the baseline trials remained correct. In other words, all relations trained or tested prior to introducing B-C training were present, but when tested for the emergence of new relations she responded in the opposite way.

Summary of results

Jonathan and Kate carried out three equivalence tests and Kate responded correctly on the last test. Jonathan's performance on the other hand did not improve with repeated testing. Performance on B-C baseline broke down during the last test, after he had developed a bias for one of the C-stimuli during the previous A-C trials. He also failed to respond correctly on B-A and C-B trials during this test, although he had previously done so. In other words, his performance deteriorated with repeated testing. Megan carried out only one equivalence test during which responded correctly on A-B, B-A and B-C trials. She made one correct response on A-C and C-A trials and during a subsequent test for B-A and C-B she made only one correct choice on the C-B trials, but responded correctly on the B-A test.

Figure 40

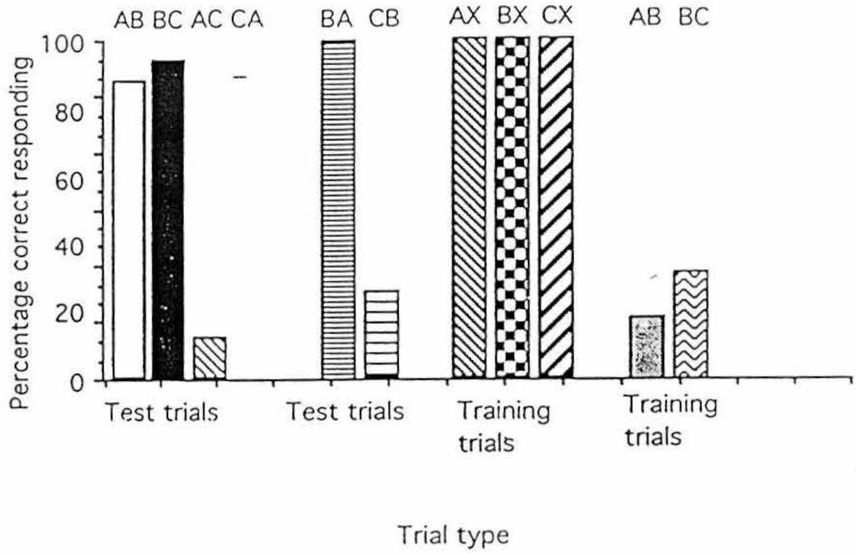


Figure 40 shows a graph of Megan's performance on the equivalence test and subsequent labelling and reinforced baseline trials. Each trial type is represented as a bar, with the trial type denoted above it.

Attempts were made to teach common labels, for the A-, B- and C-stimuli to the two children who had failed equivalence tests. This was however only successful with Megan as Jonathan left the nursery shortly afterwards.

Labelling training

Megan was taught labels for one stimulus-set at a time via the relational instruction *That is Omni/Delta* , following the procedure described in chapter 10 for labelling training. She required 48 trials to learn A-labels and 16 for B-labels, but her performance broke down when the two sets were combined and so the sets were trained separately again. Her labelling response reached 100% correct after a total of 78 trials for A-labels and 24 trials for B-labels. Labels for set-C were learnt in 16 trials, and she continued to label correctly when all three sets were combined (see graph in Figure 38).

A-B and B-C trials with contingent reinforcement were then reintroduced, and Megan carried out three sessions before refusing to continue. See Appendix 4 for a transcript of Megan's verbal responses on these sessions.

Session 1

During the first session, she responded correctly on the first trial (A2-B2) but on all other trials she matched the stimuli in the opposite way to that required for contingent feedback, i.e. A1-B2, B1-A2 etc. On the second trial she matched the C2 comparison to the B1 sample, and correctly labelled the stimuli (B1 - *Omni*; C2 - *Delta*). The scheduled consequences were contingent upon the choice of visual comparison, and Megan was therefore given feedback that she had responded incorrectly, both through the noise of the buzzer and by the experimenter saying:

You got that one wrong. Megan commented: *That <u>was</u> Delta,* to which the experimenter replied:

Yes, but it was the wrong one. Let's try another one.

Megan gave common labels to the sample and the comparison on all subsequent sessions, although she matched the visual stimuli the "wrong way around". For example when A1 appeared as the sample she correctly said *Omni* and then chose B2 and again said *Omni.* She labelled all the sample stimuli correctly, which meant that when the B2 stimulus appeared as the sample she correctly labelled it *Delta.* She also responded correctly on A-X, B-X and C-X labelling test trials carried out without contingent feedback prior to the visual matching task and half way through the first session.

On the fifth visual matching trial she said *That is right,* after carrying out a response sequence of A2 - *Omni* - B1 - *Delta..* The experimenter asked :*What was it?* after the disappearance of the stimuli, and Megan answered : *Omni and Delta.*

She refused to continue the session after the ninth trial.

Session 2

On the first three trials Megan matched the visual stimuli the opposite way and then commented:

The music is broken, and said *I can't do it.* After some gentle persuasion she did continue the session, responding correctly on the three following trials. She then chose the class-2 comparison (B2 or C2) on all subsequent trials, which meant that she received contingent reinforcement on 50% of the trials. She continued to label the samples correctly, but a technical error meant that there are no data regarding her verbal responses after choosing the comparisons.

Session 3

She carried out two trials during the third session and then declared that she did not want to play the game any more and completely refused to carry out any trials, saying:

I don't know what to do. I don't know which one to pick. I don't want to do it.

