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The determinants of naming in human infants

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University of Wales (Bangor)

THE DETERMINANTS OF NAMING IN HUMAN INFANTS

Margaret H. Bell

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relation serves to set the conditions for the object itself to enter into direct control of the child's verbal behavior, thereby occasioning naming."

Horne and Lowe (1996) have given a detailed account of how echoic imitation may bring about the naming. Thus for

> 'a child who has already learned both to echo and to listen to the auditory stimulus */shoe/*... ...when the caregiver points to a shoe and says "shoe" the auditory stimulus now occasions the child's looking at the shoe while she echoes and re-echoes "shoe". In this way, the sight of the shoe becomes a frequent antecedent and then discriminative stimulus (S^D) for her saying "shoe". Thereafter, when a child sees the shoe, it alone occasions her saying "shoe" ' (p200).

Unlike Skinner (1957), Horne and Lowe (1996) propose that naming, as described above, and not simply echoing, manding, or tacting, is the basic unit of verbal behaviour. Skinner (p. 56) suggested that reinforcement of echoing (and other simple operants that he termed verbal) might not always be overt or direct: "educational reinforcement" (described in *Chapter 1*), initially set up in infant - caregiver interaction, might still be present when the child is not under formal instruction; and that echoic behavior may be reinforced by many other indirect means. However, he maintained that it was essential that reinforcement be entered into the learning paradigm. Other theorists, notably Chomsky (1959), pointed to the emergence of novel behaviours (see *Chapter 1*) and suggested that overt reinforcement was not necessary for learning verbal relations.

In Experiment 3, none of the infants learned tact responding from learning the corresponding listener and echoic repertoires separately. Experiment 4 investigated whether tacting would emerge from simply bringing together the listener and echoic behaviours in such a way that echoing was reinforced whilst the child was attending to the corresponding stimulus object, or if explicit reinforcement of the tact response was necessary to bring about tacting.

METHOD

Participants

The five infants who took part in Experiment 3 went on to participate in this experiment. Table 5.4.1 gives, for each infant, age and MCDI production and comprehension vocabularies at the start of this experiment.

Table 5.4.1

The infants' age, and MCDI comprehension and production scores at the start of Experiment 4.

Infants'	Age at the start in months and days	MCDI Comprehension	MCDI Production
BR	22;26	203	50
HC	20;16	276	65
WP	22;18	304	207
RR	23;08	337	160
WL	21;13	249	114

The age of the infants ranged from 20 months 16 days to 23 months 8 days at the start of this experiment. It can be seen that all of these infants had production vocabularies of over 50 words and comprehension of more than 200 words.

Apparatus, Materials and Setting

The apparatus materials and setting remained unchanged. These were all described in Experiment 3.

Procedure

The infants were already well acquainted with the experimenter and the experimental setting from earlier experiments.

Experiment 4 was based on the five stages described in Experiment 3. Each session began and ended with a tact test. However Stages 2 - 4 were gradually brought together in two multiple baseline interventions. In the first intervention, the listener and echoic probes were combined to form listener – echoic trials, and the Tact Test 2 was omitted. In the next intervention, the latter tact prompts were re-instated to form combined listener – echoic – tact trials. The third intervention, which directly reinforced all tact responses, was also available. The procedures were administered differently for each participant. Not all received each intervention and the order of presentation of the interventions varied, either to investigate order effects or to facilitate criterion responding.

Baseline.

First, a number of baseline sessions were conducted to see if tacting would emerge as a consequence of yet further testing of the listener and corresponding echoic relations learned in Experiment 3, and without any further intervention. This might occur if the auditory stimulus presented in the listener trials also gave rise to echoic responding, thus occasioning a situation where the production of a matched echoic response and orientation towards the corresponding stimulus object could be reinforced, but as an unscheduled consequence of reinforcing the listener response. In the baseline condition, the procedure was identical to the final stage of Experiment 3. Each session began with the Tact Test 1 (the criterion tact test), followed by the Listener Test Trials, and the Tact Test 2. Next, the reinforced Echoic Trials were conducted in the absence of the stimulus objects. The session concluded with the Tact Test 3.

Intervention 1: Combining listener and echoic probes.

Intervention 1 combined the listener trials and the echoic trials so that for the first time reinforcement was scheduled to occur when the infant produced an echoic response while attending to the corresponding stimulus object. Intervention 1 sessions consisted of the stages described below.

Stage 1: The Tact Test 1.

This was conducted as described in Experiment 3.

Stages 2-4: Combining the Listener and Echoic Trials in Step-wise Fashion.

The three stimulus objects were placed on the table within reach of the participant and each listener relation was probed in turn, in the same way as in Experiment 3, except as follows. When the participant responded correctly as a listener, for example by selecting O1 in response to */bidge, bidge, where's the bidge?/*, the experimenter removed the remaining comparison objects from view and gave O1 to the infant to look at; she then immediately prompted the infant to produce the corresponding echoic response; that is, in this example, she said "good girl, that's right, bidge, bidge, can you say bidge?" The infant's matched echoic responses were reinforced, by verbal praise or by tokens, as before. The experimenter then playfully hid and then re-presented O1 in order to repeat the combined listener and echoic probes. Three such combined probes were scheduled in each session.

Initially the intervention was applied only to one verbal relation. The listener trials, the Tact Test 2 and echoic trials for O2 and O3 were conducted in the same was as described in Experiment 3, Stages 2 - 4, either before or after the combined trials for O1.

Stage 5: The Tact Test 3.

This was conducted as described earlier.

The intervention was extended to the second verbal relation once responding to the combined listener - echoic probes for the first targetted relation reached the criterion of ≥8/9 correct combined listener and echoic responses. The third echoic relation continued in the baseline condition.

Finally when criterion combined listener – echoic responding was seen for the second targetted relation the intervention was extended to the third.

Intervention 2: Combining the Listener - Echoic and Tact Trials

Stage 1: The Tact Test 1

As before, each session started with Tact Test 1, the criterion tact test.

Stages 2 - 4: Combining the Listener-Echoic and "Tact" Trials.

In this intervention the listener–echoic trial was combined with a "tact" probe to form a listener–echoic-"tact" trial. For the first verbal relation, following correct selection of the corresponding stimulus object, the listener trial, the infant was immediately prompted to echo, and then to respond to the probe "What is it?".

Thus the experimenter said:

> Bidge, bidge, where's the bidge? Good girl, that's right. Bidge, bidge, can you say bidge?

This was followed by a five second response interval. If the infant failed to respond or produced a mismatched response the probe was repeated up to a total of three times. When a matched echoic response was produced, and while the infant looked at the relevant object, the experimenter continued:

> So what is it (5 second response interval), what is it (5 second response interval), what is it (5 second response interval)?

Tact Test 3

This was conducted as described above.

As in Intervention 1, the intervention was applied only to one verbal relation at first. Therefore, after the combined trials of the first auditory stimulus the combined listener-echoic probes for O2 and O3 were presented as in Intervention 1. That is, Intervention 2 was implemented as a multiple baseline intervention.

Intervention 3: Direct reinforcement of the tact response

As a final intervention reinforcement of all matched tact responses was given. This intervention was implemented in one of two possible conditions, as follows: (i) if a participant was about to leave the experiment and criterion tacting had not already been demonstrated to criterion; and (ii) to eliminate production of mismatched responses when tact responding had increased significantly but remained just below the criterion of ≥8/9 consecutive correct responses. This intervention was applied either across all three verbal relations simultaneously at whatever stage the procedure had reached, or when possible, as a multiple baseline intervention.

RESULTS

Participant BR

BR began Experiment 4 at 22 months 26 days old. She received 10 baseline sessions when echoic trials were conducted in the absence of all the stimulus objects that featured in the listener trials, as in the final phase of Experiment 3.

Intervention 1, which combined listener and echoic trials, was implemented in a multiple baseline procedure. This combined the listener and echoic trials. For the second and third target relations, tacting began to "emerge" in Session 26, the 8th and 2nd sessions, respectively, of Intervention 1. No effect of Intervention 1 on the first target relation was observed, even after 17 intervention sessions, and despite the increase in tacting observed for the other two relations towards the end of this phase.

Next Intervention 2, which brought together listener responding, echoic responding and "tact" probes under reinforced conditions, was initiated as a second multiple baseline intervention. There was no immediate effect of Intervention 2 on the first target relation; only when Intervention 2 was implemented for the second target relation (to attempt to achieve consistent above criterion tacting for the latter) did tacting finally appear for the first target relation.

Whilst there are clearly correlations across relations two and three in onset of tacting, the cause of these correlations is not clear. This is also true for the onset of tacting for the first target relation when Intervention 2 was introduced to the second. These correlations are discussed further below.

Tact Responses

Tact responses were tested before the listener trials (Test 1) and after the echoic trials (Test 3). Tacting was tested after the listener trials (Test 2) in the baseline condition only. Figures 5.4.1.1 - 5.4.1.3 show the number of tact probes per session, and the number of correct and mismatched tact responses per session. The tact responses to the combined listener–echoic-"tact" trials are shown in Test 2, Intervention 2.

For the O1 — "tade" tact relation, over all the tact tests BR produced 9 matched responses in the 90 trials in the baseline condition, and only two of these occurred during Tact Test 1. She produced no matched responses during Intervention 1 for this relation, but 7 mismatched "geck" responses were produced between Sessions 25 and 28.

When Intervention 2 was initiated, there was a general increase in the number of target responses in the combined listener-echoic-"tact" trials, that is, Tact Test 2; however, in Tact Tests 1 and 3, mismatched responses were more likely than matched responses until Session 41, when Intervention 2 was extended to the second target relation. In all she produced 15 matched and 30 mismatched responses to Test 1 probes to tact O1. Criterion tacting at Tact Test 1was seen in Sessions 43 – 47.

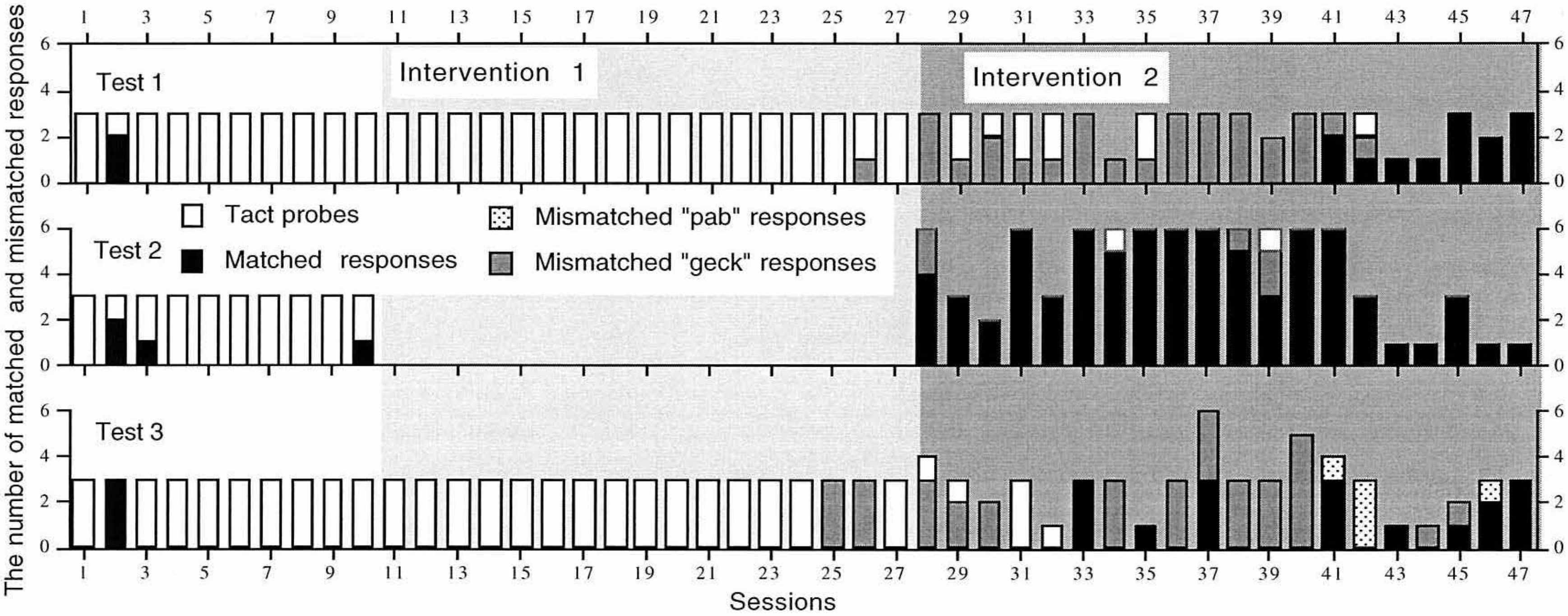

Figure 5.4.1.1 The number of matching and mismatched responses produced by BR in tests of the tact relation O1 - "tade".

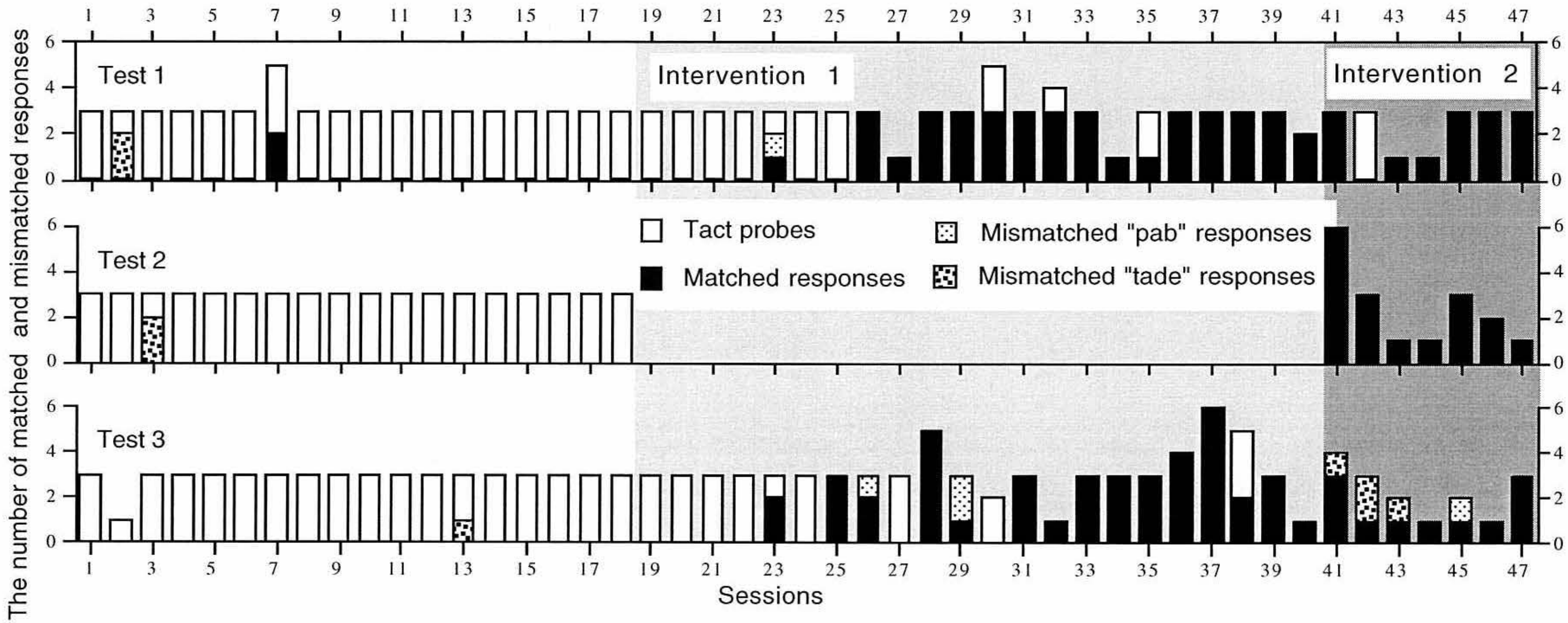

Figure 5.4.1.2 The number of matching and mismatched responses produced by BR in tests of the tact relation O2 - "geck".

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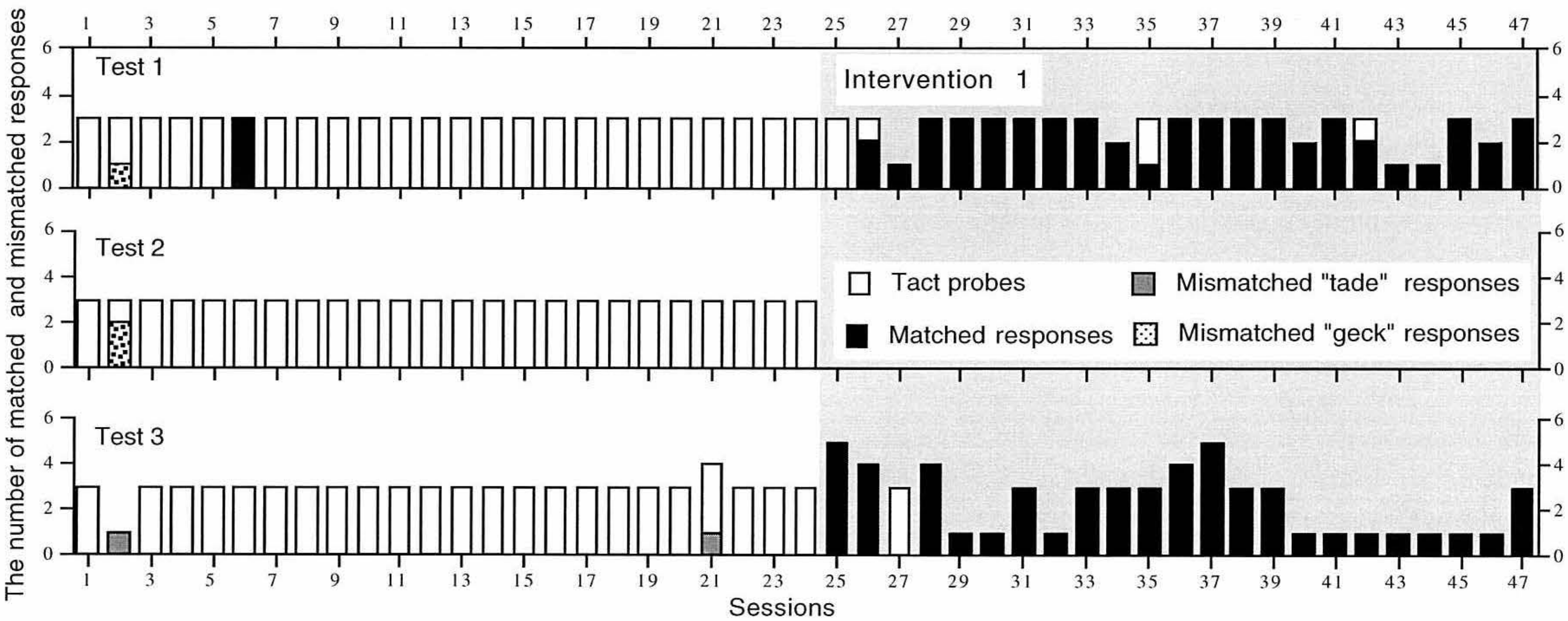


Figure 5.4.1.3 The number of matching and mismatched responses produced by BR in tests of the tact relation O3 - "pab".

For the tact relation O2 — "geck", there were only two matched and five mismatched "tade" responses in 162 tact trials (mrr = 0.01) in the baseline condition. Following Intervention 1 there was no immediate effect; she produced three matched responses (mrr = 0.08) and one mismatched "pab" response in the 36 trials from Sessions 19 to 24 inclusive. Not until listener and echoic trials were combined for the third target relation, O3 — "pab", did she start to make more frequent "geck" tact responses. Criterion responding was demonstrated in Sessions 26 – 29 when she produced matched responses in 10/10 trials (mrr = 1). Thereafter, apart from some instances of no responses in Sessions 30 and 32, tacting remained at criterion. The introduction of Intervention 2 was correlated with continued criterion responding with the exception of three no responses in Session 42.

For the third tact relation, O3 — "pab", there were two matched responses and five mismatched responses in the 215 baseline trials (mrr = 0.0093). Following the introduction of Intervention 1, responding was seen to change very dramatically. Interestingly, this improvement in performance on O3 — "pab" was correlated with a sudden onset of correct responding in O2 — "geck" trials (see above). From Session 25 onwards there were 106 matched responses in 116 trials (mrr = 0.91) and no mismatched responses. Criterion was demonstrated in Sessions 26 – 29 when she produced 9/10 matched responses (mrr = 0.9) and no mismatched responses. Criterion performance continued until Session 47 except for two no responses in session 35. So for the third tact relation, O3 — "pab", Intervention 1 alone was sufficient to bring about tact responding.

The tact responses can also be shown as the proportion of matched and mismatched responses per session. This allows the response trend to be summarised. Figure 5.4.1.4 shows the proportion of matched and mismatched responses to the number of trials per session in relation to the two multiple baseline interventions.

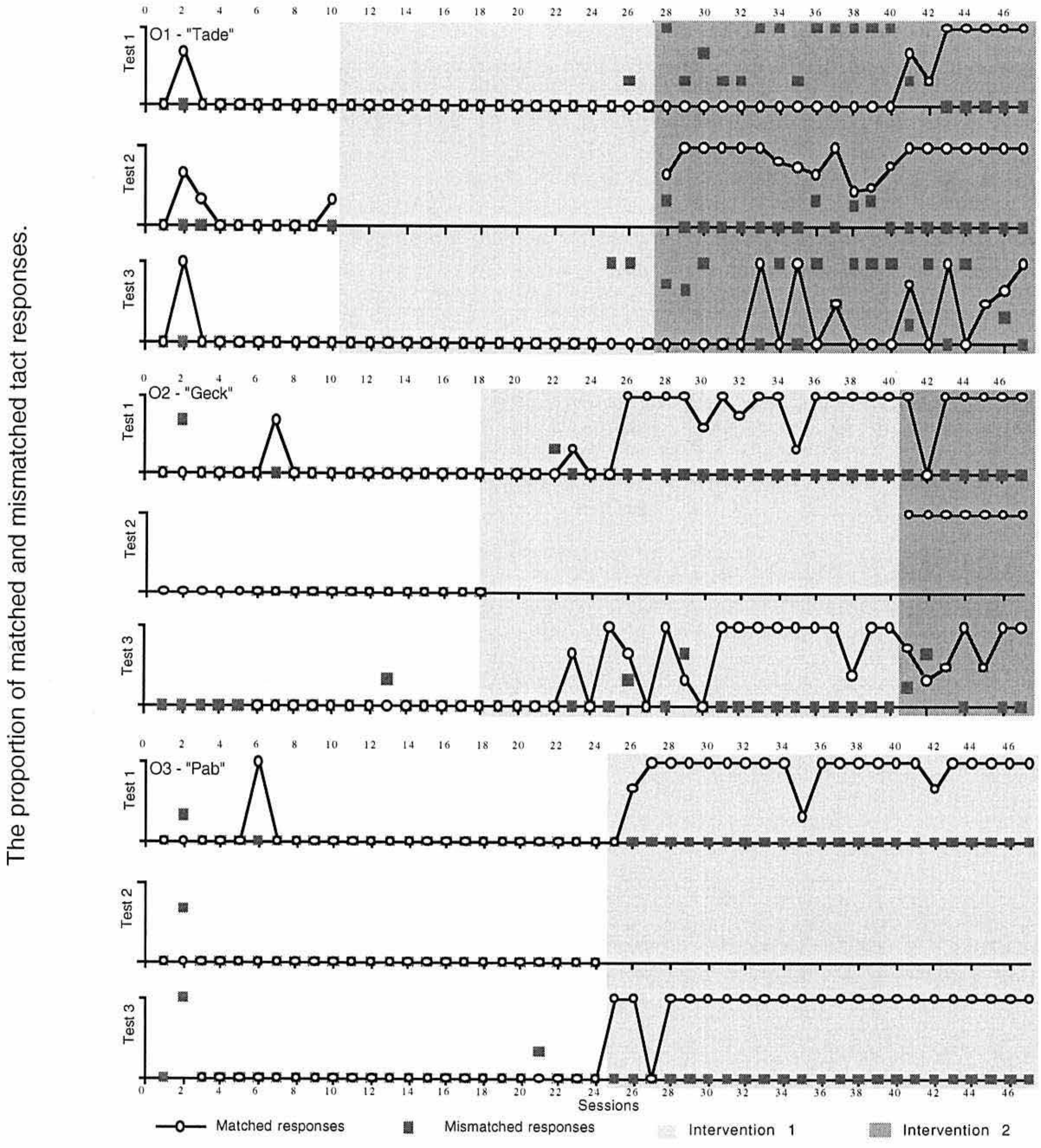


Figure 5.4.1.4 The proportion of BR's matched and mismatched responses to the number of tact probes in each session, shown in relation to the interventions (shaded).

There was no evidence of tacting in the baseline phases, when echoing was probed in the absence of the stimulus objects, and this continued to be the case when the echoing was probed whilst she was attending to the corresponding stimulus object for the first verbal relation.

When the intervention was extended to the second verbal relation she produced occasional matched responses to O2. However, when Intervention 1 was extended to the third verbal relation tacting of both O3 and O2 came into effect, but for O1 her responses were mismatched "geck" responses. However, because of the inappropriate use of "geck" responses in O1 trials, in Intervention 1 there was strong evidence for learning of the full tact relation for O3 only (see below).

When Intervention 2 was implemented for the O1 — "tade" relation, there was no change in responding in Test 1; she continued to produce mismatched "geck" responses. However, she began to produce matched responses in the listener–echoic–"tact" training trials. Finally when Intervention 2 was extended to O2 — "geck" correct responding to O1 — "tade" probes appeared, and criterion was achieved shortly afterwards, in Sessions 43 – 47. She demonstrated criterion responding to all three tact relations simultaneously, at the criterion test (Test 1), in Sessions 43 – 47 when she produced matched responses in 31/31 trials (mrr = 1). Thus BR had learned to tact all three stimulus objects; she was 25 months and 12 days old.