Session 4

She returned to the experimental room a week later but still refused to carry out any experimental trials. She was then asked if she would tell Teddy's friend Beaver (another glove puppet) how to play the game, which she was happy to do. The stimuli and one response panel were placed in front of Megan and the experimenter put the appropriate sample stimulus on the panel and asked Megan to choose a comparison. She was also asked to label the stimuli after she had completed the visual matching task. No feedback was given during this session. Megan again matched the stimuli in the opposite way, but now labelled them correctly, i.e. gave different labels to the sample and comparison on each trial.

Summary

i) Repeated testing led to success on the equivalence task for Kate but with Jonathan it led to a breakdown of previously learnt matching. The emergence of equivalence as the result of repeated testing is well documented in the literature (Sidman et al 1985), although it is not clear why it occurs. The suggestion is that the testing phase is a learning phase, and that the stimulus classes do not emerge during the baseline matching task, but during the testing phase. This could explain the different results; Jonathan developed a stimulus bias which interfered with his previously learnt responding. It first appeared on A-C trials and then generalised to B-C trials which indicates that Jonathan had learnt to respond in a novel way in the absence of reinforcement.

It is possible that with Kate the test for B-A and C-B helped to establish A-C, i.e. the symmetry test may have served as a cue for responding symmetrically. Jonathan's stimulus bias may have interfered with the potential cue for symmetry provided by the symmetry test.

ii) It is possible that performance on tests were not related to previous baseline performance. The children had learnt to respond consistently during baseline and continued to do so during testing, but the choice of comparison may have been based on chance performance on the first test trial. This could explain why Kate initially passed the C-A but not the A-C test. In other words, her performance on the C-A test may have had nothing to do with previous performance. This still does not explain why she responded consistently on all trial types except A-C.

At first glance it seems as if Kate failed a transitivity test but responded correctly on an equivalence test. But, responding on C-A may have been unconnected to previous learning, and she passed the test "by chance", she may then have responded correctly on A-C as the result of C-A performance and having carried out a symmetry test.

iii) William was reluctant to carry out the first C-A trial , because he was unsure of what to do. This reluctance to respond on new trial types was manifest with other children as well. Jonathan spent a long time choosing comparisons on the B-C training trials, often asking *Is it that one or that one?* Megan also refused to respond when she didn't know what to do after the reintroduction of baseline matching.

iv) Megan responded in the "opposite way" during the equivalence test, but it is not clear why she responded in this way. It may have been because the stimuli were placed the opposite way around compared to baseline trials, i.e. the previous comparison stimuli appeared in the sample position. This had however also been the case with the previous symmetry test, during which Megan had responded correctly. It is interesting that although she failed her responding was consistent, as this was also the case with the children who failed the symmetry test and this issue will be discussed further in chapter 11.

Baseline visual matching performance broke down after Megan had learnt to label the stimuli. She was now told when she was incorrect, and may have become confused about whether the feedback was contingent on the choice of comparison or the subsequent verbal response as these two contingencies (matching the two visual stimuli and labelling them) were running concurrently. She was required to label the sample stimuli, which was the same task as during previous labelling trials, except that the consequence was now the appearance of the comparison stimuli. She was then required to choose a visual comparison and the consequences for correct or incorrect response were then presented. It is possible that Megan may have interpreted this as referring to the labelling sequence. Being told that she was wrong on the second trial was followed by a change in the labelling response, where she consistently gave the wrong labels to the stimuli when they appeared as comparisons, although she continued to label them correctly in the sample position.

This pattern of responding changed over the sessions, and during the last session she labelled both sample and comparisons correctly. There were however few changes to her responses on the visual matching task, where she matched the stimuli "the opposite way" on the majority of trials.

These results and the difficulties involved in their interpretation, including the issues of reluctance to respond and consistent but incorrect responding, will be discussed further in chapter 11, which deals with all the results reported in chapter 9 and 10.

CHAPTER ELEVEN

General discussion and conclusions

The main aim of the studies reported here has been to investigate the role of verbal labels made in the presence of visual stimuli during matching-to-sample tasks, and in particular if this role differs depending on the method used to teach the labels. Experiments were therefore carried out to compare the effects of labels taught via different methods and the effects of labels taught before and after the acquisition of the visual-visual matching tasks. The procedure used was developed during preliminary studies, which focused on factors that may facilitate conditional discrimination learning in children. This discussions will first concentrate on these preliminary studies and the novel procedure prior to focusing on issues relating to the role of stimulus naming. The discussion will then turn the acquisition of stimulus names and the role of sample naming in the acquisition of the baseline task before focusing on the results from the symmetry tests, and the influence of stimulus labels on the children's performances. Other interesting trends in the data relating to performance on equivalences tests and the role of the scheduled consequences and will also be addressed.

Development of procedure

The procedure was successful in that it did lead to the acquisition of the baseline conditional discrimination task for the majority of the children (17 of the 20 subjects learnt the task). These children made very few errors and learnt the task quickly, which meant that potential problems related to prolonged studies, such as decreased motivation to carry out the task, subject attrition and influence of developmental changes, were minimised. There were three adaptations to the standard matching task, made in the following order; the use of three-dimensional stimuli, the presentation of stimuli in blocks of trials of the same kind, and the incorporation of an identity matching task with the stimuli serving as samples on every trial.

It is not possible to determine exactly why the procedure was successful, as there was no systematic manipulation of these variables, but it is likely that the combination of the variables was more important than the absence or presence of any one. The blocked trial procedure and the identity matching task were incorporated to ensure discrimination between the comparison stimuli and discrimination between sample stimuli respectively. The results from Experiment 1 (Chapter 8) support the suggestion made by Saunders & Spradlin (1990) that both factors need to be present to facilitate the acquisition of the baseline task. It is however possible that sample identity matching alone was a critical factor as it was the last to be introduced. Identity matching is commonly used as pre-training for arbitrary matching tasks to teach the basic requisites of the task (Sidman et al, 1985) and it may provide a contextual cue for conditional responding, i.e. a cue that the choice of correct comparison depends on the presence of the sample. Further studies were identity matching is systematically manipulated are however needed to determine its effectiveness. The same is true for the use of the three-dimensional stimuli.

The three-dimensional stimuli may have been important because they allowed the children to manipulate the stimuli. The action of putting the sample and the corresponding comparison on the response panel may have served as a contextual cue for the relationship between the two stimuli. The involvement of both tactile and visual modalities may have helped to increase attention to the stimuli. Although this might explain why the majority of the children learnt the baseline task it leaves the question of why it was not sufficient for some. The role of the three-dimensional stimuli could be investigated by to comparing the same child's performance on the present task with that on a task using two-dimensional stimuli. A multiple baseline across subjects could be used where children who failed with one procedure were introduced to the other. Alternatively, a matched subjects group design could be used, although this may provide practical problems in terms of recruitment and time required to complete.

Acquisition of sample labels and its effect on the A-B baseline matching

The labels taught via the relational instruction "*That is* " were learnt quickly and with few errors. The non-relational labelling instruction was less successful, with the children in this group requiring more trials to learn, and one child (Carlie) only learning after being told to point to the stimuli while saying the words. The precise function of the pointing response is unclear, but it is possible that pointing, like the instruction *That is*, served to indicate the relationship between the visual stimuli and the verbal responses. These cues to the relationship between words and objects have a long pre-experimental history. Adults start to show things to infants, naming them and talking about them as they do so, from the time the infants are three to four months old. From around seven months adults start using pointing gestures to direct the infants' attention, and around ten months infants themselves begin to point (Clark & Clark, 1977).

The three children who had initially failed to learn the A-B task did so immediately after learning to label the samples, regardless of how the labels had been taught. The effect of sample labels was particularly dramatic in the case of Rhys, who, during the initial A-B task, persevered with the same comparison through each session, regardless of whether it was correct or not. In contrast he responded 100% correctly immediately on the reintroduction of the A-B task after he had learnt sample labels.

Non-linguistic differential sample response have been shown to facilitate matching, both with humans (Sidman, Rauzin, Lazar, Cunningham, Tailby, & Carrigan, 1982) and non-humans (Cohen, Looney, Brady, & Aucella, 1976; Eckerman, 1970). The precise function of the sample specific responses in the present study is however unclear. Saunders & Spradlin (1990) taught sample naming "merely as a convenient means of establishing the sample discrimination" (ibid, p.249). In a previous study (Saunders & Spradlin, 1989) this had been established though button pressing on different schedules of reinforcement in the presence of each stimulus. They argue that the function of naming and button pressing was the same, i.e. establishing the discrimination between the sample stimuli. In the studies reported here discrimination between the sample stimuli was already established prior to sample labelling through the integration of identity matching and hence attention to the stimulus was ensured on each trial.

However, the type of discrimination facilitated by the identity matching trials may have been different from that ensured by the sample naming procedure. The identity matching procedure ensured simultaneous discriminations between the stimuli, whereas naming may ensure successive discriminations between the samples. The latter was certainly the case in the studies by Saunders and Spradlin, as their subjects were presented with one stimulus at a time. It was also the case in the present studies because, although both stimuli appeared at the start of each trial, only one was present when the verbal response was made.

It is also possible that sample naming functioned in the same way as other types of differential responses used with non-humans, i.e. naming was effective because the verbal response itself controlled the choice of comparison in a chaining sequence; e.g. A1 - *Omni* - B1.

A third possibility is that the labelling training provided an experimental history of consistent responding controlled by the set-A stimuli and that this transferred to responding on the A-B trials. In other words, the children may have learnt about matching in general, a general skill. Object-word matching is itself an example of conditional control, and having learnt this with one type of stimuli the skill may generalise to another type (object-object matching). The fact that learning a new discrimination can be influenced by a subject's history of discrimination learning has been well documented with simple discriminations (Catania, 1984a). There is also evidence that subjects who have a history of reinforcement for responding conditionally tend to respond conditionally more readily thereafter, i.e. subjects who learn one conditional discrimination task often require less training for learning subsequent conditional discrimination tasks. Several studies have shown that if subjects with an experimental history of consistent responding on two-choice conditional discrimination tasks are exposed to novel tasks of the same kind they will consistently select one comparison in the presence of one sample and the other comparison in the presence of the other sample (Harrison & Green, 1990; Saunders, Saunders, Kirby & Spradlin, 1988; Stromer, 1986; Stromer & Stromer, 1989). As Stromer and Stromer (1989) and Saunders and Spradlin (1990) have pointed out, it is possible that subjects who acquire conditional discriminations during training procedures may have learn something more general than specific stimuli relations. They may have learnt that within each trial, comparisons go with samples on a one-to-one basis. In other words, the general skill of experimental matching-to-sample has been learnt, and this can transfer to new types of stimuli.