The Tact Training

BR learned to tact O3 simply from reinforcing echoing while she was attending to the corresponding stimulus object, Intervention 1. Once the latter intervention was introduced she made no mismatched responses in probes for this relation. Onset of her matched responding to O3 occurred in Session 26, that is, at the same point at which tact responding to O2 appeared. It is important to note, however, that following this increase in matched responding in probes for O2 — "geck", there was a corresponding increase in the number of mismatched "geck" responses to tact probes for O1.

Evidently, she had learned to tact O3 — "pab", and she had not learned to tact O1 — "tade", but it was not clear that she had learned to tact O2 — "geck" because she also used the "geck" response in a large proportion of the probes to tact O1.

In Intervention 2 she was reinforced for producing a "tact" response in Stage 2-4 when the listener, echoic and tact trials were combined. When this intervention was introduced to O1 —"tade", it produced a gradual increase in the number of matched tact responses during these training trials. These are shown in the Tact Test 2 fields in Figure 5.4.1.1, Sessions 28 - 47. At first, there was little or no effect of the latter responding on her responses to the Tact Tests 1 and 3. However, gradually she began to produce occasional matched responses together with mismatched responses in Tact Test 3. There was no generalisation of this response to Tact Test 1, where she continued to produce mismatched "geck" responses to all tact probes. Interestingly, she also produced mismatched "geck" responses in the Tact Test 2 intervention trials. However, once the intervention was extended to the O2 — "geck" relation no further mismatched "geck" responses were made in these trials.

When Intervention 2 was extended to the *geck* relation, so that her matched tact responses were reinforced whilst she was acting upon the corresponding stimulus object O2, there was a significant decline in the number of mismatched "geck" responses she produced in Test 1 for the O1 — "tade" tact relation. There was a corresponding increase in matched responses for the latter relation so that she attained criterion responding for all the tact relations within the next seven sessions. However, note that even during these criterion sessions she still produced occasional mismatched responses in the Tact Test 3.

Listener trials

In Experiment 3 it was found that listener responding fell below the learning criterion, but remained well above chance frequency. This trend was repeated throughout Experiment 4. BR's responses to listener test trials are shown in Figure 5.4.1.5. It can be seen that for the listener relation */pab/* — O3 responding was consistent after the implementation of Intervention 1, when she learned to tact. For the */pab/* — O3 relation she was correct in 42/47 (mrr – 0.89) and following the intervention in 23/23 trials (mrr = 1). This was not reflected in her listener responses to either */tade/*— O1 or */geck/* — O2. This, together with the frequency of her mismatched "geck" responses to the tact probes for O1, suggests that she could not reliably discriminate the O1 and O2 stimulus objects. Tact probes for both objects were likely to produce "geck" responses, and listener probes for */geck/* tended to produce orientation to either O1 or O2. It should be noted, however, that the */tade/* and */geck/* listener relations were less stable than the */pab/* listener relation in their respective baseline phases.

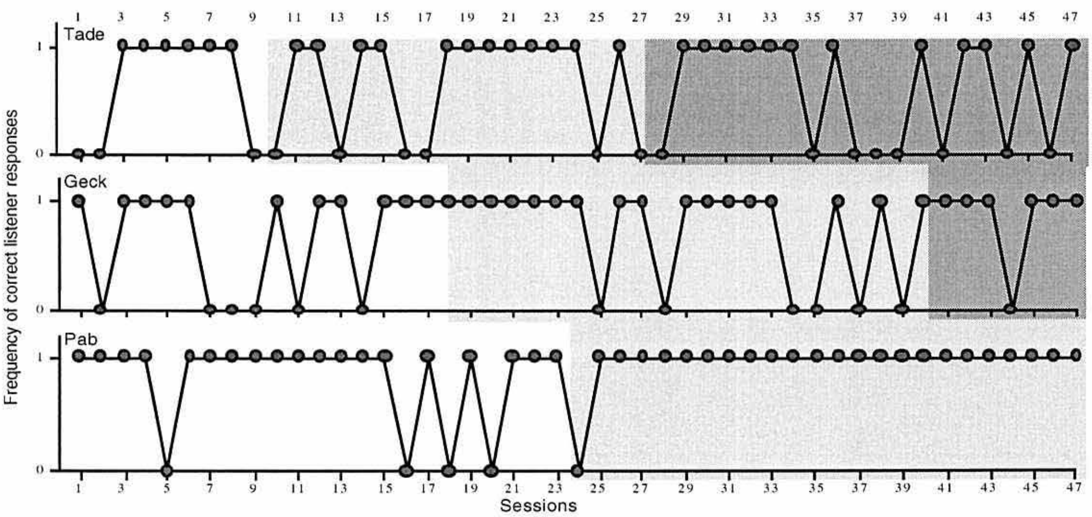


Figure 5.4.1.5 The listener responses of BR during Experiment 4.

For the listener relation */tade/* — O1 she responded correctly in 30/47 trials (mrr = 0.64). For the */geck/* — O2 relation she responded correctly in 34/47 trials (mrr = 0.72).

Unprompted vocalisations

Few unprompted vocalisations were seen during the listener trials of this experiment. Figure 5.4.1.6 shows the number of echoes, echo-tacts and other unprompted vocalisations made in each session.

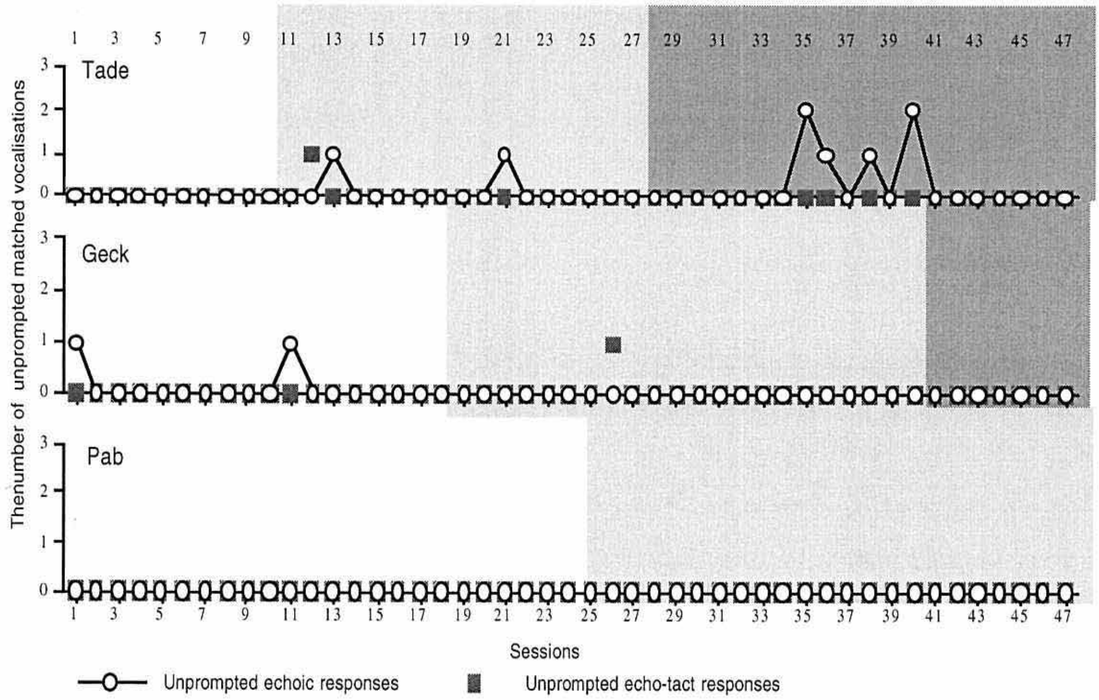


Figure 5.4.1.6 The unprompted matched vocalisation produced by BR in the listener trials, shown in relation to the multiple baseline intervention.

In the trials of the listener relation */tade/*— O1 BR produced eight unprompted echoes and one unprompted echo-tact. She produced two echoic responses and one echo-tact response in the *geck* trials, and neither echoic nor echo-tact responses in the pab trials.

Echoic Responses

Echoic responding had already been demonstrated to criterion in Experiment 3. In this experiment BR was required to echo whilst orienting to the corresponding object.

As shown above listener test responses were not always correct. Consequently further listener probes were given until correct responding was demonstrated and the infant correctly oriented to the corresponding object. Only then was she prompted to echo.

Thus all echoic responses were made contingent upon orientation to the corresponding stimulus object. The number of prompts per session varied with the interest the infant showed in the interaction. For this reason, echoic responses are shown in Figure 5.4.1.7 as a proportion of the number of probes per session.

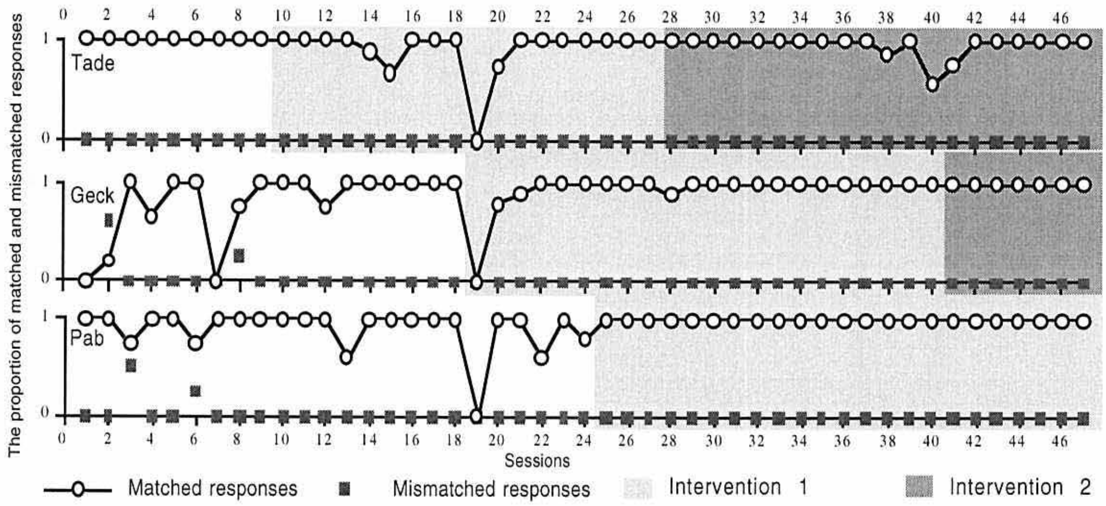


Figure 5.4.1.7 BR's matched and mismatched responses shown as a proportion of the echoic probes per session.

Echoing was initially probed in the absence of the stimulus objects, as in Experiment 3. In Intervention 1, echoing immediately after listener responding was reinforced; later listener responding, echoing and tacting were reinforced (Intervention 2).

There were 228 correct responses in 250 probes for the echoic relation */tade/* - "tade"(mrr = 0.91), 175 correct responses in 195 probes for the relation */geck/* — "geck" (mrr = 0.90), and 182/189 correct responses for */pab/* - "pab" (mrr = 0.96). There were only seven mismatched echoic responses. She said "pab" once and "tade" three times in the *geck* trials, and she said "tade" three times in the *pab* trials, all in the early sessions of the baseline condition. Echoing was thus robust and above criterion responding throughout the experiment.

Unprompted Vocalisations

There were occasional unprompted vocalisations of the auditory stimuli during Experiment 4 but these occurred much less frequently than in Experiment 3. Figure 5.4.1.8 shows BR's unprompted vocalisations during the echoic trials.

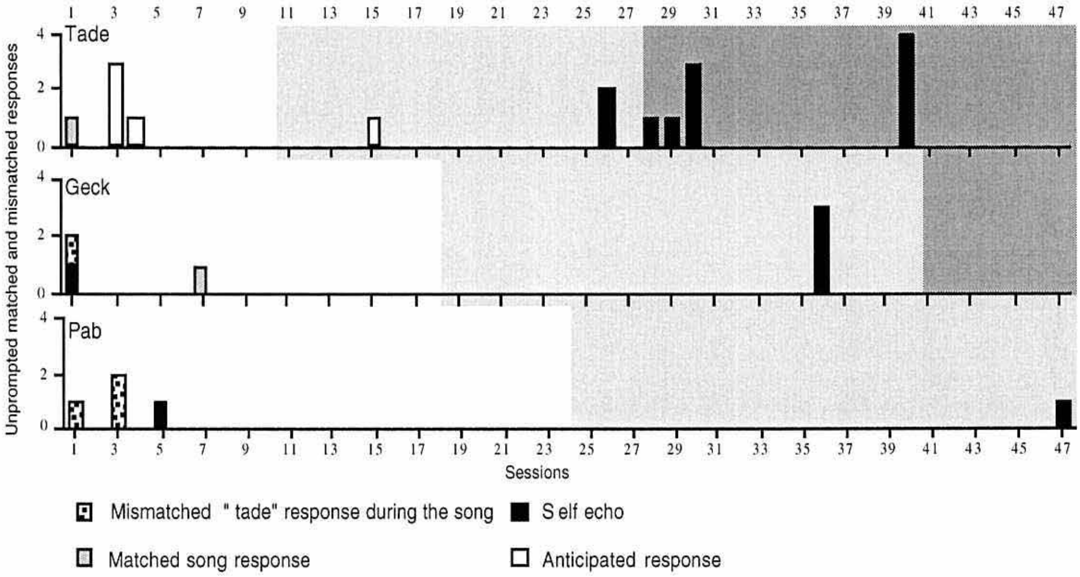


Figure 5.4.1.8 BR's unprompted matched and mismatched vocalisations, in the echoic trials.

In the *tade* trials there were eleven perseverated echoes, one matched response in the song probe and five responses when BR "anticipated" the echoic probe, that is, produced a response before the echoic probe was completely presented. In the *geck* trials there were three perseverated echoes, one matched song response and one mismatched "tade" response in the song probe. In the *pab* trials there were two perseverated responses, and three mismatched "tade" responses in the song probe. The song responses were infrequent and when they did occur were usually "tade". The number of unprompted vocalisations was minimal.

Learning to Tact

Summary

BR began Experiment 4 when she was 22 months and 26 days old. She had previously learned three listener relations and three corresponding echoic relations to criterion. Under conditions of reinforced echoing echoic responding remained robust; throughout this experiment, listener responding though well above chance, was only maintained to the learning criterion for the */pab/* — O1 relation.

Two interventions were implemented in Experiment 4. When listener trials were combined with echoic imitation trials so that echoing was reinforced when she was attending to the corresponding stimulus object, BR learned to tact only one of the stimulus objects, O3. Though BR simultaneously achieved criterion responding for the second target relation, O2 — "geck", we must view this with caution, since the response "geck" was emitted with very high frequency also in probes with the O1 object. When listener, echoic and tact trials were combined she learned to tact the two remaining stimulus objects. Thus tacting to criterion had been demonstrated for all three tact relations. Only the pab listener relation had been maintained to criterion. Thus the full name relation of both speaker and listener behaviour was only demonstrated for the pab relation.

Continuation

Further sessions were conducted to see if, having learned the three tact relations: (i) would listener responding return to criterion across the board; and (ii) would mismatched responses be eradicated from Tact Test 3.

The procedure continued as before, without further intervention, save that the combined listener-echoic-"tact" probes were extended to the third relation in Session 49. In Figure 5.4.1.9 BR's responses are shown as the proportion of matched and mismatched responses to the number of trials per session. This information is shown for Tact Test 1 (the criterion tact test), the echoic trials, and the listener trials.

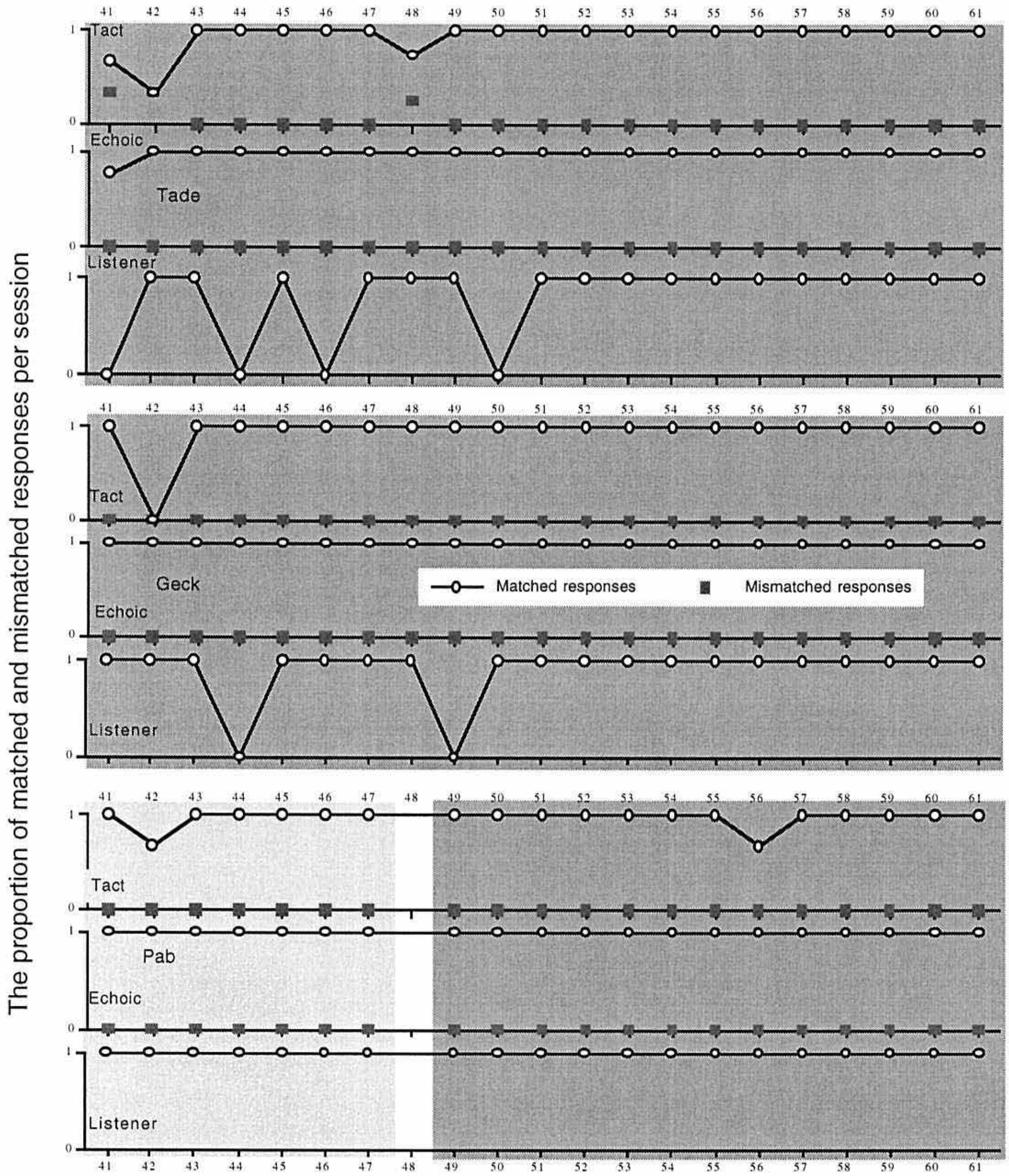


Figure 5.4.1.9 The proportion of matched and mismatched tact, echoic, and listener responses of BR, from the last Intervention to the end of the continuation trials.

Figure 5.4.1.9 clearly demonstrates that BR had learned the full name relation: following Session 47, in which criterion tacting was achieved for all three target relations, listener responding was also at criterion level. Tact, echoic, and listener relations were at or above the criterion of ≥8/9 correct consecutive responses throughout the 14 session continuation phase.

This effect was also observed in Tact Test 3. Mismatched responses were minimal and she produced matched responses in 13/14 trials (mrr = 0.93) of O1 – "tade", 14/15 trials of O2 — "geck" (mrr = 0.93) and 15/15 trials (mrr = 1) of O3 — "pab".

Participant HC

HC began the experiment at 20 months, 16 days. She was expected to be unavailable for a period of one month and it was hoped that she would complete the procedure before this interruption. For this reason, the interventions were implemented in rapid succession in order to complete the experiment quickly.

First, 10 baseline sessions were conducted. In these sessions the tact and listener behavior continued to be tested at the beginning of each session, and the echoic relation was reinforced in the absence of the stimulus objects.

In the next two sessions Intervention 1 was introduced for the first target relation (i.e. the *bidge* relation) while the second and third target relations remained in baseline, that is, the echoic probes for */gav/* — "gav" and */jeck/* — "jeck" continued to be probed in the absence of the stimulus objects.

In Session 13, two changes were introduced. Intervention 2 was implemented for the *bidge* target relation, and Intervention 1 was implemented for the second target relation (i.e., *gav*). The third target relation continued in the baseline condition.

In Session 16, Intervention 2 was implemented for the *gav* relation, and the third relation (i.e., *jeck*) continued in the baseline condition.

Intervention 1 was omitted from the procedure for *jeck* because HC was about to leave the nursery (see above) and Intervention 1 had not been effective in bringing about tacting for the first two target relations. Intervention 2 was implemented for this third relation in Session 17.

In Session 24, after a minimum of six sessions of Intervention 2 for all three echo-tact relations, HC was still not tacting at criterion. Consequently, Intervention 3 was introduced as follows: one probe for each tact relation was made at each tact test, and if the response was a correct match it was reinforced. This was done to ensure that repeated probes under unreinforced conditions did not create the conditions for a forced change of response. This intervention was applied to all the tact probes in the next 8 sessions. Tacting under reinforced conditions reached the criterion of ≥8/9 consecutive correct responses in these 8 sessions and was maintained in 4 further unreinforced sessions. Figures 5.4.2.1- 5.4.2.3 show the tact responses, at Tests 1 and 3, for each relation during these 35 sessions; data shown for Test 2 are responses to the listener-echoic-"tact" probes that constituted Intervention 2.

For the tact relation O1 — "bidge" there was one matched and one mismatched response, both in Test 1, in the baseline condition. There were no target responses in the two Sessions for Intervention 1.

When Intervention 2 was implemented, there was an increase in both matched and mismatched responses. This was most apparent in Test 3. There were five matched and four mismatched "gav" responses in Test 3 and two matched responses in Test 1.

Hence during the first 23 sessions she produced 3/66 matched responses (mrr = 0.045) and one mismatched "jeck" response at Tact Test 1. There were no target responses in Test 2. In Test 3 she produced 5/57 matched responses (mrr = 0.088) and four mismatched "gav" responses. Reinforcement of responses to the listener–echo-"tact" probes was correlated with a slight increase in the frequency of correct tacts in

Test 3 but this did not approach criterion level responding. At Test 1 her responding remained very infrequent and well below criterion.

In the first eight sessions of Intervention 3 criterion tacting was demonstrated. She produced matched responses in 9/10 trials (mrr = 0.9) and one mismatched "gav" response at the criterion Test 1. In the last four unreinforced sessions she produced matched responses in 4/4 trials (mrr = 1) and no mismatched responses. In the twelve sessions in Test 3 she produced 11/16 matched responses (0.69) and four mismatched responses. There were no mismatched responses in the last five sessions.

Thus the tact relation O1 — "bidge" required direct reinforcement of matched tact responses to attain the criterion level of ≥8/9 consecutive correct responses, but once established remained robust without further reinforcement.

For the tact relation O2 — "gav", HC two matched responses and one mismatched "bidge" response in the baseline condition. There was no change to this baseline responding after Intervention 1 was implemented; only one matched response was produced in Test 3. Once the Intervention 2 was introduced, there was an increase in target responses and, as in the first tact relation, this was most evident in Test 3. She produced 2/15 matched responses in Test 1, again with one mismatched "bidge" response, and 7 matched responses in ten trials (mmr = 0.7) and one mismatched "bidge" response in Test 3.

Criterion was demonstrated in Sessions 24 – 31, following Intervention 3, when she produced 10/10 matched responses (mrr = 1) at Test 1. In the unreinforced Sessions 32 – 35 she maintained this faultless responding, producing 4/4 matched responses (mrr = 1) and no mismatched responses. In Test 2 she produced 11/15 matched responses (mrr = 0.73), two mismatched "jeck" responses and one mismatched "bidge response.