The data do not permit a firm conclusion in favour of any of the possibilities above. The effect of the stimulus labels (A-X) on the A-B task was immediate, i.e. there was no training history of reinforced A-X-B trials prior to correct performance on A-B, which lends support to an explanation in terms of transfer of learning. If transfer was the case one might also have expected transfer from the identity matching task which also involved conditional discriminations. The A-X and A-B tasks, unlike identity matching, do however involve arbitrarily determined relations which may explain why no transfer occurred.

Further studies with different stimuli used during labelling training and the subsequent visual-visual matching task could decide the issue. The possibility of response mediation and successive discriminations could be controlled for by training subjects to make verbal responses to stimuli other than those used during the visual matching task. For example, learning the A-B task after being trained on C-X would provide evidence for an interpretation in terms of transfer of learning rather than response mediation or successive discrimination between samples. A transfer of learning account would however still leave open the question of why Rhys and David failed the symmetry test after learning to label the set-A stimuli, i.e. why there was no transfer to the B-A task.

There is of course no reason why the verbal responses could not facilitate successive discrimination between the sample stimuli and function as mediating responses.

The role of stimulus naming on the performance on symmetry testing

Seventeen of the 20 children given A-B baseline training in Experiment 1 learnt the task and 14 of these 17 passed a symmetry test without any experimental interventions. The children's spontaneous comments during the task and post-experimental tests showed that the majority had individual, mainly descriptive names for the stimuli but there was no evidence of common naming. Some of the children learnt the baseline task and passed the symmetry test also described the relationship between the stimuli. The data do not allow any conclusions about why three of the children failed the baseline task or why the three who had learnt later failed a symmetry test. These children did not differ in any obvious way from those who responded correctly on the task, neither in relation to age, their level of language development as assessed by the Reynell test nor willingness or motivation to carry out the task. Learning to label the stimuli was followed by changes in the performances for all them, and there seemed to be a difference depending on the type of instruction used by the experimenter.

The acquisition of labels for the set-A stimuli resulted in immediate acquisition of the A-B baseline task and two of the children (Laura & Carlie) who had been given the non-relational instruction went on to pass a symmetry test after learning A-X. The effect of the non-relational instruction is however not clear as several other variables may have influenced the performances of these children. Carlie had also been taught to point to the stimuli and in addition formulated her own description of the relationship between the set-A and the set-B stimuli. Laura spontaneously formulated her own relational instruction (*That is Omni/Delta*) and labelled the set-B stimuli, i.e. had common names for the stimuli. Joseph, the third child in the non-relational instruction group, also labelled the set-B stimuli on reinforced A-B trials, but he failed a subsequent symmetry test even when required to label the B-stimuli.

The B-A test performances of the children who had learnt the labels with the relational (*That is*) instruction were more uniform. There were no changes after learning to label the A-stimuli, but acquisition of common labels was followed by immediate correct performance on the symmetry test. In other words, the three children (Rhys, David, Daniel) who had learnt common labels with the relational instruction all passed the test. Laura, who spontaneously formulated the relational instruction and learnt common labels also passed the test. These result therefore suggest that common labelling together with the relational term *That is* facilitates the emergence of symmetry regardless of previous experience on the task. Joseph's initial performance suggests that common labels without such a relational term may not be sufficient for correct responding on a symmetry test. The fact that he passed the test after being given labelling trials with the relational instruction lends further support to this conclusion.

The data suggest that common labelling may facilitate new relations between visual stimuli more readily if the naming context is made explicit, i.e. that a contextual cue for the relationship between the labels and the visual stimuli is an important variable.

Why is this the case? It may be that verbal responses only facilitate stimulus equivalence when they themselves are related to the visual stimuli through equivalence relations and that this relationship occurs more readily if the experimenter provides explicit instructions that it is appropriate. In these studies the absence of such instructions appeared to result in more variable responding.

It is possible that verbal responses made to the samples mediate the choice of comparisons, as suggested by Dugdale and Lowe (1990). They argued that the visual stimuli become symmetrically related because they are symmetrically related to the subject's vocal responses; stimulus-response symmetry mediates stimulus-stimulus symmetry. The visual stimuli and the verbal responses form equivalence classes; A1-B1-X1 and A2-B2-X2. The verbal response X1 made in the presence of B1 comes to control the choice of a A1 because previous training on A1-X1 has resulted in the emergence of X1-A1, i.e. B-X and X-A leads to emergence of B-A. Dugdale and Lowe further suggest that A-X training result in the emergence of X-A as a result of the child's previous history during language learning. Their argument is being extended here to suggest that the symmetrical counterpart of a trained stimulus-response relation will occur more readily if the procedure contains cues for the naming context. If it does not, the verbal response may function as a tact rather than a name. In other words, the stimulus-response symmetrical relationship may not emerge.