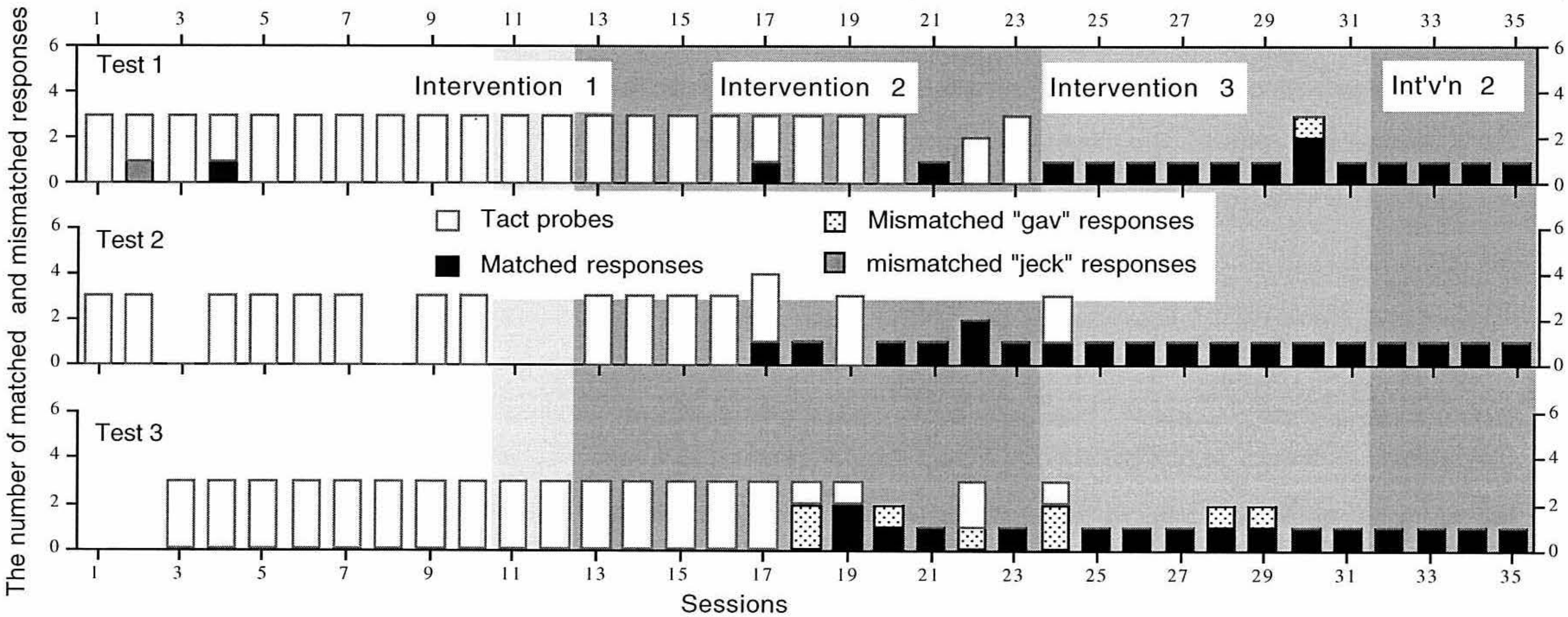


Figure 5.4.2.1 The number of matching and mismatched responses produced by HC in tests of the tact relation O1 - "bidge".

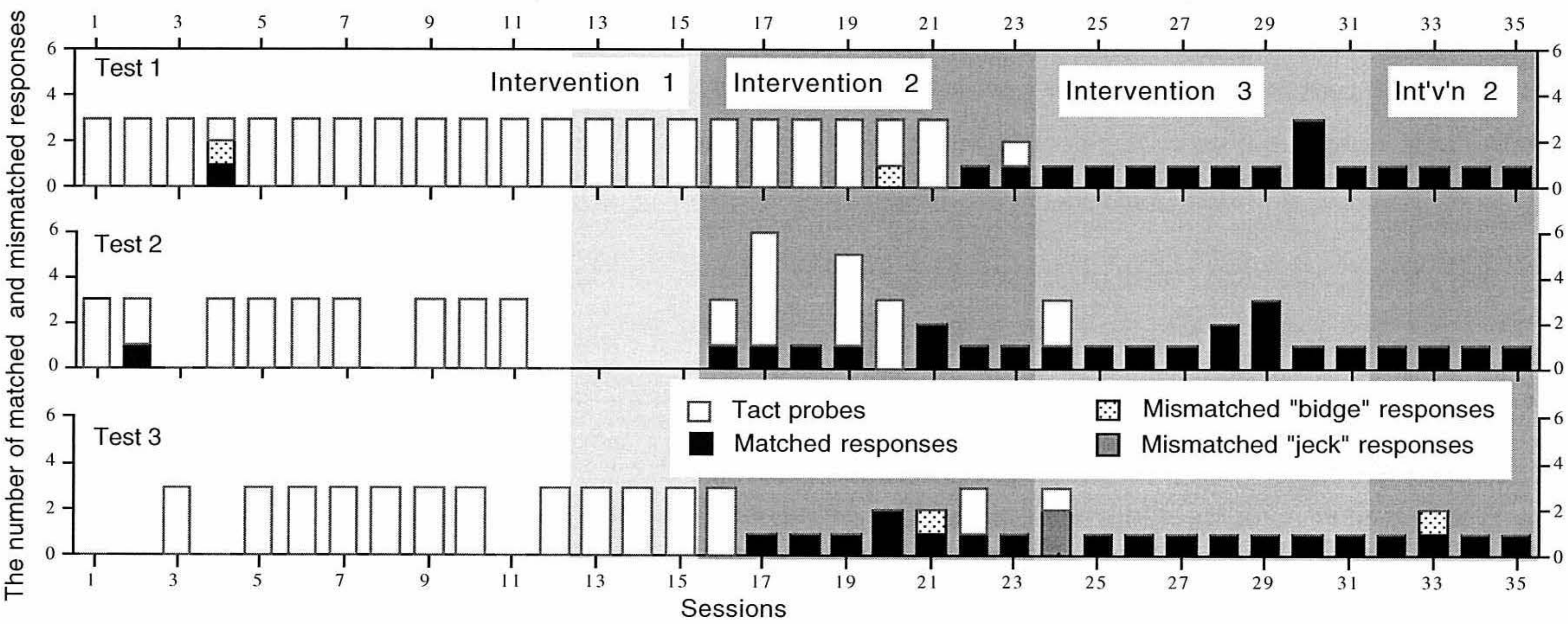


Figure 5.4.2.2 The number of matching and mismatched responses produced by HC in tests of the tact relation O2 - "gav".

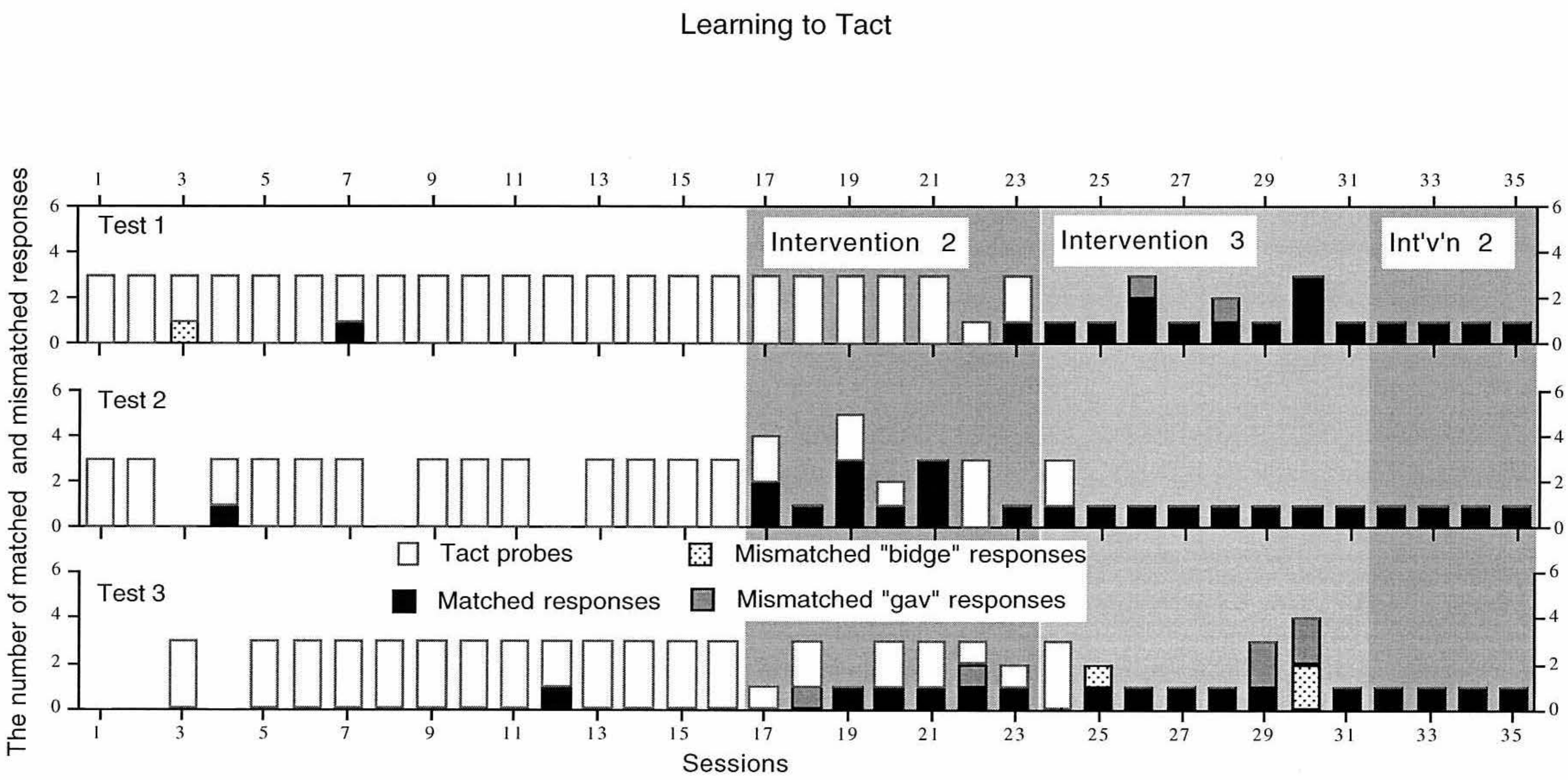


Figure 5.4.2.3 The number of matching and mismatched responses produced by HC in tests of the tact relation O3 - "jeck".

Thus for this tact relation, reinforcing the listener-echoic-tact trials in Stages 2 – 4 was correlated with an increase in matched tact responses in Test 3. There was evidence that this behaviour was extending to the Test 1 trials before Intervention 3 was implemented.

However, due to time constraints Intervention 3 was implemented at this stage. Under conditions of direct reinforcement of matched tact responses, in Intervention 3, tacting at Test 1 was demonstrated to criterion, and remained robust when reinforcement was withheld.

For the tact relation O3 — "jeck" a similar picture emerged. In 130 baseline trials there were only three matched responses and one mismatched response. Intervention 1 was omitted for this relation and she proceeded directly to Intervention 2. Once again there was an increase in the number of target responses following the intervention and this was particularly so in Test 3. There were five matched and two mismatched "gav" responses in the 15 trials in Test 3. Again, there was evidence that this was beginning to transfer to Test 1 in the last session of Intervention 2, when the first matched response of this phase occurred.

After Intervention 3 was implemented, her responding increased significantly. In the first eight sessions in Test 1 she made10/12 matched responses (mrr = 0.83) and two mismatched responses. She attained the criterion of ≥8/9 consecutive correct response over the last nine of these trials. In Session 32 – 35, without reinforcement, she produced 4/4 matched responses (mrr = 1). In Test 3, she produced 10 matched responses, four mismatched "gav" responses, and three mismatched "bidge" responses in twenty trials. Only in Session 24 did she fail to produce a matched or mismatched target response.

Thus for HC, the O3 — "jeck" tact relation began in Test 3 in Intervention 2, but did not reach criterion in Test 1 until it was directly reinforced in Intervention 3. However, once at criterion it remained robust over four unreinforced sessions.

These results suggest that in response to Intervention 2 there was an increase in the number of target responses produced in Test 3, and that these were often, but not always, matched responses. However, because of the premature introduction of Intervention 3, the full effect of Intervention 2 cannot be conclusively determined for this participant. Intervention 3 was, however, sufficient for the establishment of tacting to criterion for all three relations.

The tact responses can be shown as a proportion of the number of trials. This allows the frequency of production of matched responses to be observed, and also shows how Intervention 2 was instrumental in bringing about increased responding to tact probes. Figure 5.4.2.4 shows HC's matched and mismatched responses as a proportion of the number of tact trials in each session for the three tact tests in each verbal relation. Her responses to the reinforced tact probes in Stages 2-4 are shown, after Intervention 2 was implemented, in Test 2.

Tact Training

HC learned all the tact relations to criterion after Intervention 3 was implemented for all three relations simultaneously. However, there was evidence of emergent tacting in Test 3 in Intervention 2. Figure 5.4.2.4 shows how the rate of production of tact responses following listener and echoic probes related to her responses in the other tact tests.

She produced very few target responses in the baseline sessions and this continued when Intervention 1 was implemented. For HC, the few sessions of Intervention 1 were ineffective. Intervention 2 brought about an increase in tact responding by prompting for echoing and then immediately prompting for tacting. As she began to produce matched tact responses in the reinforced trials in the combined Stages 2 – 4, she also began to produce more target responses (i.e. both matched and mismatched) in the unreinforced tact trials in Tests 1 and 3.

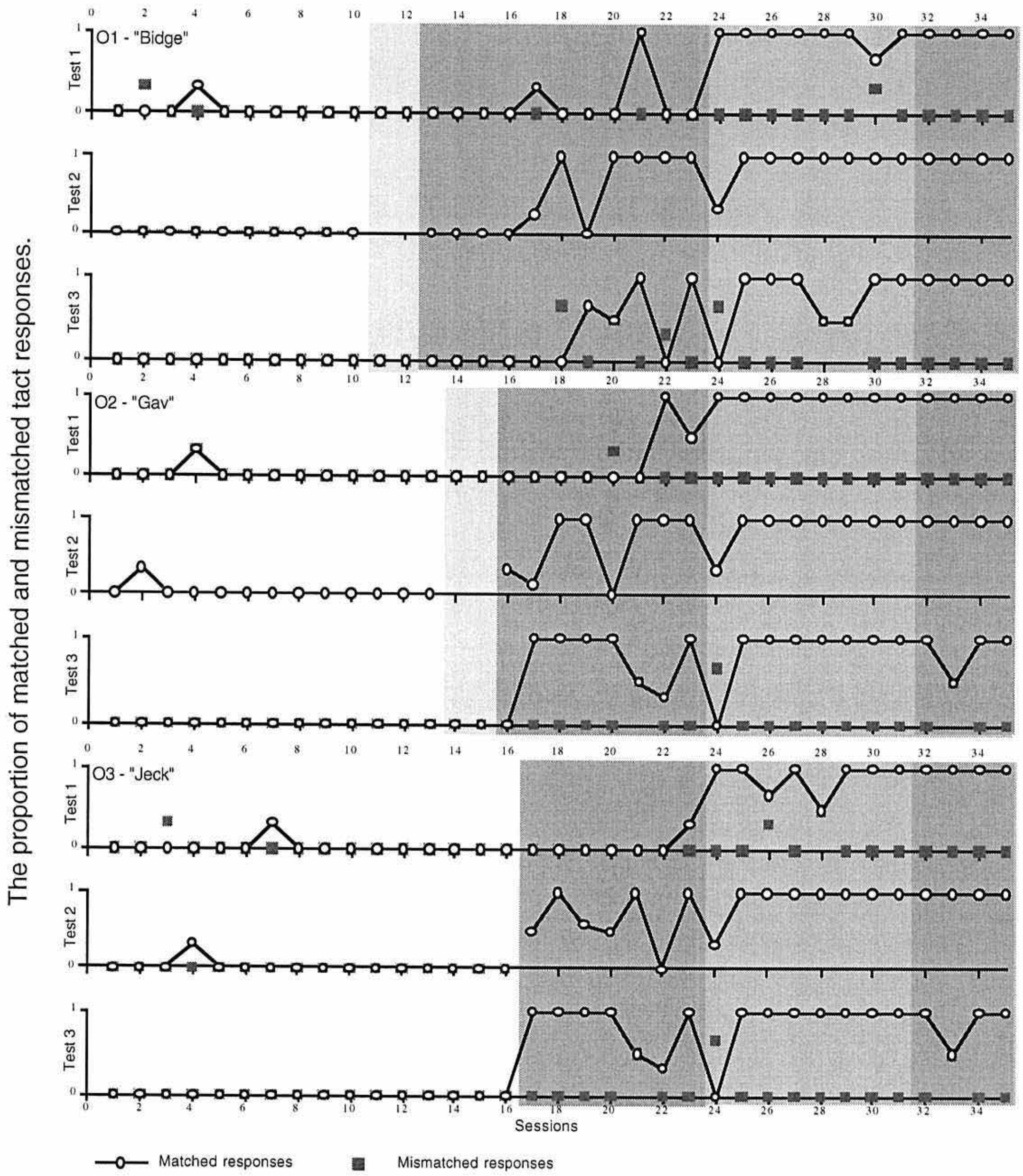


Figure 5.4.2.4 The proportion of HC's matched and mismatched responses to the number of tact probes in each session, shown in relation to the interventions (shaded). interventions.

It can be seen that in Test 3 there were many more tact responses in this period and that, particularly for O1 — "bidge" and O3 — "jeck" there were also mismatched responses. This was less evident for O2 — "gav" because HC produced "gav" responses during Test 3 for all three target relations. Towards the end of Intervention 2, she was beginning to produce matched responses in Tact Test 1.

However, criterion tacting did not emerge until all tact responses were directly reinforced in Intervention 3.

Listener responses

Each listener relation was tested once in each session. HC's listener responses are shown in Figure 5.4.2.5.

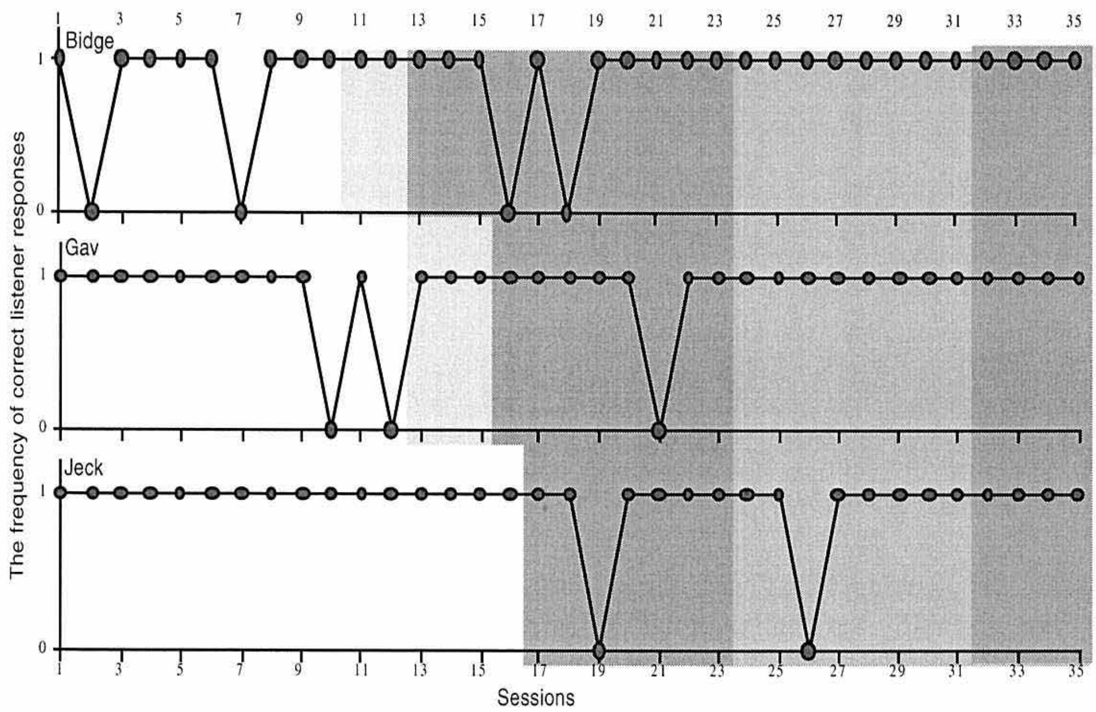


Figure 5.4.2.5 The frequency of HC's correct listener responses, shown in relation to the multiple baseline interventions.

Listener responses remained robust throughout the experiment. She was correct in 31/35 trials (mrr = 0.88) of the listener relation */bidge/* - O1, in 32/35 trials (mrr = 0.91) of */gav/* - O2, and in 33/35 (mrr = 0.94) trials of */jeck/* — O3. Thus her responses to all listener probes were at or above the criterion of ≥8/9 consecutive correct responses throughout the experiment.

In the last 12 sessions, when tacting was demonstrated to the criterion level, she produced 35/36 correct listener responses. As both listener and tacting behaviour was at criterion she had learned to name the stimulus objects.

Unprompted Vocalisations

HC produced very few unprompted vocalisations during the listener trials. There were fifteen unprompted echoes of the listener prompts, five of */bidge/*, six of */gav/*, and four of */jeck/*. There were eight unprompted echo-tacts, two in response to*/bidge/*, two to */gav/*, and four to */jeck/*. In addition there were two mismatched "bidge" tacts of O2 in the */gav/* — O2 listener trial in Session 19. These responses are shown in Figure 5.4.2.6.

It can be seen that most of the unprompted vocal production occurred during Intervention 2 when she was learning to produce vocal responses to the tact probes.

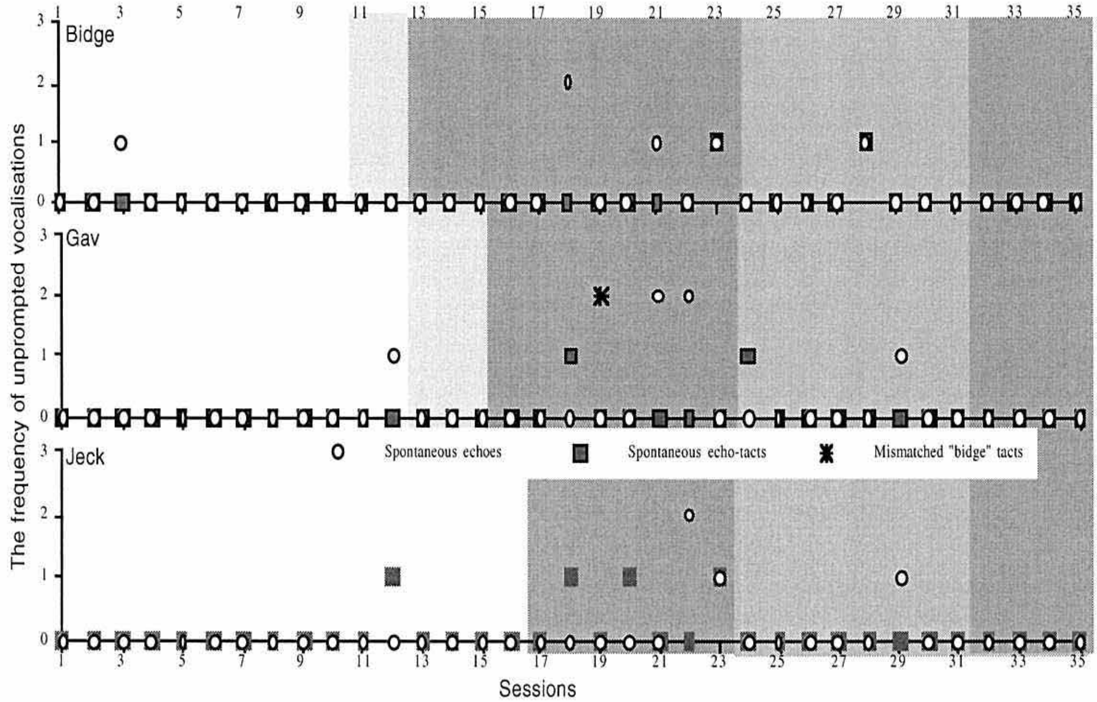


Figure 5.4.2.6 The unprompted vocal responses produced by HC in the listener trials, shown in relation to the interventions.

Echoic Responses

The frequency of matched and mismatched echoic responses is shown in Figure 5.4.2.7.

Echoing in the absence of the stimulus objects, that is in the baseline condition, remained robust and there was no evidence of mismatched echoing.

Following the introduction of the first intervention, echoic responding became less consistent but again mismatching only occurred in Session 15. The change in the response frequency occurred when previously separate listener and echoic trials were combined. This was because the change in the procedure made it necessary to give several prompts for echoing before she responded.

In Intervention 2 (when listener, echoic, and tact probes were combined) echoing appeared to return to its previously robust level, and continued at criterion level throughout Intervention 3.

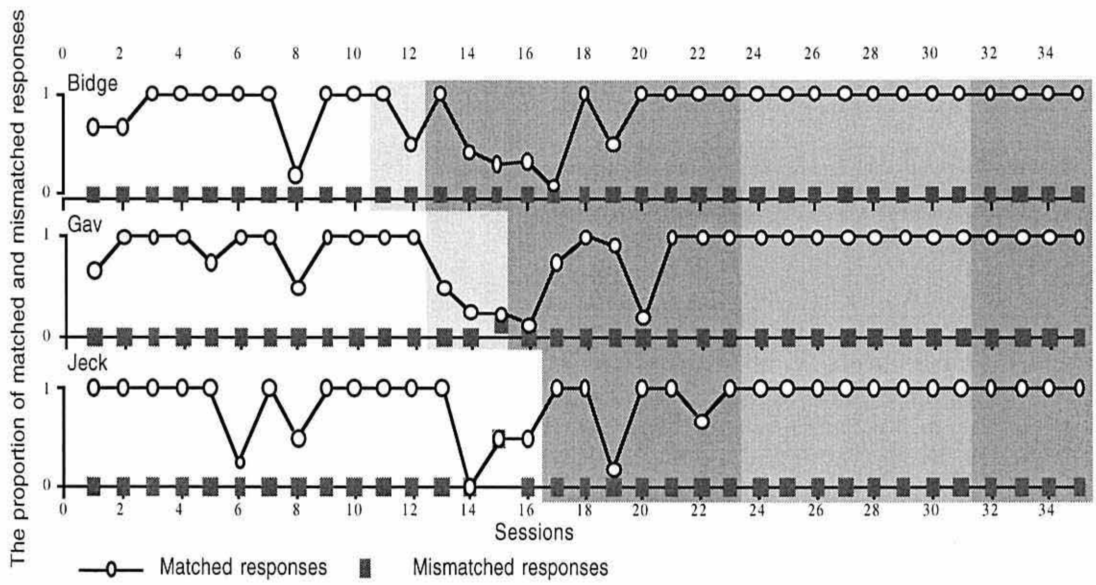


Figure 5.4.2.7 HC's echoic responses and unprompted vocalisations during Experiment 4.