The effect of the relational instruction can also be accounted for in terms of Hayes's relational frame theory, which also appeals to previously established response patterns but does not require mediation through common responses. The basic premise is that responding on equivalence tests is done in terms of previously learnt response patterns, and that the appropriate type of responding is determined by contextual cues. In other words, there are two basic requirements for responding in terms of a relational frame; a past history for doing so and a contextual cue for responding in accordance with the frame. Names do not mediate directly but the naming context indicates the applicability of a synomy frame. It is therefore possible that naming (stimulus-stimulus symmetry) can function as a contextual cue for responding in terms of stimulus-stimulus symmetry. If the results can be accounted for in terms of cues for a naming context alone common names for the samples and corresponding stimuli may not be necessary.. However, if that was the case we would expect symmetry to emerge after teaching the names for the set A-stimuli, which did not occur with any of the children given the relational instruction during labelling training.

Although the cue to the naming context was not enough for the emergence of symmetry it is possible that common naming functioned as a contextual cue for responding in terms of symmetry relations. In other words, common naming may have mediated the appropriate response pattern rather than directly controlled the choice of comparisons.

The question this raises is whether a relational frame account is necessary, as response mediation is sufficient for explaining the data presented in this thesis. However, Hayes has argued that relational frame theory can account for other types of relational responding as well (Hayes 1991) and as such has a wider scope. Steele and Hayes (1991) trained subjects on three different types of relational responding - same different and opposite - with each relation being trained in the presence of different contextual cues (unfamiliar visual forms).The subjects were then required to carry out matching-to-sample tasks in the presence of these cues. The results showed that matching performance was correlated with the cues, i.e. subjects choose comparisons that were same, opposite or different to the sample depending on which cue was present. Steele and Hayes argue that the responding was controlled by the presence of visual cues. However, as the subjects were college students and were therefore able to describe their own responses, it is possible that responding was controlled by the subjects' verbal descriptions rather than the visual stimuli presented by the experimenter. The question of control by self-generated verbal responses will be returned to later.

Do the verbal responses need to physically mediate the choice of comparisons? The performance of Daniel showed clear evidence of response mediation, as incorrect name was followed by incorrect choice of comparison, i.e. the verbal response controlled the latter. The verbal responses made to the samples may also have mediated the choice of comparisons in the case of Rhys, David, Joseph and Laura. It is also possible that the acquisition of B-X facilitated the emergence of B-A because the labels ensured successive discrimination of the B-samples. Joseph's performance does however provide evidence against this conclusion. He correctly labelled all the sample stimuli after being given the non-relational instruction but still failed the test, which shows that sample specific verbal responses to the set-B sample stimuli were not enough to pass the symmetry test.

Summary The procedure used in these studies ensured attention to the sample stimuli and discrimination between the comparisons and for most subjects this was enough to learn conditional discrimination and pass a symmetry test. For those who failed, differential verbal responses to the samples were sufficient for one child (Carlie), and the others passed the test after learning the same response for the comparisons. The following conclusions can be made regarding the role of common labels in the emergence of symmetry:

a) Naming context per se was not a contextual cue for stimulus-stimulus symmetry, as evident by the fact that A-B and A-X training did not result in B-A symmetry.

b) The B-X training were also necessary, but as shown by the performance of Joseph common verbal responses may be not sufficient in the absence of cues to the naming context. In other words, both common responses and cues for the naming context were necessary. These result suggest that the important factor is not the acquisition of the common verbal responses but how those responses are related to the visual stimuli. Words that function as tacts, i.e. exist in a uni-directional relationship with the stimuli may not facilitate symmetry responding, whereas words that function as names (symmetrically related to the stimuli) readily do so. This does not mean that common naming of stimuli is necessary for formation of equivalence classes. The studies reported in this thesis, like many others (Hird & Lowe, 1985; Sidman et al 1985) show that this is clearly not the case. Common naming is one way to pass symmetry test but it is not the only one.

Carlie and several of the children who passed the test without experimental interventions did formulate their own descriptions ; e.g. saying *That one goes with that one*. So although common naming is not necessary, it is possible that verbal mediation in the form of description of the task and the relationship between the stimuli play an important role in the emergence of equivalence responding. As Beasty and Lowe (1985) have suggested performance on tests may depend on how subjects have described the relationship between the stimuli during the baseline task. If the experimenter provides a description subjects may respond in accordance with it, but otherwise they may formulate their own. As discussed in Chapter 1 there is a large body of evidence showing that self-instructions can influence responding on schedules of reinforcement, and there does not seem to be any reasons for excluding their possible influence on equivalence tasks. What the experimenter says to subjects influence their responding, but what they say to themselves can have an even stronger influence. This discussion is part of a wider debate regarding the role of language in control of behaviour and whether there are fundamental differences between verbal stimulus control and control by other stimuli.

Investigations are compounded because the possibility of covert verbalisation can never be excluded, i.e. subjects may formulate their own verbal responses covertly. In the present studies Laura and Carlie made clear formulations, but others may have done covertly. Many of the children showed evidence of actively trying to respond correctly. William, Rhys and Megan for example were reluctant to respond in absence of reinforcement because they were unsure of what to do, saying *I don't know what to do, I can't do it.* They and several other asked for feedback during the testing sessions wanting the experimenter to tell them which stimulus to choose or if their choices were correct. This suggest that the children treated the task as one of problem solving. That adult subjects tend to perceive laboratory tasks as test, or problems to which there are correct or exact solutions is a phenomenon well documented by social psychologists (Rosenberg, 1969). The suggestions made here is that this can also be true for children.