For the echoic relation */bidge/* — "bidge", HC produced 22 matched echoic responses to 32 probes (mrr = 0.69) in the baseline condition. This low response rate was largely due to her no responses in Session 8, when she produced only two responses to ten probes. In Sessions 11 - 17 she continued to show a high frequency of no responses, producing 18 matched echoic responses to 38 probes (mrr = 0.47). Her echoic responding improved markedly after this. In Sessions 18 – 24 she produced matched echoes in 9/10 trials (mrr = 0.9), and from Session 24 onwards she produced matched echoic responses in 12/12 trials (mrr = 1).

Thus there was a clear difference in her responding to */bidge/* — "bidge" between Sessions 11 – 17 when the Interventions 1 and 2 were introduced.

For the echoic relation */gav/* — "gav" she produced 25 matched echoic responses to 28 probes (mrr = 0.89) in the baseline condition. Following the implementation of Intervention 1 she produced matched responses in only 15/47 trials (mrr = 0.32) and this reduced echoic responding continued for the first two sessions in Intervention 2 when she produced matched responses in only 2/16 trials (mrr – 0.125). However from Session 21 onwards she produced matched echoic responses in 16/16 trials (mrr = 1), repeating the trend seen for the first echoic relation.

This was not as obvious for the echoic relation */jeck/* — "jeck". Intervention 1, which adversely affected the first two echoic relations, was omitted for this verbal relation. In the baseline trials (Sessions 1 – 17) she produced matched responses in 31/37 trials (mrr = 0.84). Following Intervention 2 she responded correctly to the single echoic probe in Session 18, but in Session 19 she produced only one matched response to six probes (mrr = 0.29). From Session 20 onwards she again returned to criterion responding producing matched responses in 26/26 trials (mrr = 1). Again, this corresponds with the introduction of an intervention, but it is difficult to draw any conclusion from her responses in a single session.

So, although echoic responding was well established there was a short period, following the implementation of Intervention 1, when HC responded to less than half the probes. This effect was seen in Sessions 11 – 17 for the *bidge* relation, and in Sessions 13 – 20 for the *gav* relation, and covered the period of introduction of both Intervention 1 and Intervention 2. It is possible that this reduced responding was brought about by the change in the procedure rather than Intervention 1 specifically, as there was a corresponding but smaller effect, in Session 19 only, after Intervention 2 was introduced for the *jeck* relation.

Unprompted Vocalisations

There were occasional unprompted matched responses in the combined training trials. These were perseverated self echoes, anticipated echoic responses, or mismatched tact responses. These are shown in Figure 5.4.2.8.

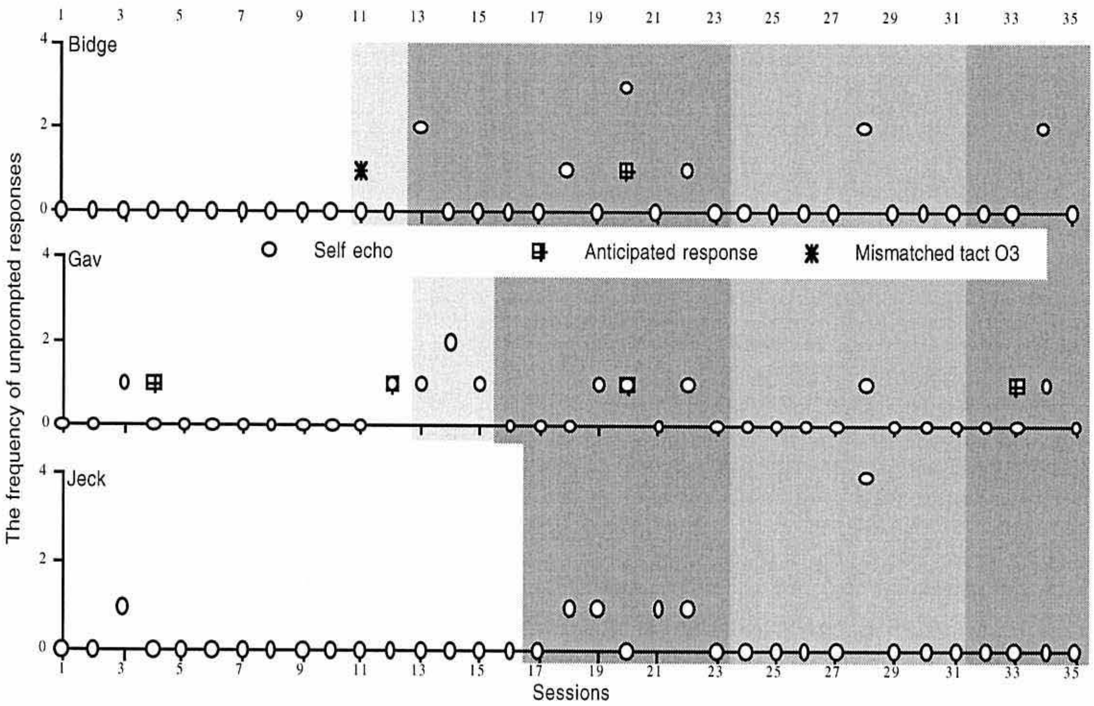


Figure 5.4.2.8 HC's unprompted matched vocalisations in the combined training trials, shown in relation to the interventions.

Unprompted vocalisations were infrequent in the baseline condition. She produced no matched responses in the *bidge* trials, two self echoes and two anticipated echoic responses, in the *gav* trials and one self echo in the *jeck* trials.

In the trials of Intervention 1, she produced one mismatched tact of O3 in the *bidge* trials, and three self echoes in the *gav* trials.

In intervention 2 she produced seven self echoes and one pre-empted echoic response in the *bidge* trials, three self echoes and one pre-empted response in the *gav* trials, and four self echoes in the *jeck* trials. The pre-empted echoics occurred when she interrupted the echoic probe and anticipated the required response after an incomplete "Can you say…?" When this followed a listener probe she had heard a prior auditory stimulus and oriented to a stimulus object, but her vocal response was not contingent upon an immediately preceding model of the auditory stimulus. It was contingent on the incomplete echoic probe.

After Intervention 3 there were a further two self echoes in the *bidge* trials, two self echoes and one pre-empted response in the *gav* trials, and four self echoes in the *jeck* trials.

Thus the majority of unprompted productions were self echoic, and were heard as perseverated echoic responses. Occasionally HC anticipated the echoic probe. In later trials these occurred when she heard the auditory stimulus for the listener trial and consequently was able to pre-empt the echoic probe. However, she also made these responses in the baseline condition, when the auditory stimulus had not been presented. These responses were contingent upon the echoic probe itself. When there was no preceding model it was not possible to say if they were matched or mismatched.

In addition, HC produced two mismatched tacts. These occurred together and were produced when she looked at O3 and said "bidge".

HC also produced matched unprompted tacts of the stimulus objects. These occurred as follows: in Session 18, before the echoic probe for both "gav" and "jeck", and after Tact Test 3 for "bidge" and "jeck"; in Session 19 in the listener trial for *gav* she indicated O1 and said "bidge"; in Session 25 before Tact Test 1 for "gav" and "jeck"; in Session 29 before Tact Test 1 for "bidge"; in Session 30 before Tact Test 1 for bidge, twice; and in Session 34 before Tact Test 3 for "jeck".

Summary

HC participated in 35 sessions in this experiment. Listener responding and echoing, which had been established in earlier experiments, were maintained throughout the experiment, but the introduction of the interventions coincided with a short disturbance to the frequency of echoic responding.

Reinforcement of matched tact responding in Intervention 2 gave rise to increased target responding. Matched and mismatched responding to tact probes began to emerge after the introduction of Intervention 2. This was first seen in Tact Test 3, but this did not immediately transfer to Test 1.

Learning to Tact

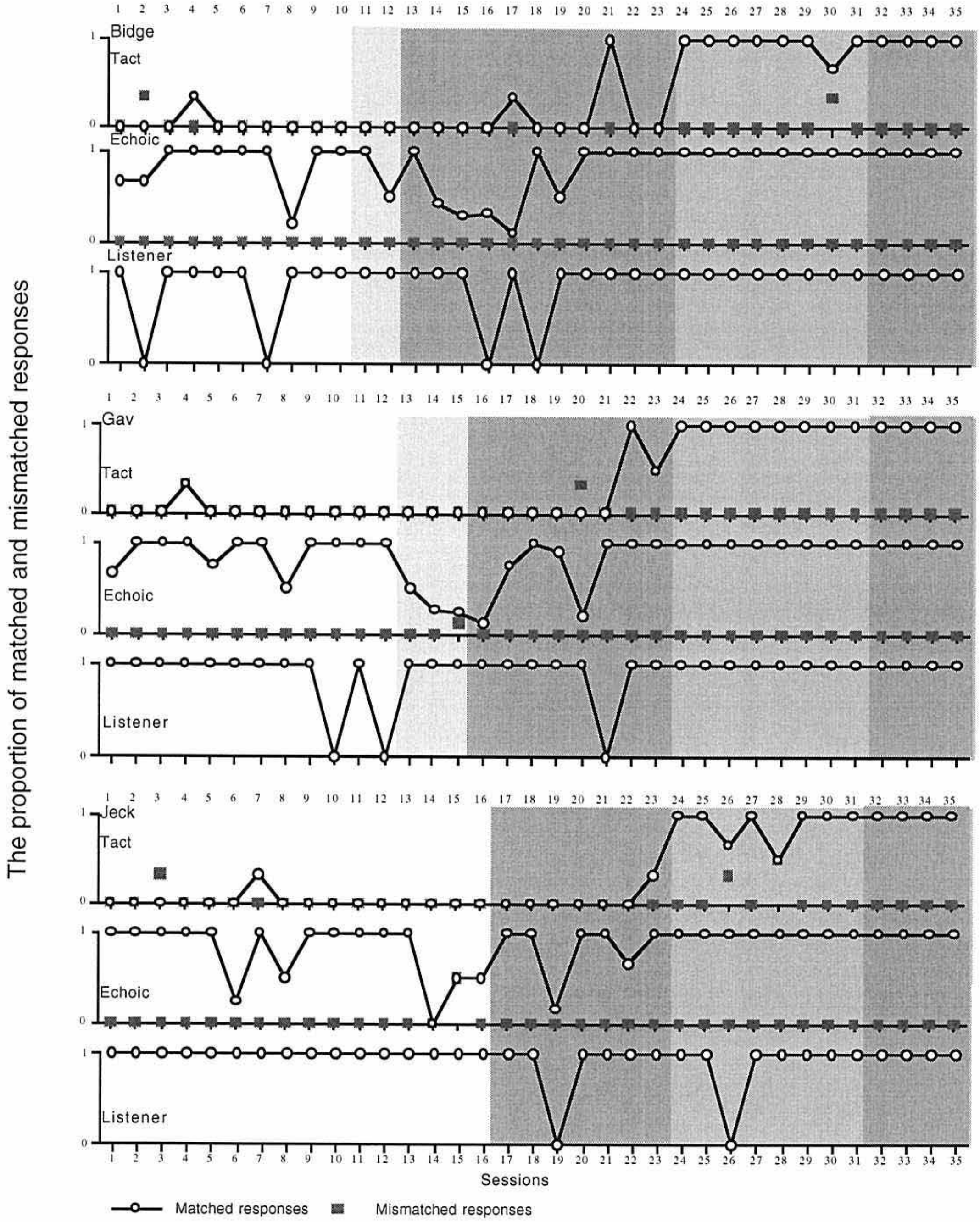


Figure 5.4.2.9 The proportion of tact, echoic, and listener matched and mismatched responses per session of HC, shown in relation to the interventions.

Criterion tacting was established in Intervention 3 when all matched responses were reinforced. This was maintained over the last four sessions when reinforcement was withheld from the criterion Tact Test 1. She was 22 months and 12 days old.

Figure 5.4.2.9 shows the proportion of matched and mismatched responses to the number of trials in each session for the criterion tact test, the echoic trials, and the listener trials. From this overview, it can be seen that in the baseline condition there was no evidence of tacting, but the echoic and listener relations were well established. During the Interventions 1 and 2 there was a brief disturbance of echoic responding which did not return to strength until the tact responses began to appear. Following reinforcement of all tact responses, in Session 24, tacting was demonstrated to criterion and remained at criterion in Sessions 32 – 35 when reinforcement was withdrawn from the criterion tact test.

Thus for HC reinforcement of tact responding was sufficient to bring about tacting of the three experimental stimulus objects.

Participant WP

WP was 22 months and 18 days old at the start of this experiment. In the earlier experiments she had established three listener relations and three corresponding echoic relations to criterion. Tacting of the corresponding stimuli did not emerge as a consequence of learning these two behaviours.

In this experiment baseline sessions were extended because listener responding had not only fallen below criterion, but had approached chance levels of accuracy. Concurrently, WP became increasingly likely to produce "tade" responses to all the tact probes.

In an attempt to overcome the indiscriminate production of the "tade" tact response, WP received feedback in the form of "yes that's right", for correct responses, or "no that's the wrong one" for incorrect responses she produced during tact probes. This intervention, Intervention 3, was introduced for the first relation, O1 — "tade", in Session 27 and was extended to the second (O2 — "geck") and third (O3 — "pab") relations in Sessions 36 and 40, respectively. Probes for the echoic relation continued to be made in the absence of the stimulus objects, as in the baseline phase.

Listener responding returned to criterion across all three listener relations in Sessions 31 – 42. Her echoic responses, produced only intermittently at the beginning of this experiment, steadily improved from Session 27 onwards . However, her tact probe responses remained predominantly "tade", despite the appropriate feedback.

Intervention 1 had not proved to be effective for the two previous participants, thus, following Intervention 3, WP progressed directly to Intervention 2, which as an addition to Intervention 3, was implemented as a multiple baseline intervention, first for O2 — "geck", second for O3 — "pab" and last for O1 — "tade".

Tact Responses

The number of tact probes per session, and the number of matched and mismatched responses are shown in Figures 5.4.3.1 – 5.4.3.3.

Throughout, and particularly towards the end of, the baseline period, the predominant vocalisation produced in all tact tests for all three target relations was "tade". Because of the almost exclusive production of this vocal response, Intervention 3, feedback for all responses during the tact tests, was implemented in Session 27 for the O1 — "tade" target relation.

In the baseline sessions, WP produced 55 matched responses in 225 trials (mrr = 0.24), and one mismatched "geck" response. Between Sessions 27 and 60 she received feedback on all her "tade" responses, so that the frequency of her matched responses in the latter increased rapidly and were apparently at criterion in Sessions 32 – 34. However, as described above, this response was also still predominant in the tact tests for the other two target relations, and so cannot be accepted as tacting. In these 34 sessions, during all three tact tests, she produced 199 matched responses (mrr = 0.72) in 276 trials of O1 — "tade", one mismatched "pab" response and 12 mismatched "geck" responses; seven of the latter occurred after Session 53, when Intervention 2 was implemented for the verbal relation O2 — "geck".

In Session 61, Intervention 2 was extended to the O1 — "tade" relation. In the eleven remaining sessions WP produced 23 matched responses to 44 probes (mrr = 0.52); she also produced 16 mismatched "pab" responses and five mismatched "geck" responses. Her matched response rate had fallen to 0.52.

Figure 5.4.3.1 shows that after Session 57, when Intervention 2 was implemented for the relation O3 — "pab", she became increasingly likely to produce mismatched "pab" responses during O1 — "tade" tact probes. She narrowly failed to meet the criterion in Test 1 in Sessions 62 – 68 when she produced 7/8 matched responses (mrr = 0.875), but she was unable to sustain this behaviour in the next three sessions. Unfortunately tacting of O1 — "tade" was no longer at criterion.

It can be seen that in the 35 sessions in the baseline condition, WP produced only eight matched responses in the 297 probes to tact O2 — "geck" (mrr = 0.027). There were 82 mismatched "tade" responses. When Intervention 3 was implemented, she continued to produce many more mismatched "tade" responses than matched responses. In these 9 sessions, she produced 36 mismatched "tade" responses and only one matched "geck" response in 78 trials (mrr = 0.013).

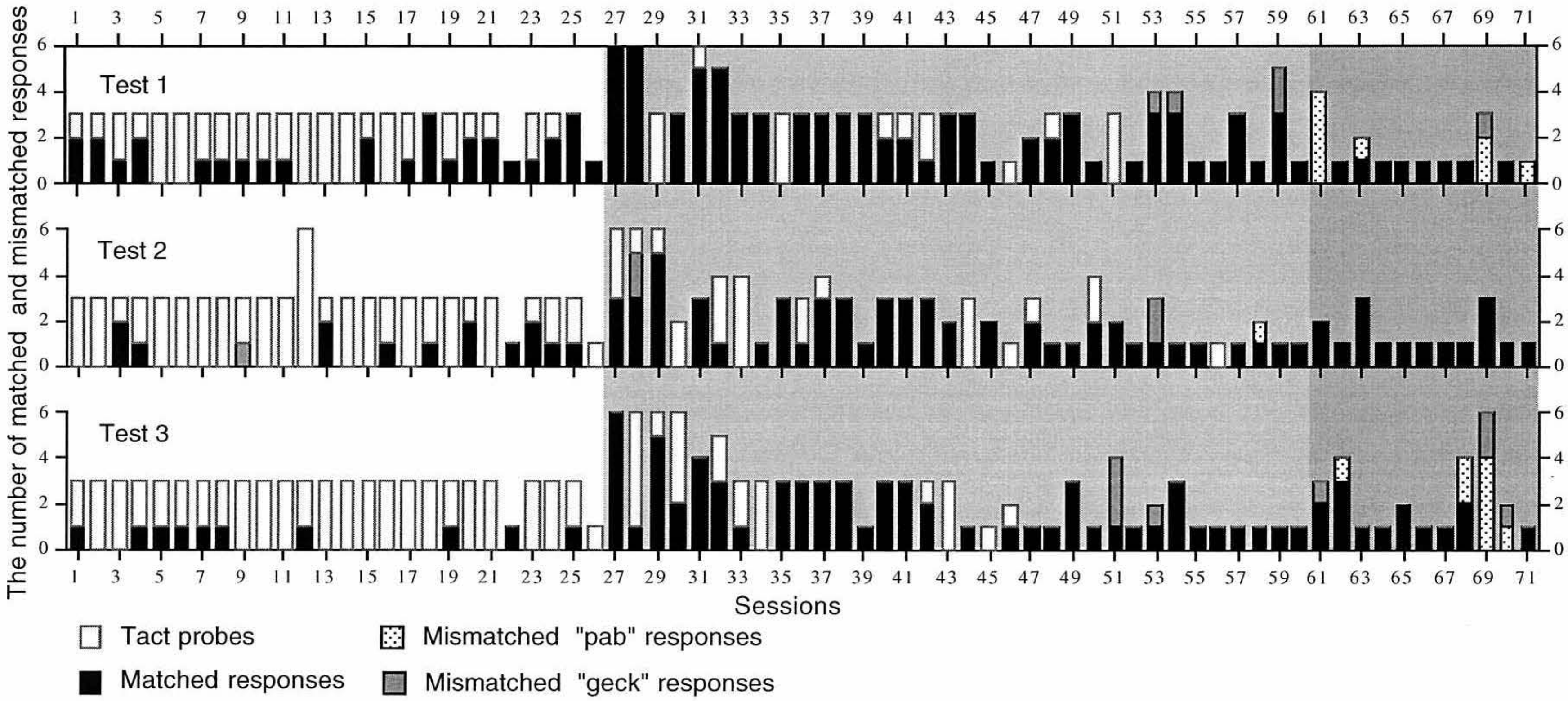


Figure 5.4.3.1 The number of matching and mismatched responses produced by WP in tests of the tact relation O1 - "tade".

Learning to Tact

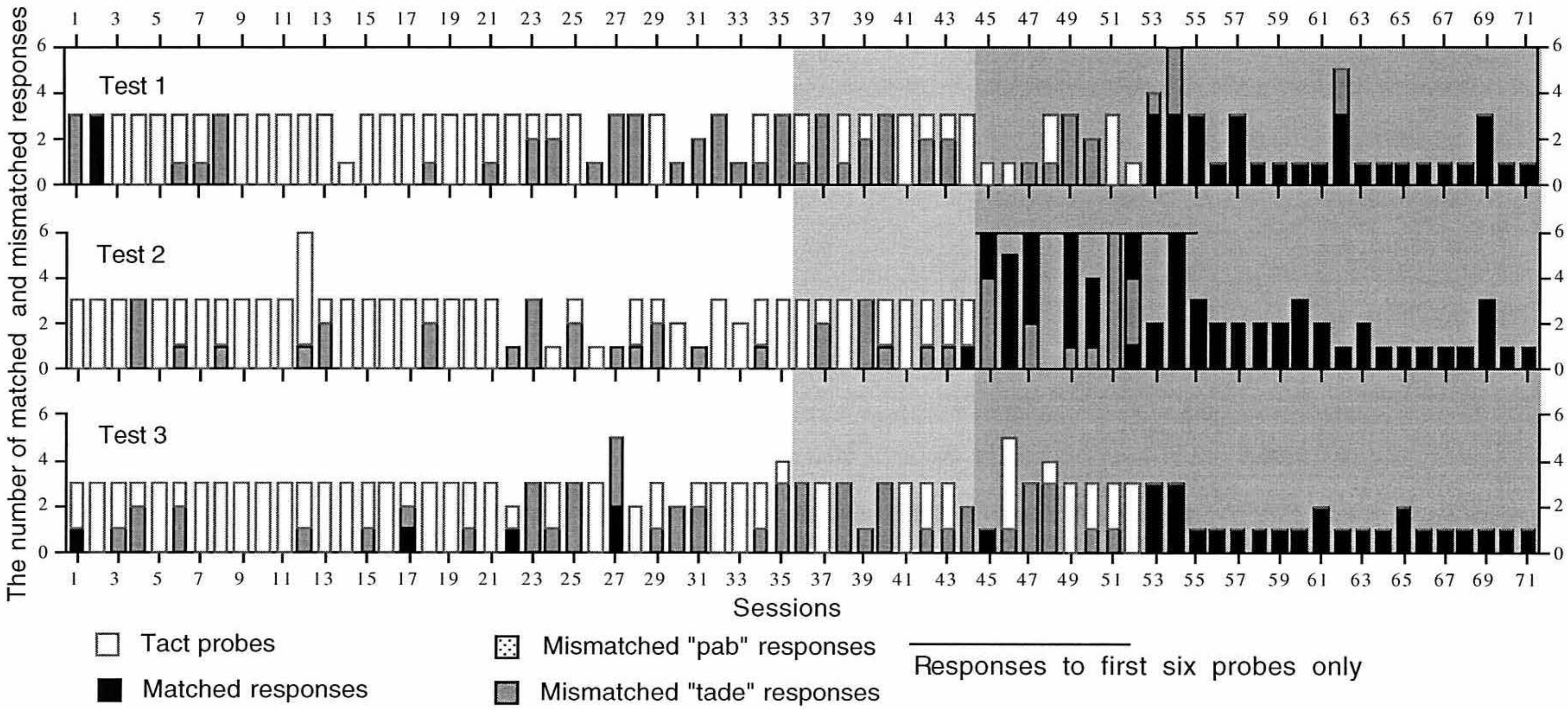


Figure 5.4.3.2 The number of matching and mismatched responses produced by WP in tests of the tact relation O2 - "geck".

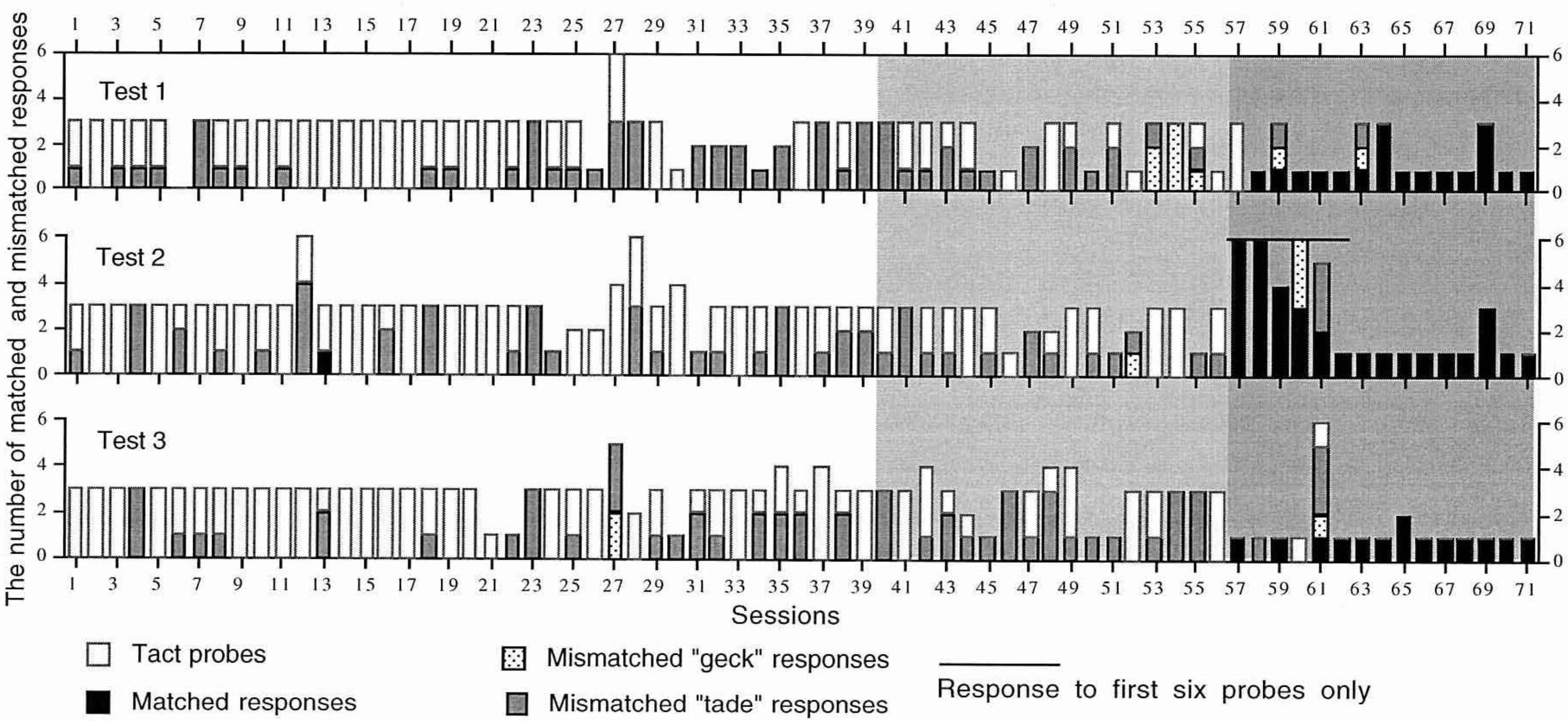


Figure 5.4.3.3 The number of matching and mismatched responses produced by WP in tests of the tact relation O3 - "pab".

Intervention 2 was implemented for this target relation in Session 45. It took eight sessions for the intervention to take effect. This period is correlated with a period of inaccurate responding in the early sessions of the listener-echo-"tact" training. Once correct responding in the latter was established, from Session 53 onwards, there was a marked increase in the frequency of matched responses and a corresponding decrease in mismatched responses in Tact Tests 1 and 3. Between Sessions 45 – 52 she produced only two matched responses in 67 tact trials, and 33 mismatched "tade" responses. However, from Session 53 onwards she produced 68 matched responses in 75 trials (mrr = 0.91) and only six mismatched "tade" responses.
Criterion tact responding was seen in Sessions 63 – 71, when she produced 11/11 consecutive matched responses (mrr = 1), at the criterion Test 1. She was also correct in all the Test 3 tact trials in this period.

For this target relation, "geck" tact responses appeared simultaneously across the three tact tests. The effect of the Intervention 2, in combination with Intervention 3, was clearly reflected in her responses in the tact tests. The tact relation O3 - "pab" was not in evidence during the 39 baseline sessions. There were only three matched responses in 340 tact trials (mrr = 0.0088); however, there were 108 mismatched "tade" responses. Again, there was no change to the frequency of mismatched responses when Intervention 3 was introduced. In Sessions 40 – 56 she produced no matched responses and 58 mismatched "tade" responses in 129 trials. She also produced seven mismatched "geck" responses, all of which were heard in Sessions 52 – 56 when Intervention 2 was in effect for the "geck" relation.

Not until Intervention 2 was implemented for the target relation O3 — "pab", in Session 57, did the production of "pab" responses begin to emerge.

Tact Test 2 was conducted in addition to the listener-echoic-"tact" probes in Sessions 57 – 61 only. In the first seven sessions following the intervention she continued to produce mismatched responses to the tact test probes. In Tests 1, and 3, she produced 12 matched responses, 6 mismatched "tade" responses, and 2 mismatched "geck" responses. In Tact Test 2, in Sessions 57 – 61, she produced 2 matched responses to the tact probes for "pab", she also produced 8 mismatched "geck" responses, and 13 mismatched "tade" responses. In all 15 sessions of the intervention, in all three tact tests, WP produced 35 matched responses in 77 trials (mrr = 0.45).

Criterion tacting for this relation was demonstrated in Sessions 64 – 71 when she produced 12/12 consecutive matched responses (mrr = 1) at the criterion Test 1. She was also correct in all of the Test 3 trials in this period.

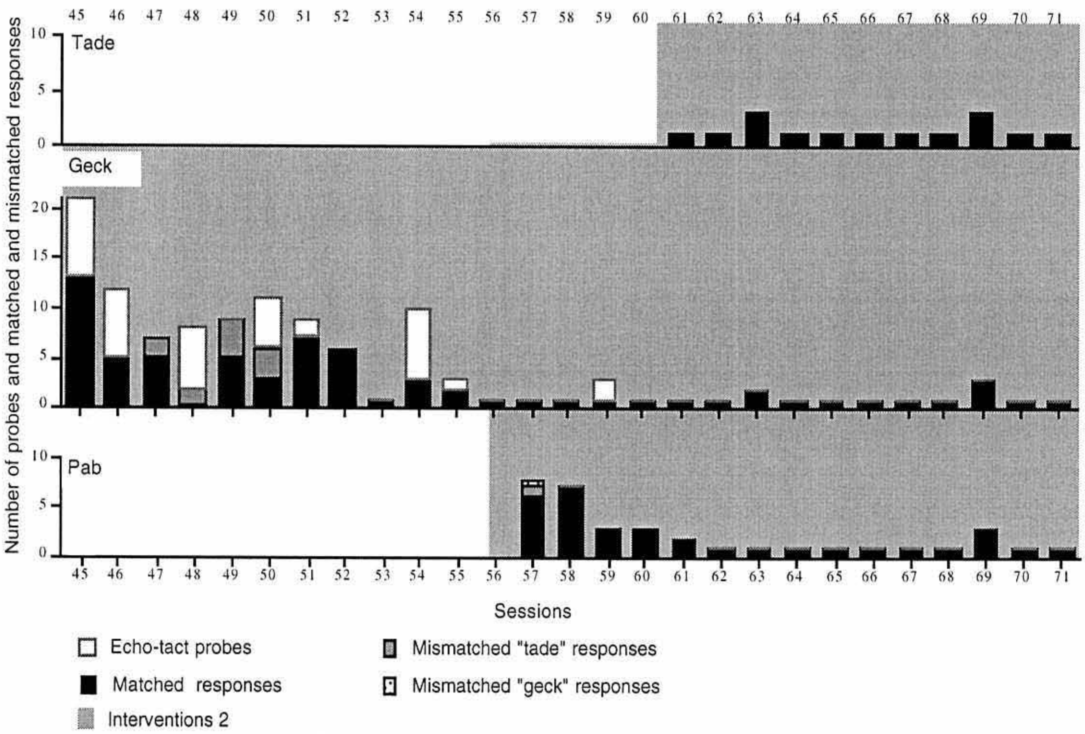


Figure 5.4.3.4 The number of probes and matched and mismatched echo-tact responses during Intervention 2.

The Tact Training

Figure 5.4.3.4 shows the number of echo-tact probes, and the number of matched and mismatched responses in each session of Intervention 2.

In Intervention 2, WP was reinforced for production of echo-tact responses. Figure 5.4.3.4 shows that for the first trained echo-tact relation, O2 — "geck", learning to produce a matched response was, at first, rather sporadic. Gradually, over the first eight or nine sessions, she learned to produce matched responses; the number of mismatched responses and "no" responses virtually disappeared.

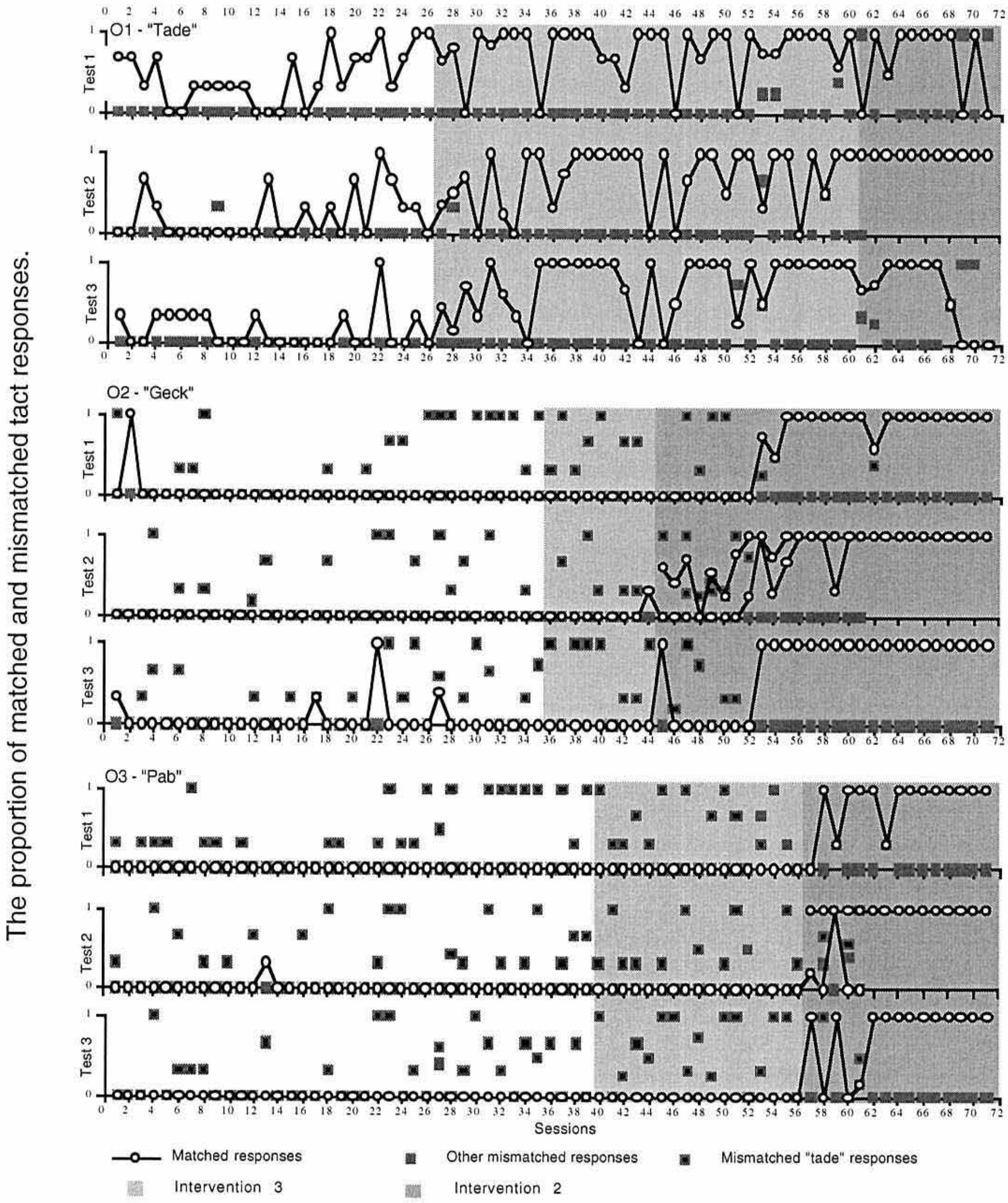
When Intervention 2 was extended to the target relations O1 — "tade" and O3 — "pab" matched responding was immediately in evidence.

Figure 5.4.3.5 shows the proportion of matched and mismatched responses to the number of tact trials for each verbal relation in each session. The shaded areas show where the interventions were implemented.

The high frequency of "tade" responses is immediately apparent. These feature as mismatched responses in the first two verbal relations and as matched responses in the O1 — "tade" relation. It is quite clear that Intervention 3 did not reduce the frequency of "tade" mismatched responses for the target relations O2 — "geck" and O3 — "pab"; however it immediately increased the number of matched responses to O1 — "tade" so that criterion responding for the latter was intermittently evident from Session 25 onwards.

The effect of the Intervention 2 was clearly demonstrated for both O2 —"geck" and O3 — "pab". Prior to Intervention 2, there were no matched responses, in Tact Test 1, for either of these two tact relations.

Reinforcement of matched responding for these target relations resulted in criterion tacting for both in Sessions 63 – 72. However, learning to tact O2 and O3 in turn appeared to produce an increase in mismatched responding to O1 so that by the end of this period responding to O1 failed to meet the criterion of ≥8/9 consecutive correct responses. Thus WP scored 7/8 correct responses between Sessions 63 and 68, but failed to sustain this performance.



5.4.3.5 The proportion of WP's matched and mismatched responses to the number of tact probes in each session, shown in relation to the interventions (shaded). The results of the reinforced echo-tact training trials, Intervention 2, are shown in the Test 2 position, in line with the sequence of testing and training.

Listener Responses

Recall that at the end of Experiment 3 WP learned to echo to criterion but her listener behaviour was not maintained. Figure 5.4.3.6 shows how her listener responses became more reliable over the course of Experiment 4. The shaded area shows where Interventions 3 and then 2 were implemented.

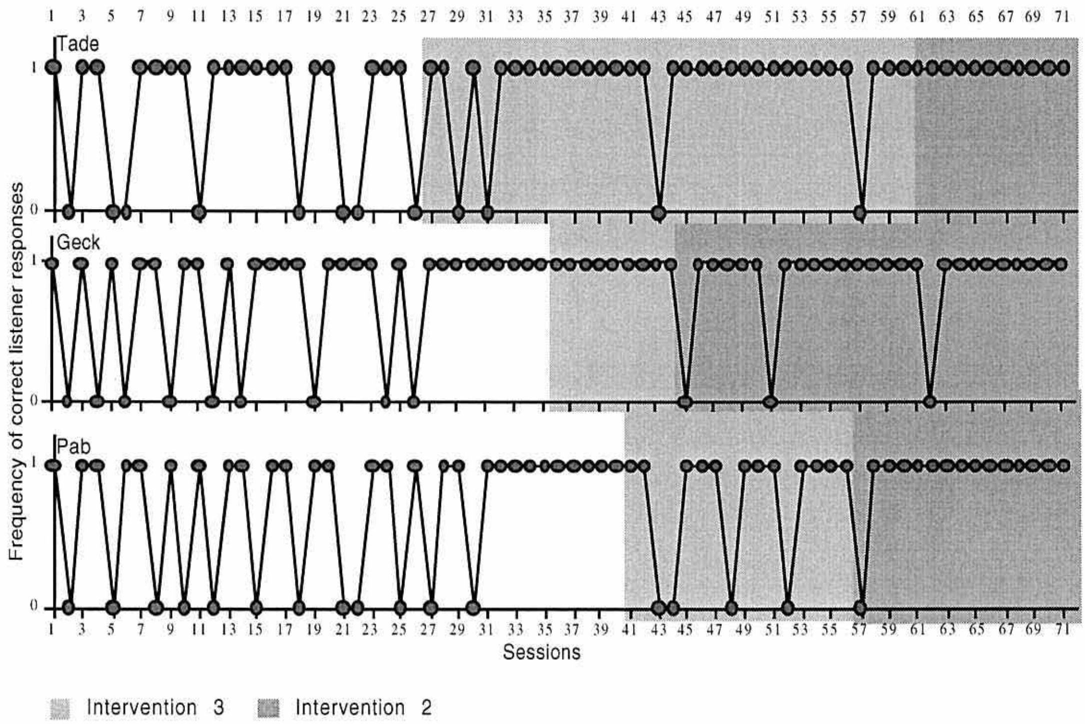


Figure 5.4.3.6 WP's listener responses during Experiment 4.

During the baseline period of this experiment, listener responses continued to be below the criterion of ≥8/9 consecutive correct responses. However over the course of the experiment they gradually returned to criterion level. WP showed criterion responding across all three listener relations simultaneously from Session 31- 42 and from Session 58 onwards. Listener relations were re-established before criterion tacting was demonstrated, and remained robust once tact behaviour was in evidence.

Unprompted vocalisations

Unprompted vocalisations which occurred during the listener trials are shown in Figure 5.4.3.7.

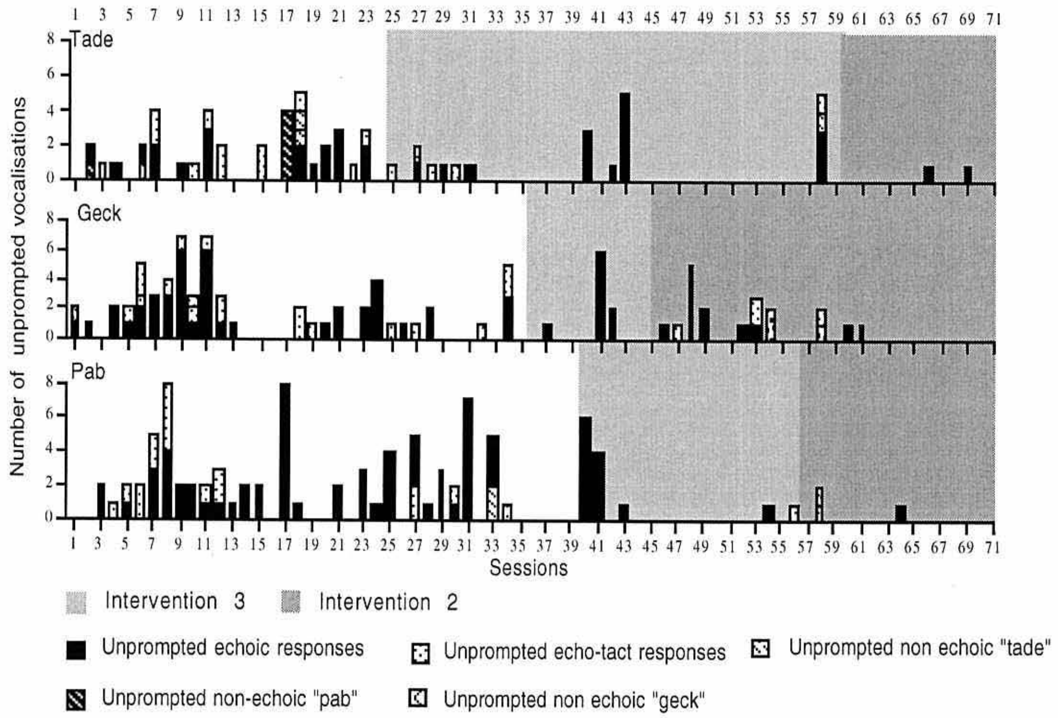


Figure 5.4.3.7 The unprompted vocalisations of the auditory stimuli produced by WP during the listener trials.

Unprompted target responses were evident from the beginning of Experiment 4. WP produced occasional matched or mismatched putative tacts, but at this point her unprompted target responses were mainly echoic or echo-tact responses, which by definition were dependent upon a preceding auditory stimulus for their production. Over the course of the experiment echoic production of the target responses decreased, so that by the time criterion tacting appeared her responses were chiefly non-echoic matched or mismatched tact responses.

Echoic responses

At the beginning of this experiment echoic responses were below criterion. In addition, WP produced "tade" responses after the song prompt, without regard to the stimulus being thus modelled. For this reason the responses she produced during or immediately after the song were recorded as unprompted responses.

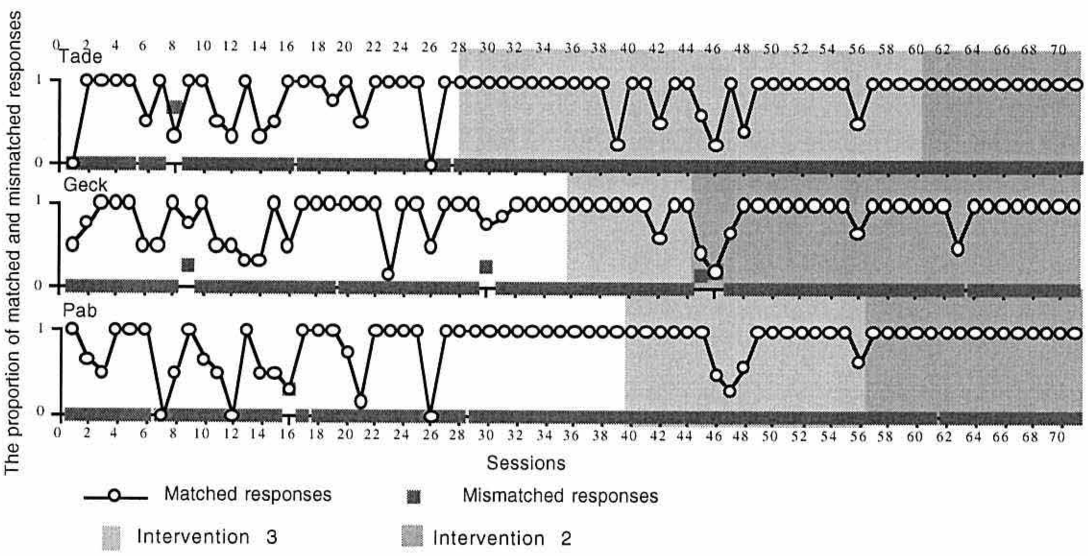


Figure 5.4.3.8 The proportion of matched and mismatched responses to the number of echoic probes in each experimental session.

Figure 5.4.3.8 shows the number of echoic probes and the number of matched responses in each session. The shaded area shows when each intervention was implemented.

During the first 26 sessions responses for all three echoic relations fell below the criterion of ≥8/9 consecutive correct responses. However, there was an observable increase in the frequency of matched responses in Session 27, which corresponded with the implementation of Intervention 3 for the relation O1 — "tade". There was some evidence of a return to below criterion responding in the middle of the experiment, during Sessions 39 – 48, and this was particularly evident for the */tade/* —

"tade" relation. However, from Session 49 onwards echoing returned to, and remained above, criterion level.

For the echoic relation */geck/* — "geck", WP responded as follows: she produced matched responses in 48/64 trials (mrr = 0.75) in the baseline sessions; she responded correctly in 43/47 trials (mrr = 0.91) in Sessions 27 - 44; and she produced matched responses in 50/59 trials (mrr = 0.85) during Intervention 2 and 3 combined.

For */pab/* — "pab" she produced matched responses as follows: 43/65 (mrr = 0.66) in the baseline sessions; 71/80 (mrr = 0.88) in Sessions 27 - 57; and 24/24 (mrr = 1) in Intervention 2 and 3 combined.

For */tade/* — "tade" she responded correctly as follows: 45/62 (mrr = 0.73) in baseline; 65/77 (mrr = 0.84) in Intervention 3; and 21/21 (mrr = 1) in Intervention 2 and 3 combined.

Thus after some initial difficulty, echoing of all three auditory stimuli returned to criterion around Session 49, and remained fairly robust throughout the remainder of the experiment.

Unprompted vocalisations

WP continued to produce unprompted vocalisations during the echoic trials. These included "tade" responses during the song prompt and other mismatched echoic responses. These are shown in Figure 5.4.3.9.

There were few unprompted target vocalisations during the echoic trials. There were occasional self echoes of all three echoic responses. Target responses, mainly "tade" responses, were produced during the song and these were most evident in the earlier sessions. There was one pre-empted "pab" response in Session 35 when she produced the response before the probe had been completed and thus before she had heard the model.

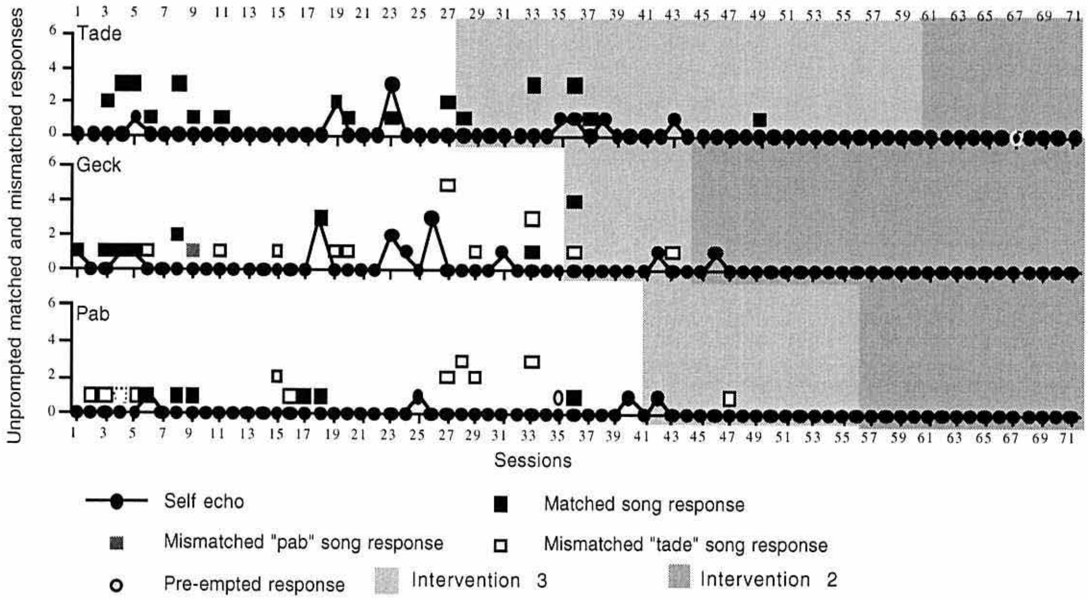


Figure 5.4.3.9 Unprompted vocalisations produced by WP during the echoic trials.

Summary

WP had learned three listener and three corresponding echoic relations by 22 months 18 days when she began this experiment. Over the next three months she continued to receive reinforced listener and echoic imitation trials and latterly reinforced tact trials. Even when reinforcement of correct tacting was available and both listener responding and echoic responding were at criterion response levels tacting did not emerge. This may be due in part to a preferred tact probe response of "tade", which resulted in at or about criterion level of responding for the target relation O1 — "tade", from Session 25 onwards. This response was very resistant to correction. Criterion tacting for O2 — "geck" and O3 — "pab" emerged after the implementation of Intervention 2 during which the combined listener –echoic-"tact" probes provided the opportunity to reinforce the correct production of alternative target vocalisations.

An overview of WP's results is presented in Figure 5.4.3.10 which shows the proportional matched and mismatched tact, echoic and listener responses in each session of Experiment 4.