Within behavioural analysis this kind of responding is accounted for in terms of rule governed behaviour. The argument is that humans are able to influence their own behaviour, that the verbal behaviour of self or others can act as rules, which are discriminative stimuli for own responses. "Rule governed behaviour is a relation between listener activity and verbal behaviour, or the product of verbal behaviour in which a relation between two or more events is specified by a speaker" (Chase & Danforth, 1991). The important aspect of the argument is that rules can be self-generated.

The argument that humans are capable of transforming their responses through self-generated stimuli which become the immediate cause of behaviour also forms the basis for Vygotsky's account of human behaviour. Vygotsky referred to this kind of responding as "mediated activity" or "higher mental functions" to distinguish it from direct responding to environmental stimuli.

In the experiments reported in this thesis the verbal responses made to the samples may have controlled the choice of comparisons during the symmetry tests. For the children who did not have common names for the stimuli it is possible that responding was mediated through self-generated rules, i.e. verbal mediation is not necessarily restricted to common naming.

For example, the reason that Laura and Megan reversed the relationship between the stimuli, i.e. responded in the opposite way around matching e.g. B1-A2 may have been the result of the reversed position of sample and comparison stimuli during testing. Responding may have been controlled by a verbal response like; "now it is the other way around", so when stimuli were "the other way around", so was responding.

Related to the discussion of instructions is the role of the tangible consequences. It is possible that in human learning "reinforcement operate as information which is used by the learner to determine subsequent responses rather than as a mechanical event that strengthens the stimulus-response association" (Bricker & Bricker, 1974). Weardon (1988) for example has suggested that contingent events in human laboratory studies do not function as "classical" reinforcers but that they provide informational feedback, which is used for problem solving. His argument is based on the fact that there is no food or water deprivation with humans and consequences are not primary reinforcers or stimuli that have been associated with primary reinforcers. Tangible reinforcers such money or snacks have little nominal value and are not essential for subjects' physical wellbeing. So why do they work? According to Weardon they work because they give information to subjects about correctness of response and that is why subjects continue to respond. Tangible consequences may not be necessary if informational feedback is present. For example the fact that feedback in the form of "Good", "Poor" can shape performance on schedules of reinforcement suggests that informational value is more important than nominal value of consequences (Weardon & Shimp, 1985)

In the studies reported in this thesis the music, lights and plastic tokens provided the children with information that their responding was correct or incorrect and may have functioned as feedback rather than reinforcement in the traditional sense. It is doubtful that the toys given at the end of session had a direct effect on matching performance and are more likely to have reinforced the children's willingness to carry out the task, rather than learning. The big toys were not contingent on the number of correct responses in a session but on the number of stars collected by the child, i.e. were given as the result of cumulative performance over more than one session. Getting a smaller toys was contingent on making at least six correct responses during the session, but not on immediately preceding performance. There is no doubt that the children knew when their responses were correct as the contingency between the responses and the consequences had been fully explained. It is possible that being right, being able to do the task, was more important than the tangible consequences. This was certainly the case with those children who were reluctant to respond during the testing phase, complaining that they did not know what to do, although they still received the stars and buttons at the end of the session.

The role of instructions in general needs further conceptual clarification because, as Wulfert & Hayes (1988), have pointed out, there are no adequate behaviour-analytical theories of instructional control. It is possible that instructions may contribute substantially to the outcomes of matching-to-sample tasks in the same way as they do on schedules of reinforcement, however almost nothing is known about the role of instructions in establishing different types of stimulus relations (Green et al, 1991). The studies presented in this thesis show that different instructions can establish different relationships between visual and verbal stimuli. Further studies are clearly needed to investigate the robustness of these findings and the role of instructions in establishing relations between purely visual stimuli.

The latter could be investigated by providing the subjects with different types of instructions during the baseline task, or by teaching children to overtly ask themselves questions about the task. Fjellstrom, Born, and Baer, (1988) for example have shown that children who were initially unable to learn matching-to-sample responding were able to perform the task after being taught to ask themselves a series of questions about the stimuli and answer their own questions. When told not to use self-questions and answers performances deteriorated. The children were then taught covert self-questions and performance improved again. An alternative method may be to study the verbal interactions between two children working together on the task.

The non-relational instruction used in these studies was designed to produce verbal responses that would function as tacts rather than names. It did however only have such an effect with one subject, Joseph, and the conclusion that the role of common label may depend on cues to the naming context can therefore only be tentative. Further studies are needed to determine the exact nature of instructions used during name training, but the problem in establishing verbal responses that do not function as names need to be addressed. Perhaps one way would be to teach non-vocal responses, for example, manual gestures. Their would however still be the possibility that subjects may name the gestures and that the names would come to function as mediating responses. The result do point to the effect of relational terms included in instructions and future studies that do not take this into the consideration run the risk of neglecting a potential important variable in the control of human responding on matching to sample tasks.

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Appendix 1

Specimen copy of letter sent to parents asking their permission for their children to participate in the studies.

Dear Parent / Guardian

I am a researcher working with Prof. C. F. Lowe at the Psychology Department at the University, and involved in studying factors influencing the development of concepts in children aged 2 - 5 years. This study is a continuation of research carried out at the department for a number of years and we are now hoping to carry out further studies at (*name of school or nursery*).

The study is designed to investigate how children at different ages form arbitrary concepts, i.e. how they learn that things go together although there are no obvious physical similarities between them. Differently shaped wooden blocks are used and it has been decided on a totally arbitrary basis that certain blocks go together. The aim of the study is to look at various ways of teaching the children how to match the blocks to each other. The sort of questions we are interested in are ;
Is it enough for the children to just see the blocks next to each other? Is it necessary for the children to do something in relation to the blocks, e.g. pick them up? Is it necessary for the children to learn names for the blocks?