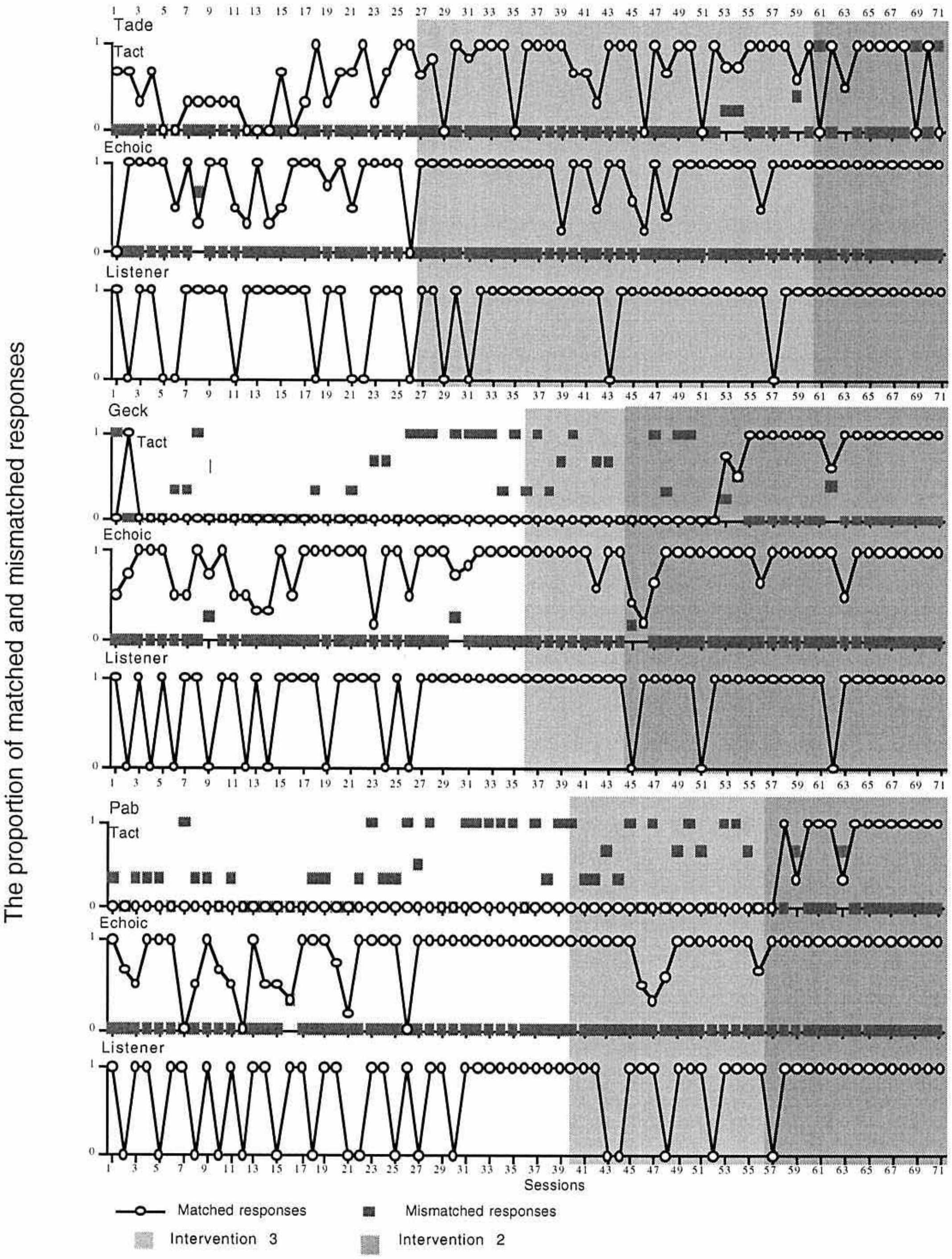


Figure 5.4.3.10 The proportion of matched and mismatched tact, echoic and listener responses of WP, shown in relation to the multiple baseline intervention.

Following Intervention 2, which directly trained the echo-tact relation, the tact relations O2 — "geck" and O3 — "pab" were demonstrated to criterion in unreinforced tact trials, at Tact Test 1, when she was 27 months old. Tacting of O1 — "tade" was established to criterion during the training trials but this did not transfer to the unreinforced Tact Test 1 situation.

Thus for WP, listener and echoic behaviours were clearly unrelated behaviours for a number of months. Although she was able to demonstrate echoic speaker behaviour, in order for the stimulus object to come to control the vocal response, both the listener – echoic - tacting and tact test responses had to be directly reinforced. She was 27 months old at the end of this experiment.

WP had an MCDI production vocabulary of 308 words at 25 months old; this corresponds with Session 27. However, her history of learning names in her own verbal community did not facilitate mastery of three novel relations under these experimental conditions.

Participant RR

In the previous experiments, RR had learned listener and echoic behaviour but he had not demonstrated tacting to criterion. At 22 months and 15 days, he began Experiment 4. In the baseline condition, listener trials and echoic trials in the absence of the stimulus objects were conducted, as in Experiment 3.

For the first target relation, fourteen baseline sessions were conducted. During this period, RR increasingly produced target responses to the tact probes. The tact probes were scheduled to be presented under test conditions, that is, in the absence of the delivery of reinforcers for correct tact responses (but see below). As he began to produce target responses more frequently, he also began to produce self-corrections, for example "tade, tade, not tade". It was important that he should begin to produce matched responses as his first response and not after a string of mismatched responses, even when self-corrected. To overcome this pattern of responding, Intervention 3 was implemented as a multiple baseline intervention. Tacting to criterion for all three relations was demonstrated at Tact Test 1 within five sessions, apparently after only the first verbal relation had been targetted for intervention. As he was still producing occasional mismatched responses in Tact Tests 2 and 3, the intervention was extended to the second and third target relations in an attempt to reduce mismatched responding.

However, a review of the baseline audio-visual recordings for this participant revealed that contrary to the scheduled contingencies, the experimenter had directly reinforced correct responding on an intermittent basis in the case of all three target tact relations: nine times for "tade" responses before the scheduled intervention of reinforcement for tade in Session 15; six times for "geck" responses before the scheduled introduction of reinforcement for geck in Session 20; and eleven times for "pab" before the scheduled introduction of reinforcement for pab in Session 23. In addition, from Session 3 onwards, whenever RR produced a correct response on the first or second tact probe, the experimenter frequently modified her probe from "What is it?" to "Again!" RR's matched and mismatched tact responses are shown in relation to the number of probes per session in Figures 5.4.4.1 - 5.4.4.3.

For the O1 — "tade" tact relation, responding at Test 1 appears to gradually increase to the criterion level of ≥ 8/9 correct responses in the last three sessions of the "baseline" period, when he produced 9/10 matched responses (mrr = 0.9) in the criterion Test 1. Over the fourteen "baseline" sessions he produced 67 matched responses (mrr = 0.55) in 121 trials. He produced 12 mismatched "pab" responses and 7 mismatched "geck" responses. In Sessions 12 – 14, over all three tact tests,

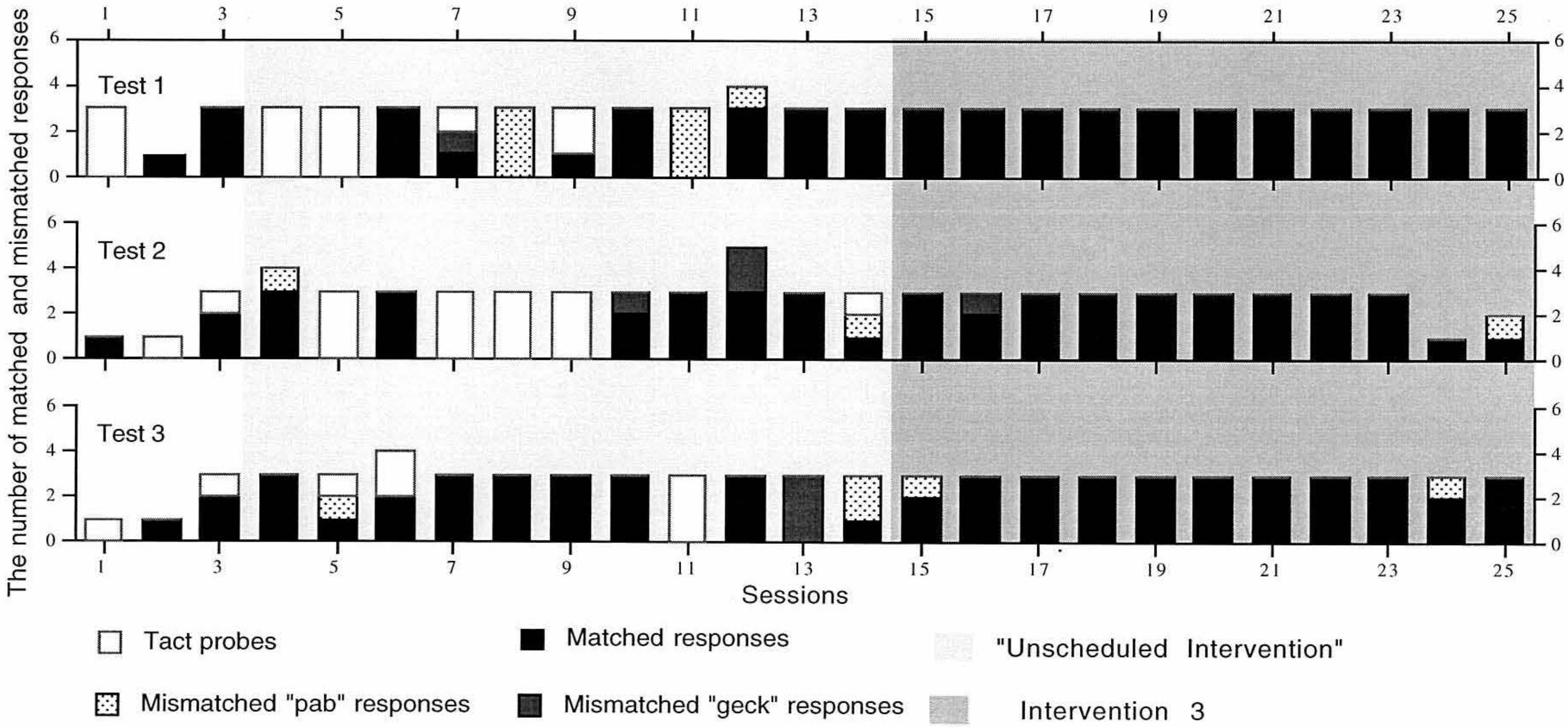


Figure 5.4.4.1 The number of matching and mismatched responses produced by RR in tests of the tact relation O1 - "tade".

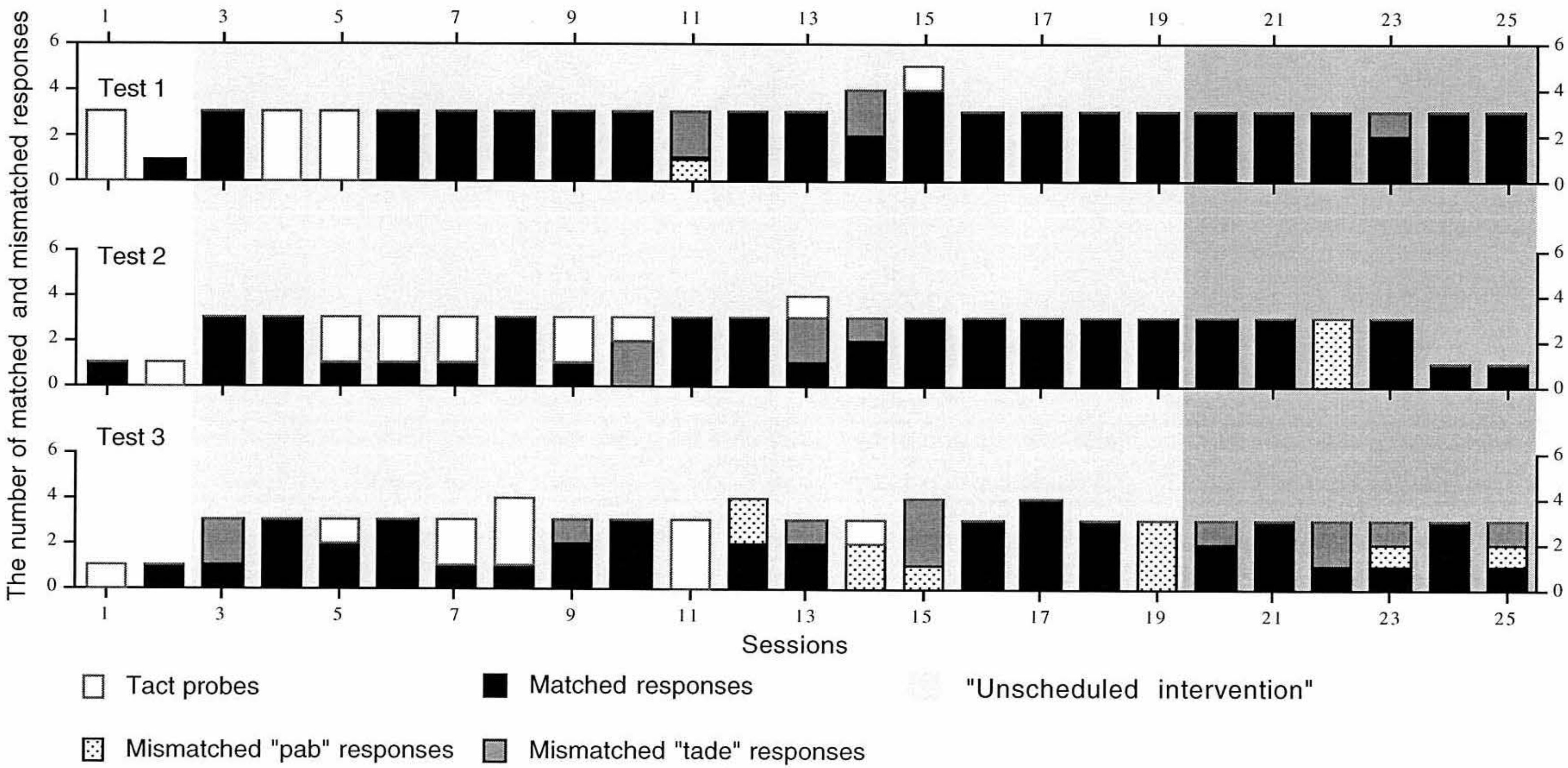


Figure 5.4.4.2 The number of matching and mismatched responses produced by RR in tests of the tact relation O2 - "geck".

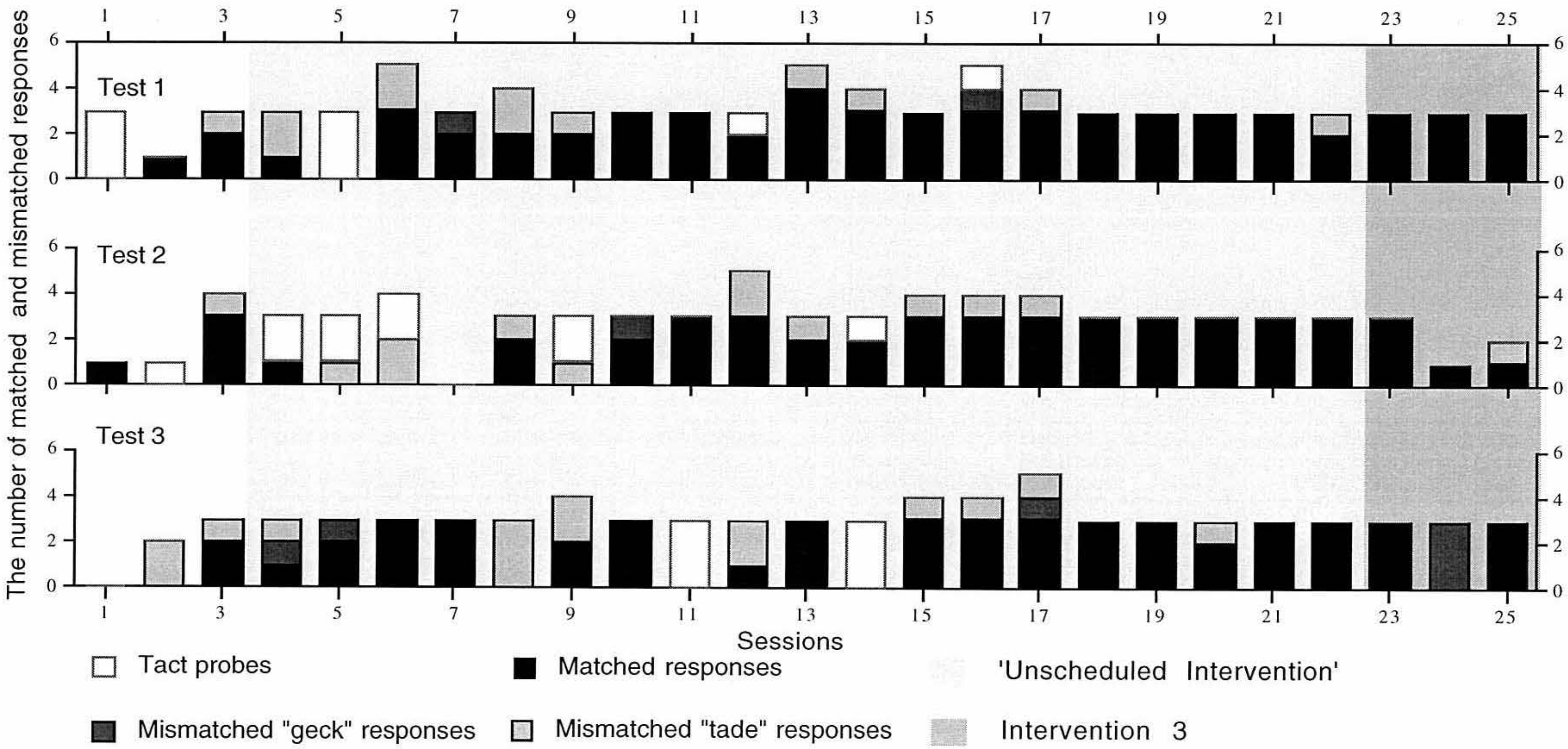


Figure 5.4.4.3 The number of matching and mismatched responses produced by RR in tests of the tact relation O3 - "pab".

he produced 20/30 matched responses (mrr = 0.67) and he produced 4 mismatched "pab" responses and five mismatched "geck" responses; in Tact Tests 2 and 3 his tact performance was still around chance levels.

Further, Figures 5.4.4.2 and 5.4.4.3 show that he was also producing the "tade" response when asked to tact O2 and O3. In the fourteen sessions he produced 43/243 mismatched "tade" responses (mrr = 0.17) in tact trials of O2 and O3, and in Sessions 12 – 14 he produced 13/62 mismatched "tade" responses (mrr = 0.21) in these trials. Thus, the inference that production of this response, at least partly, was contingent upon the tact probe and not predominantly upon his seeing O1 could not be excluded.

In nineteen "baseline" sessions of the second target relation, RR produced 111 matched responses (mrr – 0.66) in 169 tact trials. He produced 25 mismatched responses of which 16 were "tade" responses and 9 were "pab" responses. In Tact Test 1 he produced matched responses in 43/58 trials (mrr = 0.74), four mismatched "tade" responses and one mismatched "pab" response. He was most likely to produce mismatched responses in Test 3 after the echoic trials.

Criterion responding was demonstrated in the Test 1 Sessions 15 – 17, when he produced 10/11 matched responses (mrr = 0.91). In Sessions 16 – 19 he produced 12/12 matched responses (mrr = 1). Thus, he had demonstrated that he had also learned this tact relation.

Intervention 3 was implemented for this target relation in Session 20, and in the next six sessions (i.e., Sessions 20 – 25) he produced 17/18 matched responses (mrr = 0.94) and one mismatched "tade" response in Tact Test 1. Nevertheless, over all the tact tests in this period, he produced 39/50 matched responses (mrr = 0.72), six mismatched "tade" responses, and five mismatched "pab" responses.

In the continued baseline condition of the O3 — "pab" tact relation (i.e., Sessions 1 – 22 inclusive), RR produced 112 matched "pab" responses in 179 trials (mrr = 0.63). He produced 42 mismatched responses in this period of which 36 were "tade" responses and six were "pab" responses. In the criterion Test 1, he produced 43 matched responses in 64 trials (mrr = 0.67), 11 mismatched "tade" responses and two mismatched "pab" responses. Criterion responding for this tact relation was demonstrated in Sessions 9 –11, Sessions 10 – 12 and in Sessions 17 – 19.

It can be seen that after three sessions of reinforcement of O1 — "tade", that is by Session 18, the number of mismatched "tade" responses had started to diminish. There were 27 matched "pab" responses in the 31 trials in Sessions 17 – 19 (mrr = 0.87), all four mismatched responses were in Session 17. In the criterion test he produced matched responses in 9/9 trials (mrr = 1). Thus, criterion responding to the pab target relation was seen without reinforcement of this relation. However, in line with the multiple baseline, Intervention 3 was implemented in Session 23 to see if criterion tacting in all three tact tests for each of the three target relations could be attained. He produced matched responses in 20/24 trials (mrr = 0.83) and three mismatched "geck" responses.

Thus tacting to criterion for all three relations simultaneously was demonstrated in Sessions 17 – 19 when, at Tact Test 1, RR produced 27/28 matched responses (mrr = 0.96). Criterion tacting was demonstrated in Tact Test 2 in Sessions 18 – 21 inclusive, but at no time was criterion tacting at Test 3 evident for all three target relations simultaneously.

Figure 5.4.4.4 shows the proportion of matched and mismatched responses to tact probes in each session. Evidence of criterion tact responding is seen from Sessions 6 – 10 and Sessions 15 – 25 for geck, from Sessions 12 – 25 for tade, and from Sessions 17 – 25 for pab. It appears that the inadvertently introduced echoing in the presence of the object plus intermittent social reinforcement was sufficient to establish criterion responding for all three target relations. It is possible, however, that the scheduled reinforcement for correct tade responses also contributed to the concurrent establishment of target responding for all three target relations by Session 19.

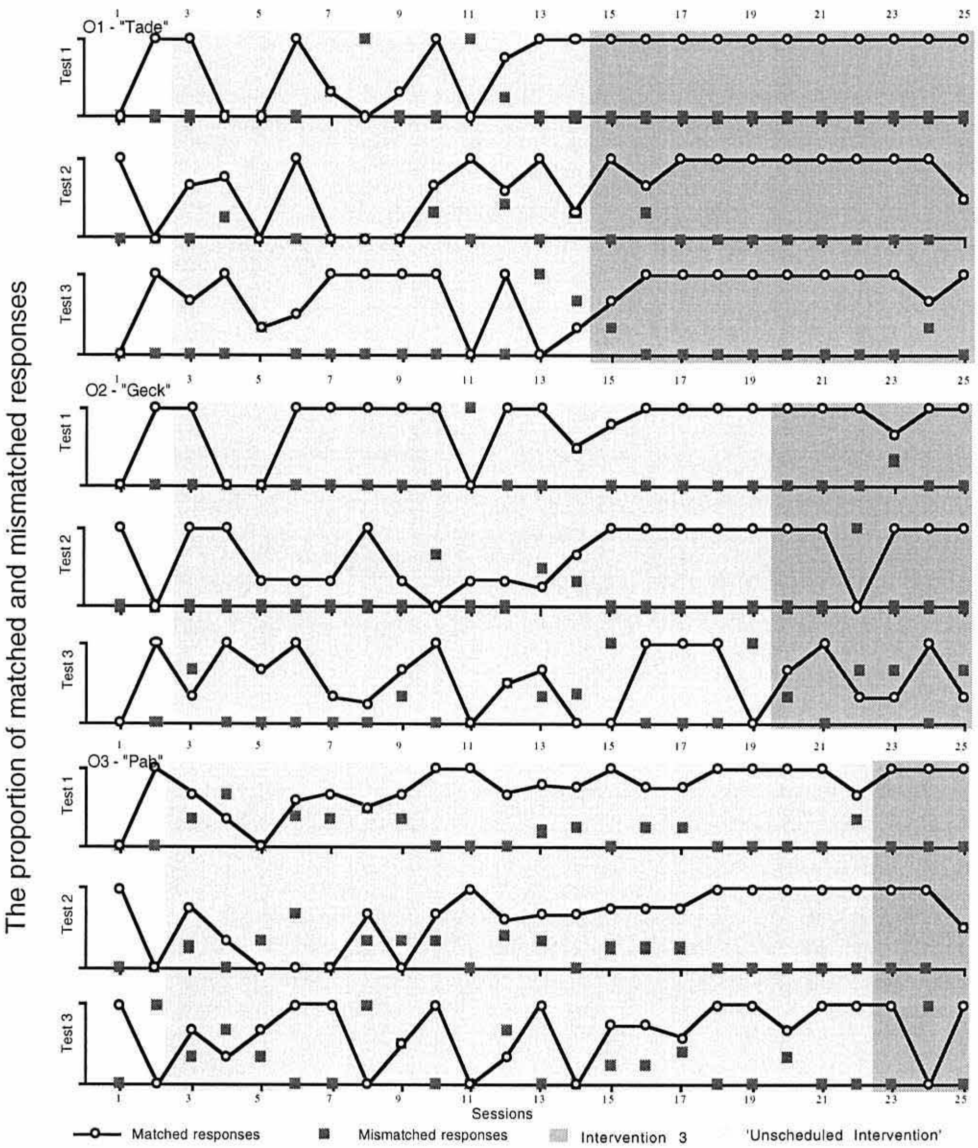


Figure 4.4.4.4 The proportion of RR's matched and mismatched responses to the number of tact probes in each session, shown in relation to the interventions.

Echoic Responses

Echoic responses and unprompted production of matching vocalisations are shown in Figure 5.4.4.5.

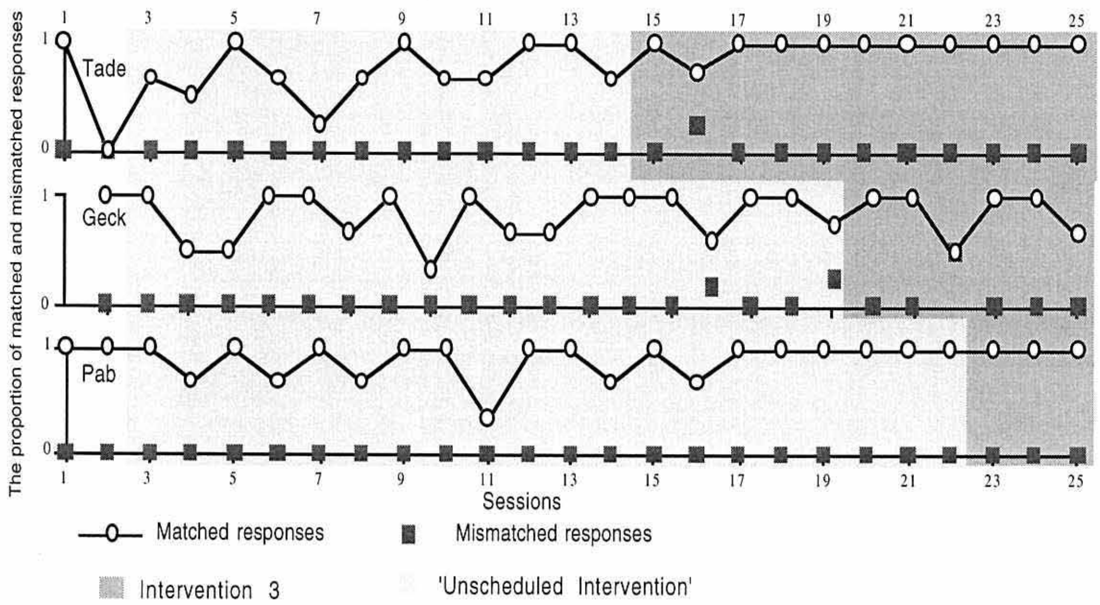


Figure 5.4.4.5 RR's matched and mismatched responses shown as a proportion of the echoic probes per session.

Echoic responses remained were fairly robust throughout this experiment, and by Sessions 12 - 14 had returned to the criterion level of ≥8/9 for all three echoic relations. Mismatched echoic responses were extremely rare, occurring in only two sessions, that is Sessions 16, 19, and 21.

Unprompted vocalisations

Vocal production had been trained in Experiment 3 and thus the operant level of target vocal responses in the experimental context was high. Figure 5.4.4.6 shows the frequency of unprompted vocal responses in each session.

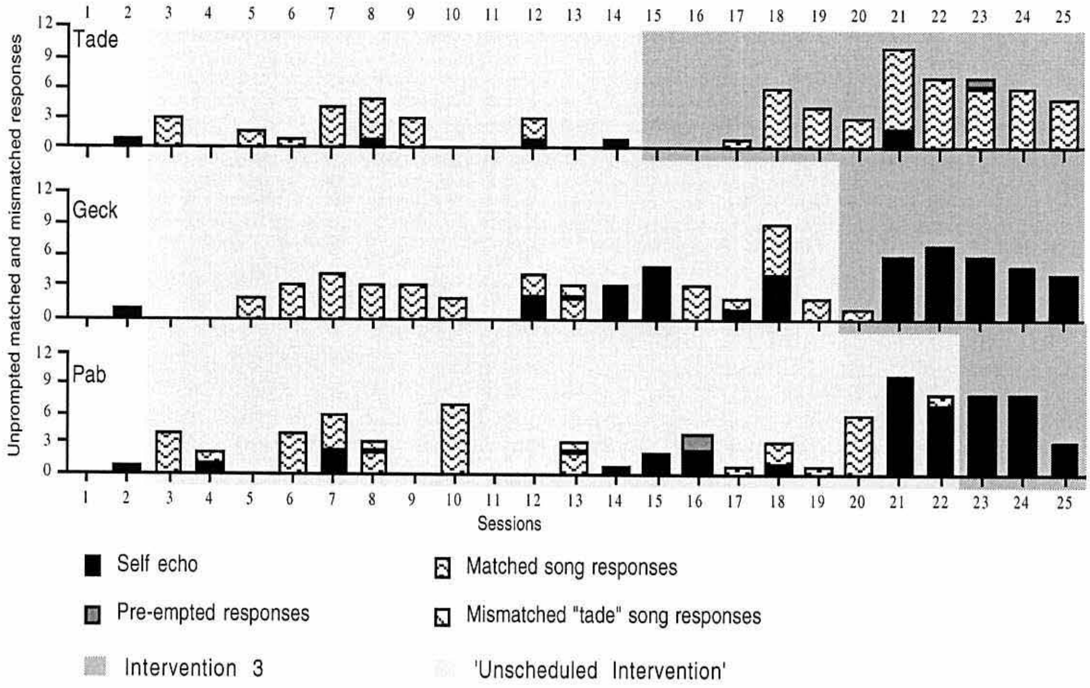


Figure 5.4.4.6 The number and type of unprompted target responses produced by RR in the echoic trials.

Unprompted responses were produced mainly during the song. RR clearly enjoyed singing, and occasionally produced "tade" inappropriately during the song for a different echoic relation. Other unprompted responses were perseverated echoic responses; these increased in frequency towards the end of the experiment, especially for geck and pab. He also produced occasional pre-empted responses.

Listener responses

Listener responses were strong throughout the experiment and are shown in Figure 5.4.4.7. He maintained criterion responding for the */geck/*— O2 and the */pab/*— O3 relations throughout the experiment. Responding to */tade/*— O1 was incorrect in Sessions 12 and 16, but returned to criterion immediately. All three listener relations were at the criterion level from Session 13 onwards.

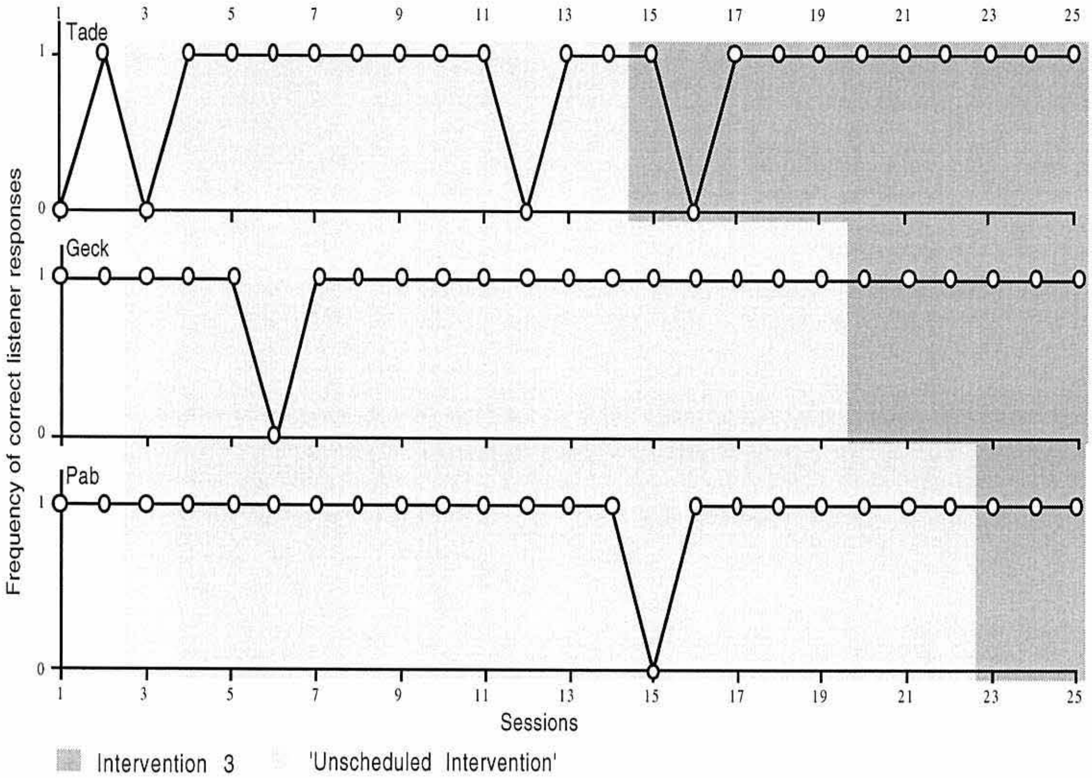


Figure 5.4.4.7 Listener responses RR during extended baseline echoic sessions and reinforced tact sessions.

Unprompted vocalisations

Unprompted vocal responses were also produced in the listener trials. These are shown in Figure 5.4.4.8. There was evidence of echoing in the listener trials of all the verbal relations, but only occasionally could this be identified as echo-tacting. There was evidence of echo-tacting of O1 following the implementation of the intervention.

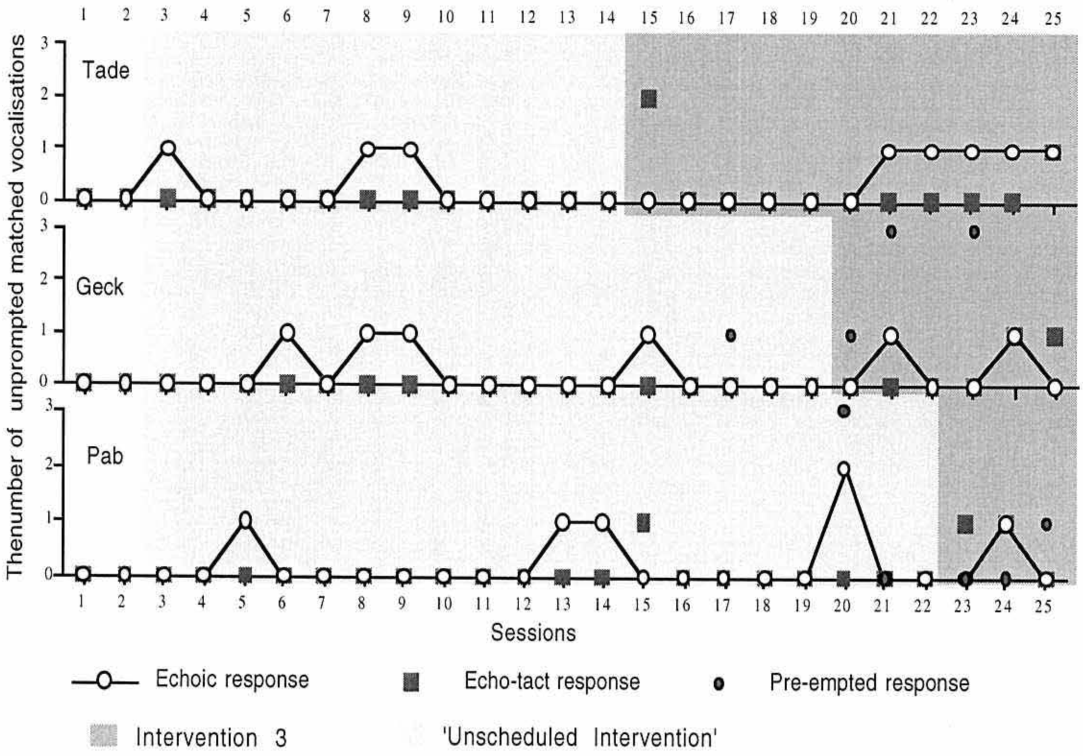


Figure 5.4.4.8 The number of unprompted target responses produced by RR in the listener trials.

Summary

Figure 5.4.4.9 shows the proportion of matched and mismatched tact, echoic, and listener responses. Criterion responding was demonstrated within five sessions of introducing Intervention 3, to the first verbal relation only. When criterion tacting was evident, both listener and echoic behaviours were also seen to be at criterion level. RR was 23 months and 15 days old.

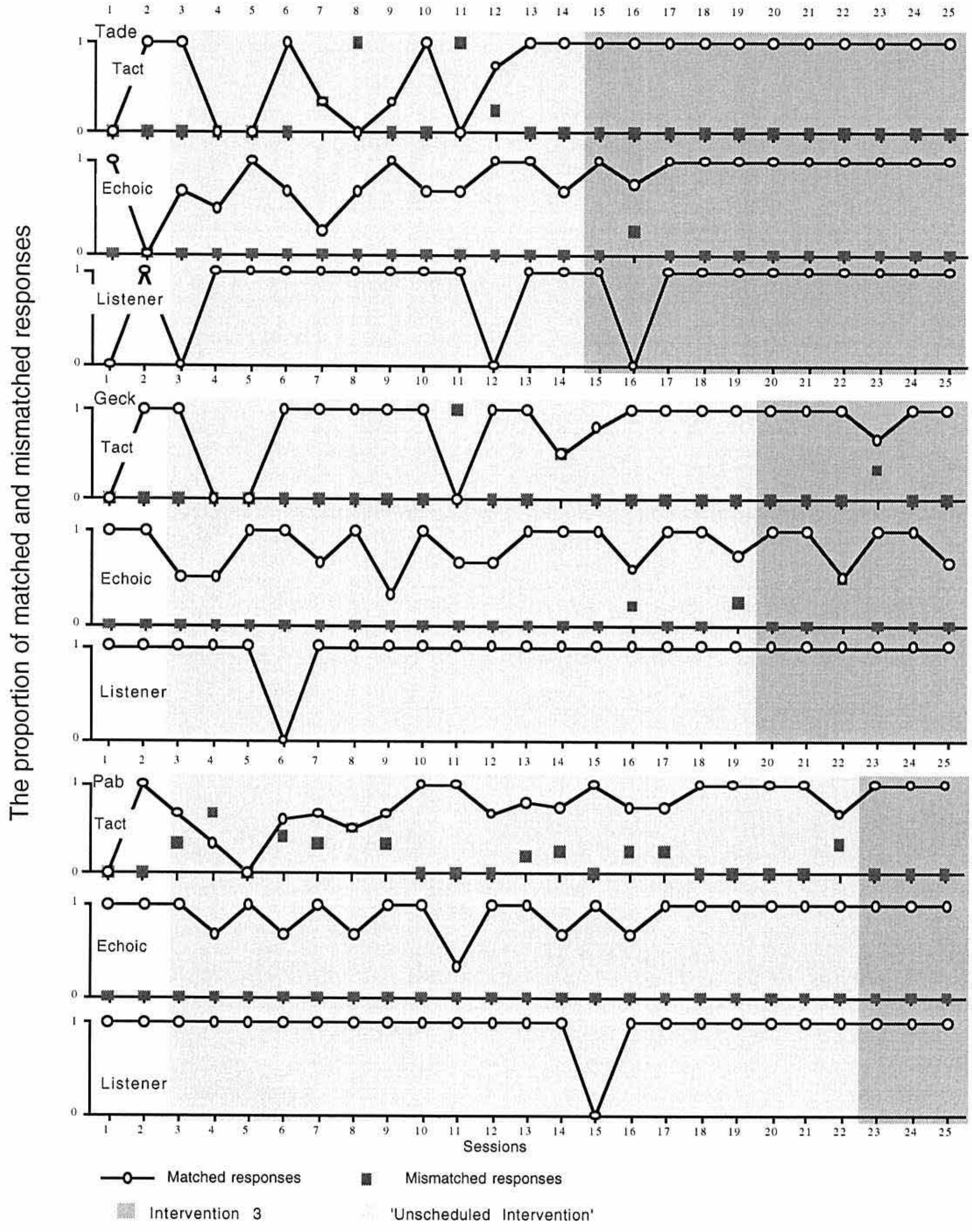


Figure 5.4.4.9 The proportion of matched and mismatched tact, echoic and listener responses produced by RR in Experiment 4.

Participant WL

WL began Experiment 4 at 22 months 10 days. For the first target relation she participated in seven baseline sessions in which tact responses, listener responses and echoic responses were probed as in Experiment 3. These sessions were followed by the introduction of Intervention 1, a multiple baseline intervention, in which the listener and echoic trials were combined so that echoing was reinforced in the presence of the corresponding stimulus object.

WL chose not to co-operate on many occasions. This was particularly so during the early part of the experiment. Over the course of this experiment, 18 sessions (a ratio of 1:4) were either abandoned altogether or were only partially completed. Consequently it was very difficult to control the conditions of reinforcement, and by the end of her second year she was indiscriminately producing the target responses. To overcome production of mismatched responses, Interventions 2 and 3 were introduced simultaneously for all three tact relations. That is, all matching tact responses in all tact tests were reinforced. Interventions 2 and 3 began when WL was 24 months 19 days. She demonstrated tacting of all three stimulus objects to the criterion of ≥8/9 when she was 26 months and 8 days old.

Tact responses

As before, there were three tests of each tact relation in every experimental session in the baseline. Following the implementation of Intervention 1, the Tact Test 2 was omitted. Figures 5.4.5.1- 5.4.5.3 show the number of tact probes and the frequency of matched and mismatched responses in each test for each of the three tact relations.

The tact tests were difficult to administer as WL frequently responded with long bursts of "no" and other signs of non-complicity. The normal experimental procedure could often be resumed after a few minutes of off-task play. When possible, three

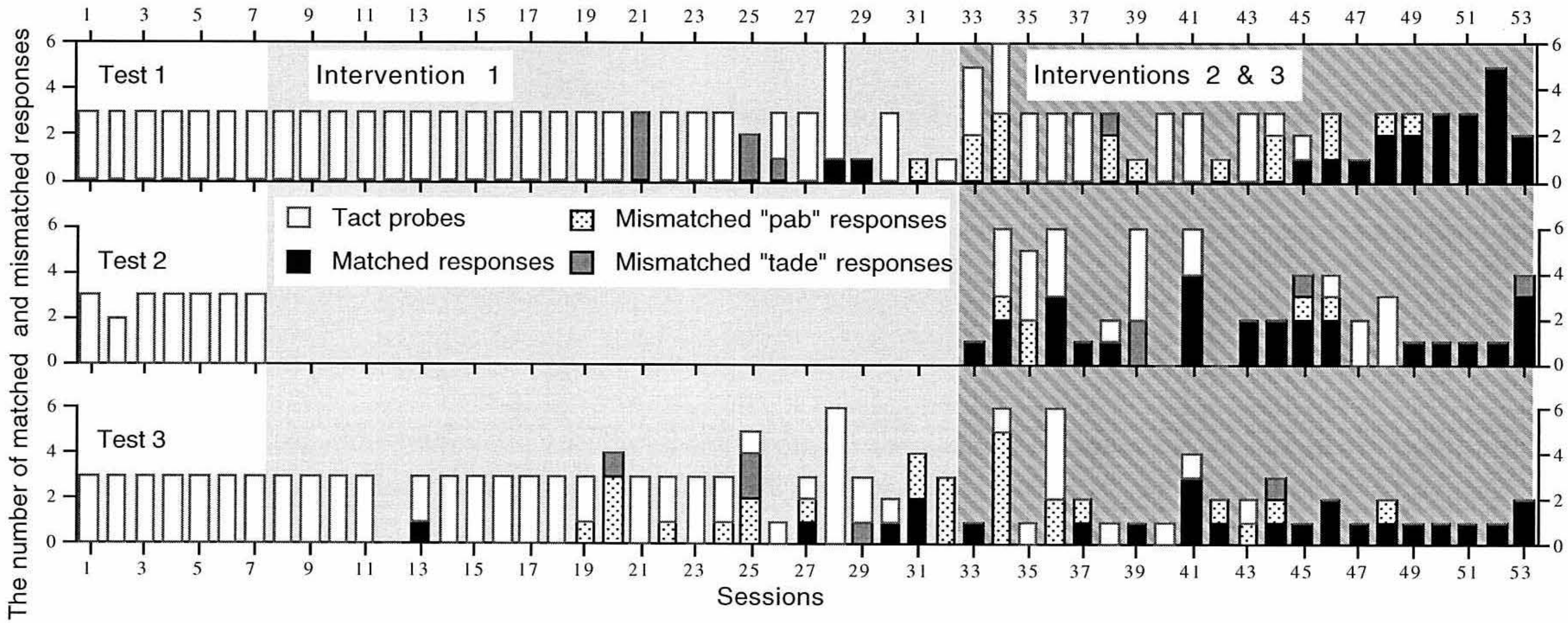


Figure 5.4.5.1 The number of matching and mismatched responses produced by WL in tests of the tact relation O1 - "geck".

probes for each relation were given at each test. Extra probes were given if she was particularly inattentive.

There was no evidence of the tact relation O1 — "geck" in the 62 tact trials in the baseline sessions. WL produced one matched response when Intervention 1 was initiated, in Test 3, Session 13. However, there was no real increase in her production of target responses until the intervention had been extended to the second and third verbal relations. In all she produced 7 matched responses in the 147 tact trials (mrr = 0.0068) during the period of Intervention 1. She produced 25 mismatched responses, 10 mismatched "tade" responses, and 15 mismatched "pab" responses. Thus Intervention 1 brought about an increase in the production of target responses but did not establish tacting. Interventions 2 and 3 were introduced simultaneously in Session 33. Tact responses to the combined listener – echoic -"tact" probes are shown in Test 2. On occasions there were more than six probes per session. A figure in the top of the corresponding column shows the number of probes per session, on these occasions. This was done to retain the comparability of the vertical axes across the three tests. There were eight trials in session 36 and 12 in session 39. Thus, the number of trials of the listener-echoic-tact relations of O1 — "geck" conducted in Sessions 33 - 53 was 64. There were 27 matched responses in these 64 trials (mrr = 0.42). There were fewer mismatched responses, only five mismatched "pab" responses and four mismatched "tade" responses were produced.

It can be seen that reinforcement of matched tact responses during this intervention brought about a corresponding increase in matched responses in the Tact Tests 1 and 3.

This emerged first in Test 3: in the first 12 sessions of this intervention WL produced 8 matched responses in 30 trials at Test 3 (mrr = 0.4), and she produced 12 mismatched responses; in the nine sessions from Session 45 – 53 she produced 11/12 matched responses (mrr = 0.92) and only one mismatched "pab" response.

In Sessions 33 – 44, WL continued to produce mismatched responses in the criterion Test 1. She produced no matched responses in the 37 trials in these sessions,

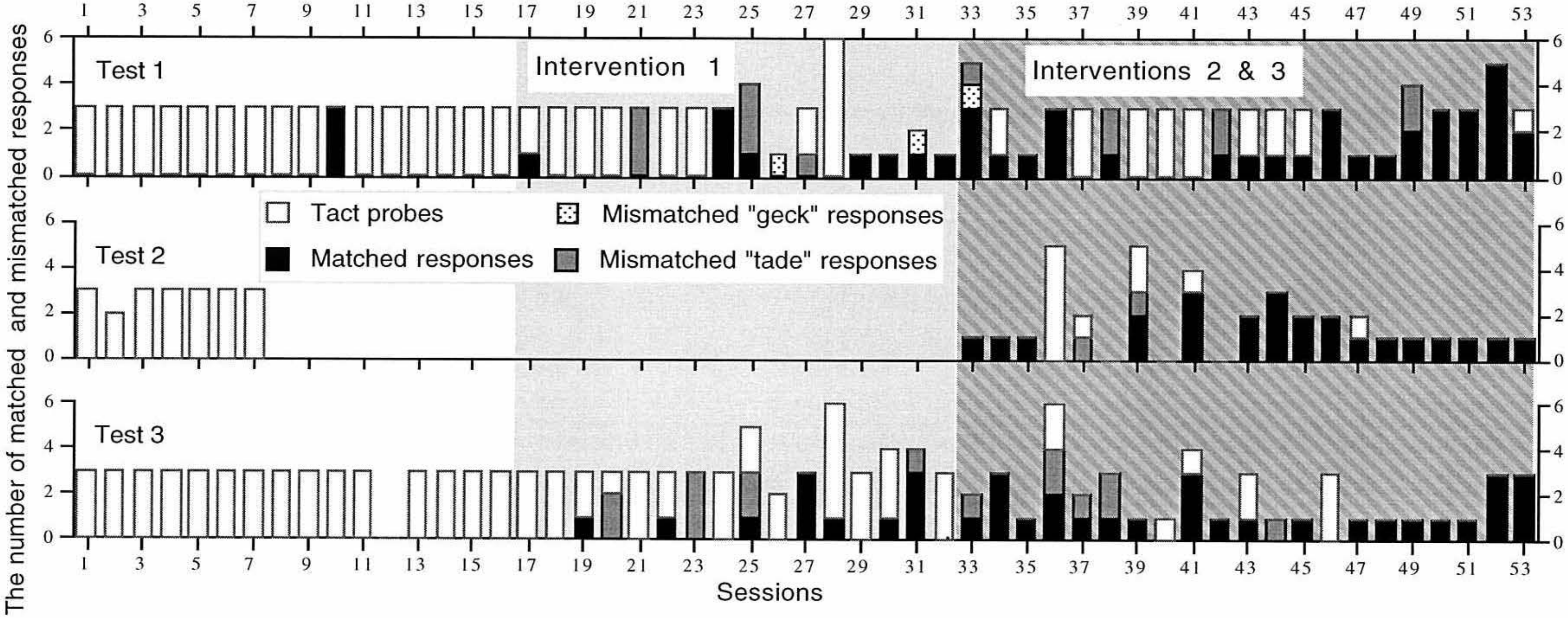


Figure 5.4.5.2 The number of matching and mismatched responses produced by WL in tests of the tact relation O2 - "pab".

but she produced 12 mismatched responses. In Sessions 45 – 53 she produced 20 matched responses in 25 trials (mrr = 0.8), and four mismatched "pab" responses. Criterion responding was demonstrated in Sessions 49 –51 when she produced 8/9 matched responses (mrr = 0.89) and tact responding was 100 percent accurate thereafter. These results strongly suggest that WL had learned the tact relation O1 — "geck".

There was no evidence of the tact relation O2 — "pab" during the baseline condition; she produced matched responses in only 3/113 baseline trials.

Tact responses became increasingly frequent when Intervention 1 was implemented. She produced 20 matched responses (mrr = 0.22), 15 mismatched "tade" responses and two mismatched "pab" responses in the 94 tact trials in this intervention. Thus this intervention had increased the number of target responses but the responses were indiscriminate.