Each child is seen individually during 10 - 15 minutes long sessions, usually three times a week for approximately six weeks. These sessions are designed as play sessions, where the child plays a game with the blocks.

We are only interested in how the children match the blocks and the task is in no way an assessment of any general abilities. Nor are any comparisons made between individual children.

If you allow your child to take part in this study, please complete the attached consent form and return it to (*name of teacher*). If you would like further information, I will be pleased to discuss any aspects of the study with you.

Yours faithfully

L. Crowther B.A.

I do / do not* consent to my child ______________________________ taking part in the study into concept development conducted by Mrs L.M. Crowther at (*Name of school or nursery*)

I do / do not* wish to receive further information about the study

Signature of parent/guardian ______________________________

Name of parent/guardian ______________________________

* delete as applicable

Appendix 2

Spontaneous verbalisations about the task and stimuli during training and testing phases, and comments made during post-experimental task. Data from children who learnt the AB task and passed a symmetry test without experimental interventions.

Child's name	Comments about stimuli	
	During experiment	**After experiment**
Megan	B2 - *a X; "like a T*	
Justin	A1 - *"that is a snowman*	A1 - *It's a snowman* A2 - *Triangle* B1 - *It's a bit like sword* B2 - *It's a bow*
Jonathan	B1 - *That is a bow*	None
Kate	None	A1 - *Hammer* A2 - *Arrow* B1 - *X* B2 - *Bow tie*
William	None	None
Luke	None	A2 - *Triangle* B1 - *Cross* B2 - *Bow*
Stephanie J.	B2 - *That shape looks like bow*	A1 - *Funny one* A2 - *Look like a triangle* B1 - *Cross; X*
Matthew	A1 - *The wiggly one* A2 - *The triangle* B1 - *The cross* B2 - none	A1 - *The wiggly one* A2 - *The triangle* B1 - *The cross* B2 - *Wiggly one, wiggly cross*
Stephanie S.	A1 - *Foot shape;Teddy foot* A2 - B1 - *Like a X; Looks like a kiss; cross* B2 - *Like a bow*	A1 - *Teddy foot* A2 - *Like a triangle* B1 - *Kiss* B2 - Bow

Michael	A2 - *Triangle*	A1 - *The other letter* A2 - *The other letter* B1 - *The other square* B2 - *The other square*
Andrew	None	A2 - *Triangle* B1 - *Cross* B2 - *Tie*
Erin	None	A1 - *Hammer shape* A2 - *Square* B1 - *Triangle* B2 - *Cube*
Melanie	None	A1 - *The teddy one* A2 - *The triangle*
Richard	None	A1 - *Oval with a round at the bottom* A2 - *Triangle* B1 - *Like a sword* B2 - *The one that goes with the triangle*

Appendix 3

Transcript of dialogue between experimenter and one of the subjects (William) in Experiment 3, during the first two A-C test trials.

The sample (C1) was present on the response panel and the two comparisons (A1 and A2) presented.
The experimenter was seated behind the panel out of William's sight.

William: *Which one is it?*
Experimenter: *You just have to try.*
W: *I don't know which one it is.*
E: *Which one do you think.*
W: *You see how I do it.*
E: *Yeh, see which one it is.*
W: *Can you tell me which one it is?*
E: *I don't know.*
W: *Just see what they are.*
E: *I don't know, William.*
W: *I don't.*
E: *Teddy does but he is not telling. You just have to try one. Try one.*
W: *Try another one.*
E: *Pick one of these up.*
W: *No, I don't want to. Do another one.*
E: *Just try it.*
W: *No, I want to do another one.*
E: *We'll do another one in a minute, just pick one of those up.*
W: *I don't know which one it is.*
E: *I know that but just try one, then we'll do another one.*
W: *I want to do it now.*
E: *Are you going to pick one of those up?*
W: *No.*
E: *Why not? Try one.*
W: *No.*
E: *Yes, you can.*
W: *No, no.*
E: *Which one would you like? Try one.*
W: *No, I don;t want it.*

The trial was the abandoned. William carried out three A-B trials without any comments and the A-C trial was then re-introduced and the following conversation ensued;

W: (After a long silence) *Which one is it?*

E: No reply

W: *That on or that one* (pointing to the comparison stimuli). *That one or that one.*

E: *Pick one up.*

W: *Oh, dear I can't do this one.*

E: *Yeh, you can, just try one.*

W: *No*

E: *Yes, try. Why don't you just try?*

W: *No, I don't want to.*

E: *I think you should try.*

W: *No.*

E: *Yeh, why don't you just try.*

W: *You see which one I pick up?*

E: *Yeh.*

W: *You put that one* (pointing to door with metal response panel) *down and see which one I pick up.*

E: Opens door but keeps her face out of William's sight.

W: *This one* (chooses the correct comparison). *Yes, it is right, isn't it?*

E: *I don't know, you see. I don't know. Only teddy knows.*

Appendix 4

Megan's performance on A-B and B-C matching task after learning stimulus labels and a transcript of her verbal responses.

Session 1

Responded correctly on labelling trials (two of each type)

Trial	Sample verbalisation	Comparison choice	Megan's verbal response	Experimenter
			We are doing Omni and Delta all the time.	
1	A2		*Delta*	
		B2	*Delta*	
2.	B1		*Omni*	
		C2	*Delta*	*You got that one wrong.*
			That was Delta.	*Yes, but it was the wrong Let's try another one.*
3.	A1		*Omni*	
		B2	*Omni*	*That wasn't right. Let's try and get it right.*
4.	A2		*Delta*	*That was right. You say the ight words, but you don't always get the right one.*
	B1	*Delta*		

Labels re-checked:

A1		*Omni*	
A2		*Delta*	
C1		*Omni*	
B1		*Delta*	*No that was wrong. That is Omni.*
B1		*Omni*	
C2		*Delta*	
B1		*Omni*	

5.	A2		*Delta*	
		B1	*Delta*	
			That is right.	
				What was it?
			Delta and Omni	
6.	B2		*Delta*	
		C1	*Delta*	
7.	B2		*Delta*	
		C1	*Delta*	
8.	B1			*Is that Omni or Delta?*
			Omni	
		C2	*Omni*	
				That wasn't the right one.
9.	A1		*Omni*	
		B1	*Omni*	*That's right.*
			I don't want to do any more.	
				Let's try just one more.
			No, I don't want to.	

Session 2

Stimulus labels checked prior and Megan responded correctly on all unreinforced labelling trials.

Trial	Sample verbalisation	Comparison choice	Megan's verbal response	Experimenter
1.	A2		*Delta*	
				Now pick the right one.
		B1		
				That was the wrong one.
2.	B1		*Omni*	*Good girl.*
		C2	*Delta*	
			(After buzzer) *Oh*	*No, that was the wrong one. Let's see if we can get some music.*

3.	A2		*Delta*	
		B1	*Delta*	
			(After buzzer) *Oops*	*That was the wrong one.*
			The music is broken.	*No, it will come on if you pick the right one. It is working all right if you get the right one.*
			I can't get the right one.	–
4.	A1		*I can't pick any.*	
				Can't you just try one.
			I can't make any music.	
				Try one.
			No, I can't do it.	
				Just try one.
			After picking up A1: *Omni*	
		B1	*Omni*	*See you can do it. Let's try again.*
5.	B2		*Delta*	
		C2	*Delta*	
6.	B2		*Delta*	
		C2	*Delta*	
7.	B1		*Omni*	
		B2		
8.	A2		*Delta*	
		B2		
9.	A1		*Omni*	
		B2		
10.	A1		*Omni*	
		B2		
11.	B2		*Delta*	
		C2		
12.	A1		*Omni*	
		B2		

13.	B1	C2	*Omni*	
14.	B1	C2	*Omni*	
15.	A2	C2	*Delta*	
16.	B2	C2	Delta	

Session 3

Trial	Sample	Comparison choice	Megan's verbal response	Experimenter verbalisation
1.	B2		Picked up the B2 stimulus and held it in her hand. *I can't put it on*	*Yes you can*
			I don't want any music.	*But you like music.*
			No, I don't.	*Oh, put it on.*
			I don't want to put something on.	
Trial abandoned				
2.	A1	B2	*Omni, Omni* *Delta, that's Delta*	*No, that wasn't the right one.*
			I don't want to play any more.	*Why?*
			I want to see mummy and James.	*They are waiting for you outside. Try one more.*
3.	A2		*Delta*	
			After presentation of comparison: *Is it Omni* (pointing to B1) *or Delta* (pointing to B2)? *I always put the wrong one on.*	*Put the right one on and I will give you a button.*

B1 *This one is the right one.*

No, that isn't right.

I don't want to do any more.

4. B2

Try one more to get a button.

I don't think I can put one on.
I don't think I can do it.

One more to get a button.

I don't want to do it.

Session 4

Asked to tell Teddy's friend Beaver about the game.

The experimenter sat next to Megan. The metal response panel and the stimuli were placed in front of Megan.

Experimenter (placing A2 in frame on panel) *If you put that one here which one would you pick?*

Megan (pointing to B1) *That one it makes lots of music.*

Experimenter (pointing to A2) *What is that?*

Megan: *Delta*

Experimenter: (pointing to B1) *And what's that?*

Megan: *Omni.*

Experimenter (placing A1 in frame on panel) *What if you put that one in there . How would you make music? Which one would you pick?*

Megan (placing B2 on the panel) *That one. It makes lots of music.*

Experimenter (pointing to A1) *What's that?*

Megan *Omni*

Experimenter (pointing to B2) *And that?*

Megan	*Delta*
Experimenter (placing B2 in frame on panel)	*Which one is this?*
Megan	*Delta, Delta, Delta*
Experimenter (showing C1 and C2)	*And which one of these would you choose?*
Megan (picking up C1)	*It makes lots of music*
Experimenter (pointing to C1)	*And what is it?*
Megan	*Omni*
Experimenter (placing B1 in frame on panel)	*What's this one?*
Megan	*Omni*
Experimenter (showing C1 and C2)	*And which one of these do you pick?*
Megan (picking up C2)	*That one*
Experimenter (pointing to C2)	*What is that?*
Megan	*Omni*
Experimenter (placing C2 in frame on panel)	*What's that?*
Megan	*Delta, Delta.*
Experimenter (showing B1 and B2)	*And which one of these would you have?*
Megan (picking up B1)	*Omni*