She showed a marked decrease in the proportion of mismatched responses to O2 following the introduction of the listener – echoic – tact intervention. There were 36 training trials (shown in Test 2, Sessions 33 – 53), in which she produced 24 matched responses (mrr = 0.67) and only 2 mismatched "tade" responses. The mismatched responses were produced in Sessions 37 and 39, early in the intervention. Criterion responding in the training trials was seen in Sessions 43 – 46, when she produced matched tact responses in 9/9 trials (mrr = 1). This improvement in the proportion of matched responses was correlated with increased matched responding in the two tact tests.

In Test 3 the number of target responses continued to rise during the first 12 sessions of Interventions 2 and 3, but mismatched responses were still frequent. She produced 15 matched responses (mrr = 0.54) and seven mismatched "tade" responses in the 28 tact trials. As responding in the training trials became established production of mismatched responses diminished. She produced no mismatched responses in

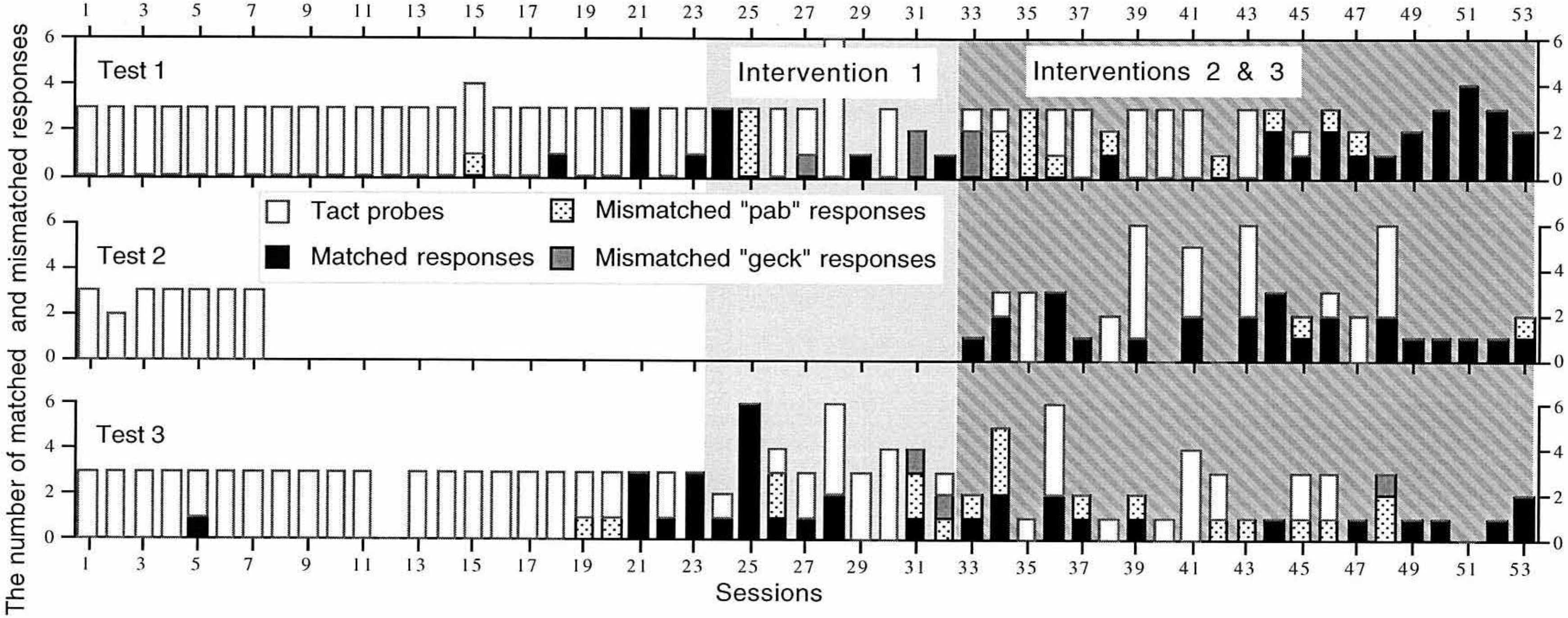


Figure 5.4.5.3 The number of matching and mismatched responses produced by WL in tests of the tact relation O3 - "tade".

Sessions 45 – 53 of this test. She produced matched responses in 12/15 trials (mrr = 0.8), and responded correctly in all trials from Session 47 onwards. In the criterion Test 1, she made 33 matched responses (mrr = 0.53), seven mismatched "tade" responses and one mismatched "pab" response in the 62 tact trials during Interventions 2 and 3. In the last nine sessions, 45 – 53, she produced 21 matched responses (mrr = 0.81) and only two mismatched "tade" responses in 26 trials. Criterion was demonstrated for this tact relation in Sessions 50 – 52 when she responded correctly in 11/11 trials (mrr = 1). She produced no further mismatched responses. These results strongly suggests that she had also learned the tact relation O2 — "pab".

For the tact relation O3 — "tade", as with the two previous relations, there was only minimal responding during the baseline period. There were 13 matched tact responses (mrr = 0.083) and three mismatched "pab" responses in the 156 trials. Intervention 1 was implemented from Session 24 to 32, and during this period the proportion of target responses increased. WL produced 17 matched responses (mrr = 0.28), 8 mismatched "pab responses, and 5 mismatched "geck" responses in 60 trials. Though the frequency of matched responses remained well below criterion, the total number of vocal responses, that is, the frequency of producing any one of the three target responses had increased from 1:10 to 1:2.

Interventions 2 and 3 were implemented in Session 33 but tact responding in the combined listener–echoic-"tact" trials did not reach criterion. This was because of the number of probes to which she produced no response. There were 52 listener-echoic-"tact" trials (eight tact probes in Session 39). She produced 25 matched responses (mrr = 0.48), and two mismatched "pab" responses. Thus she failed to respond in half the trials. However from Session 49 onwards she produced consecutive matched responses until Session 53 when she produced one mismatched "pab" response. The effect of the intervention is not as clear for this verbal relation.

In Test 3, she continued to produce matched or mismatched responses to approximately half the probes. She produced 14 matched responses, 12 mismatched "pab" responses and one mismatched "geck" response in 44 trials. Not until Session 49 did her production of mismatched responses disappear. She produced matched responses in 5/5 trials in the last five sessions.

In Test 1 the response pattern is clearer. She produced only one matched response and ten mismatched responses in the first eleven sessions. However from Session 44 onwards there was a marked increase in the frequency of responding generally and in production of matched responses in particular. She produced 21 matched responses (mrr = 0.84) and only three mismatched responses in the 25 trials in Sessions 44 –53. Criterion responding for this tact relation was demonstrated in Sessions 48 – 51 when she produced 10/10 consecutive correct responses (mrr = 1). She produced matched tact responses in all subsequent trials of this tact relation.

Thus WL had demonstrated that she had learned all three tact relations to the criterion of ≥8/9 consecutive correct responses for all three relations simultaneously. The effect of the interventions on the production of target responses and of matched responses can be seen in Figure 5.4.5.4. This shows the proportion of matched and mismatched tact responses to the number of probes in each of the tact tests for all three tact relations. Again, her responses in the tact training trials are shown in Sessions 33 – 53 of Test 2. In the graph, the sessions when multiple baseline Intervention 1 and the simultaneous Interventions 2 and 3 were implemented are shown shaded.

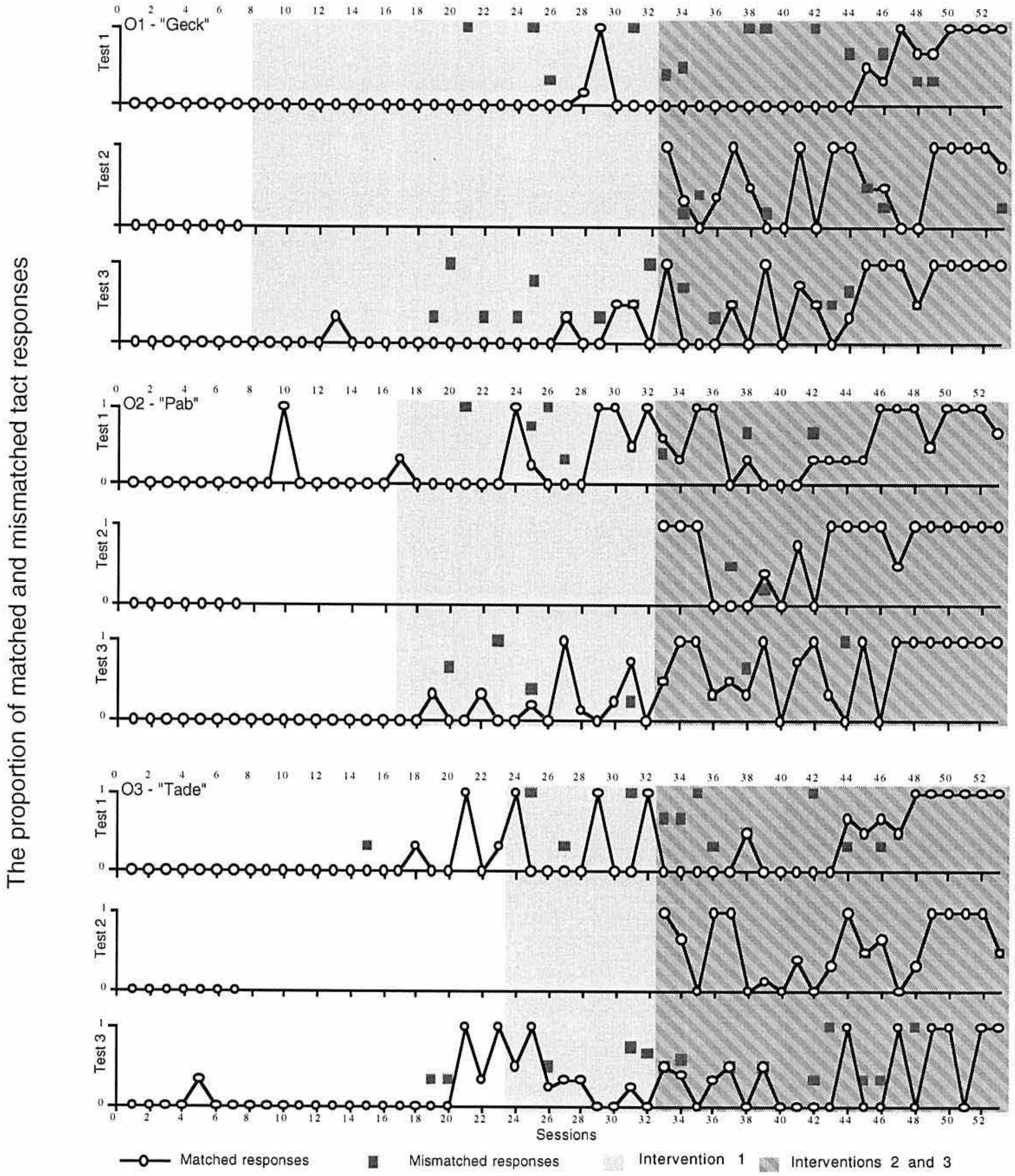


Figure 4.4.5.4 The proportion of WL's matched and mismatched responses to the number of tact probes in each session, shown in relation to the interventions.

Echoic responses

WL had previously learned to echo to criterion. However, due to her poor response rate in the early sessions of this experiment, the echoic relations could not be reinforced because she did not respond within three probes. Hence, in order to maintain the echoic relations, the number of probes could not be kept constant across sessions. Figure 5.4.5.5 shows her echoic responses as a proportion of the number of echoic probes per session.

For the first echoic relation, */geck/* — "geck", WL responded correctly in a total of 121 of 228 trials, a response rate of 0.53 over all the trials of this relation. Social reinforcement alone was never sufficient to maintain responding at criterion level, and the effectiveness of secondary reinforcers was very variable. However, it was usually possible to evoke a correct response within each session, the exceptions to this were in Sessions 20, 21, 26, 27, 28, 40, 42, 47 and 51.

For */pab/* — "pab", she produced echoic responses in 96 of 150 trials, a response rate of 0.64 over all the trials. She failed to respond in Sessions 12, 19, 20, 21, 24, 26, 28, 38, 40, 41, 42, 50 and 51.

For the relation */tade/* — "tade", she responded correctly in 91 of 149 trials, a response rate of 0.61 over all the trials of this relation. She failed to echo in Sessions 12, 13, 17, 19, 20, 24, 26, 27, 28, 30, 38, 40 and 51.

Thus WL's overall echoic response rate was only 0.58. It can be seen that responding was initially fairly stable, and failure to respond did not arise until Session 12, and was not confined to any single echoic relation. This confirms that WL had learned to echo, and that the problem with her response rate was the variable control of the conditions of reinforcement. This was quite difficult during Intervention 1, when WL produced only 71 matched responses in 128 trials (mrr = 0.55). Her response rate improved after Interventions 2 and 3 were initiated and in Sessions 33 – 53 she produced 117 matched responses in 159 trials (mrr = 0.74). As the reinforcement available for echoing was the same in both conditions this suggests that there was something intrinsically reinforcing in the second intervention that was missing from the first.

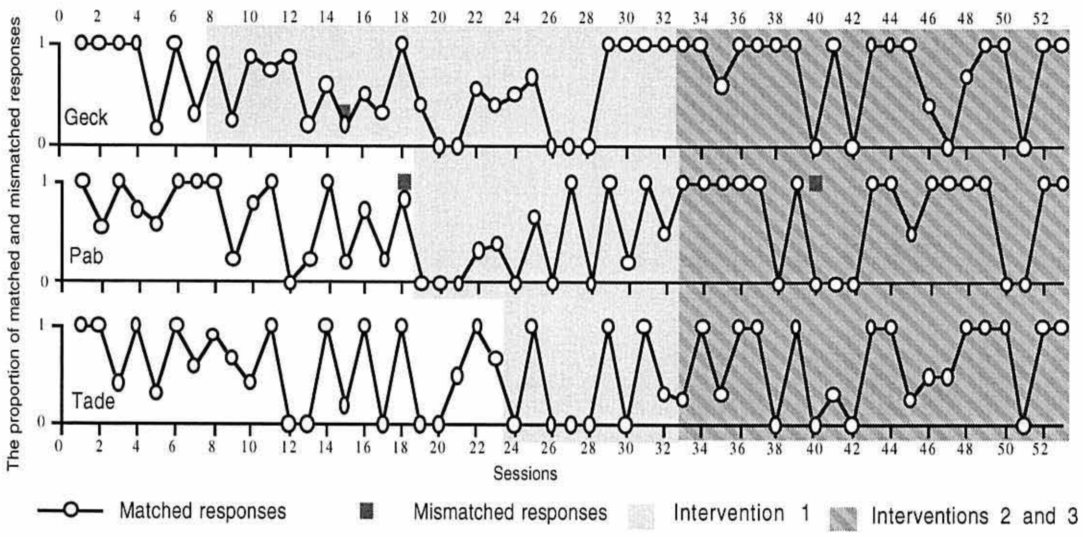


Figure 5.4.5.5 WL's matched and mismatched responses shown as a proportion of the number of echoic probes per session, and in relation to the interventions.

Mismatched echoic responses were rare throughout this experiment. In trials of the */geck/*— "geck" relation WL produced 3 mismatched "pab" responses, in trials of the */pab/*— "pab" relation she produced 4 mismatched "tade" responses and in trials of the */tade/*— "tade" relation she produced 2 mismatched "pab" responses.

Unprompted vocalisations

During the course of this experiment WL produced occasional unprompted vocalisations which matched the auditory stimuli. These were identified as echoes, echo-tacts, tacts or other unprompted production. The unprompted vocalisations occurring during the trials of echoic imitation are shown in Figure 5.4.5.6.

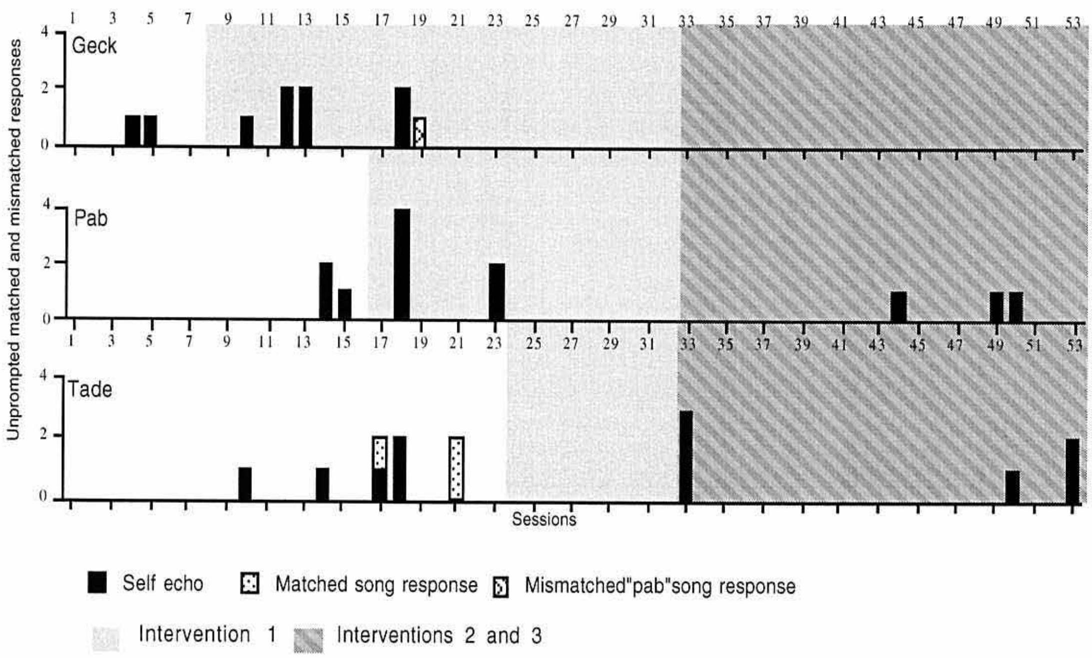


Figure 5.4.5.6 Unprompted target responses produced by WL during trials of echoic imitation and echo-tacting.

WL produced mainly perseverated echoic responses. She also, very occasionally, produced target responses, matched or mismatched, during the song prompts.

Listener Responses

As before, each listener relation was tested once at each session and if necessary further training trials were given to prevent the extinction of these responses. Figure 5.4.5.7 shows the frequency of correct test trials for each of the three listener relations.

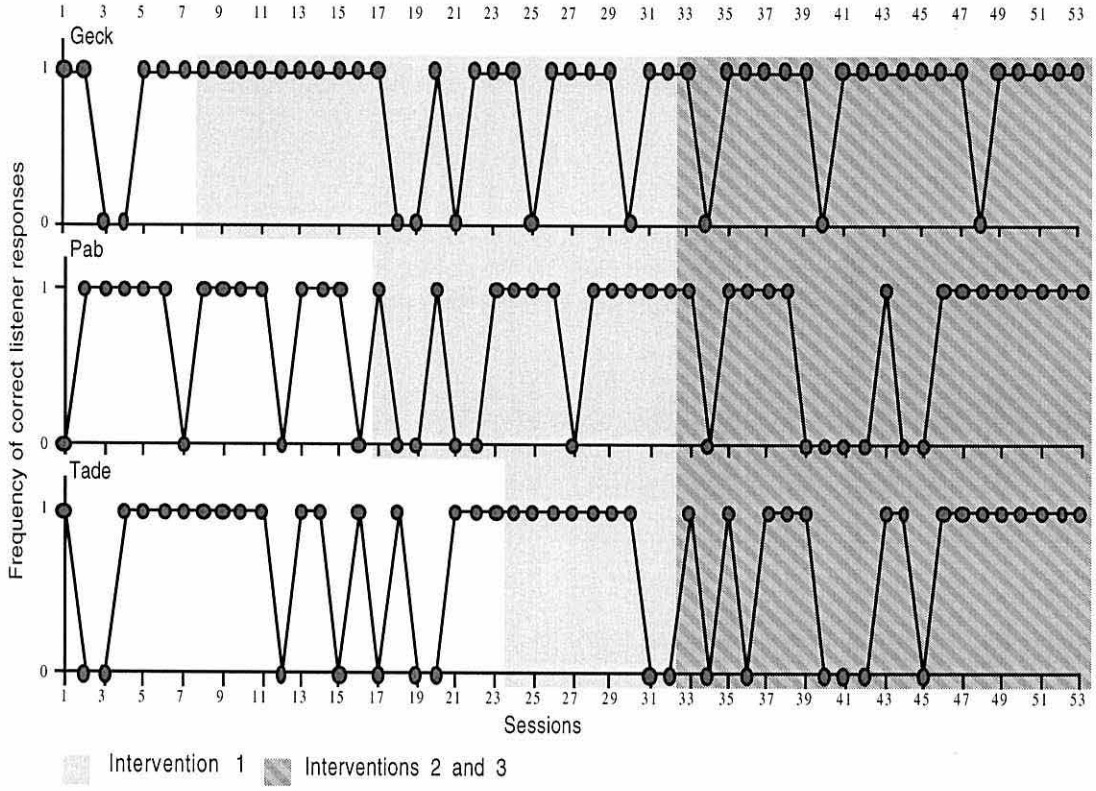


Figure 5.4.5.7 WL's responses to the listener test trials.

WL's responding during the listener relation */geck/* — O1 trials was correct in 43/53 test trials (mrr = 0.81). Criterion responding was seen in the baseline sessions and again in the period of the second intervention; however, during the implementation of the first intervention some disturbance was apparent.

For */pab/* - O2 she was correct in 37/53 test trials (mrr = 0.70). Criterion was seen in Sessions 1 - 10, 23 - 33 and 45 - 53.

For the listener relation */tade/* — O3 she was correct in 38/53 test trials (mrr = 0.72). Criterion was seen in the baseline period, at the end of the first intervention, and again at the end of the second intervention.

Across the three listener relations responding remained fairly stable and had returned to criterion level by the end of the experiment.

Unprompted vocalisations

Again, WL also produced unprompted vocal responses during the listener trials. She frequently echoed the auditory stimulus, and on occasions this appeared to be her preferred response. In some listener trials she required several repetitions of the listener probe before she stopped producing the echoic response and attended to the "give" request. Her unprompted target vocal responses are shown in Figure 4.4.5.8.

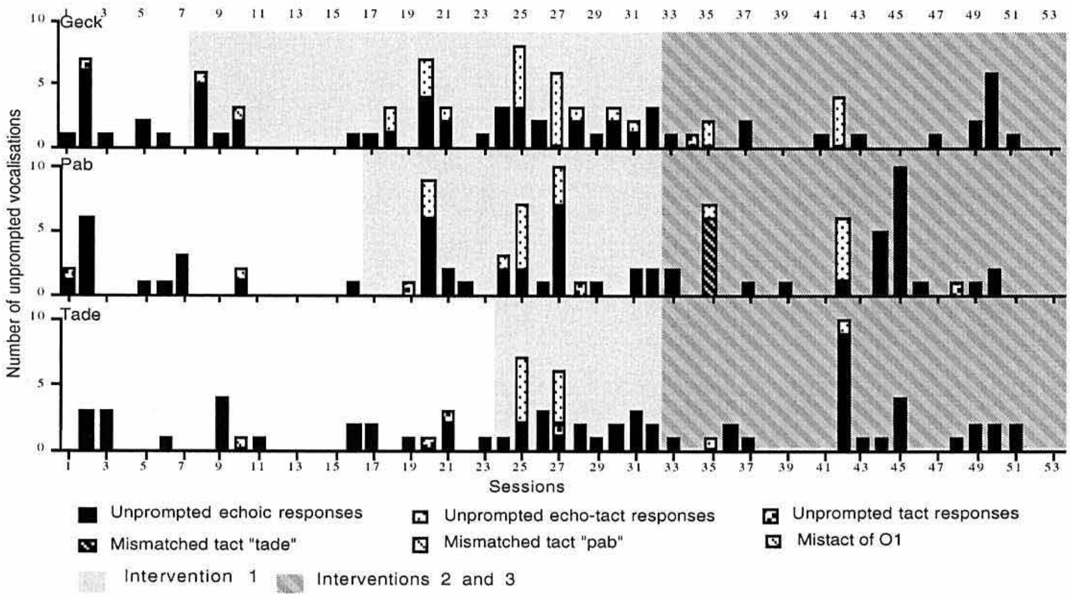


Figure 5.4.5.8 The unprompted reproductions of the auditory stimuli made by WL during the listener trials.

She produced 61 unprompted echoes of the auditory stimulus */geck/*. These were heard in 30 of the 53 sessions. In addition, she produced 27 unprompted echo-tacts in 11 sessions. These were the most frequent type of unprompted vocal responses. There were also two unprompted matched tacts and one mismatched "pab" tact; that is, she looked at O1 but said "pab". There were no other unprompted productions in the geck trials.

WL echoed */pab/* a total of 64 times in the course of 26 of the 53 sessions, and produced 18 echo-tacts. In addition, she produced four unprompted matched tacts and six perseverated mismatched "tade" tacts in Session 35.

She echoed */tade/* a total of 63 times, these were heard in the course of 30 of the 53 sessions. She produced eleven echo-tacts. Two unprompted matched tacts were heard, and one mismatched "pab" tact.

Summary

WL began Experiment 4 at 21 months and 13 days old. Her experimental sessions were infrequent at first because she was unable to complete many sessions. She was difficult to keep on task because she did not respond to social praise alone. WL's responses to the Tact Test 1, the echoic trials and the listener trials are shown as a proportion of matched and mismatched responses to the number of prompts per session in Figure 5.4.5.9.

She began to produce responses to tact probes during the Intervention 1, when the listener and echoic trials were combined. However, these responses were frequently mismatched responses. Tacting to criterion emerged following Interventions 2 and 3, in which she was reinforced for correct responding in all tact probes. At 26 months 8 days, both tacting and listener responses were at the criterion of ≥8/9 for all three relations. Thus she was deemed to have learned the three novel name relations.

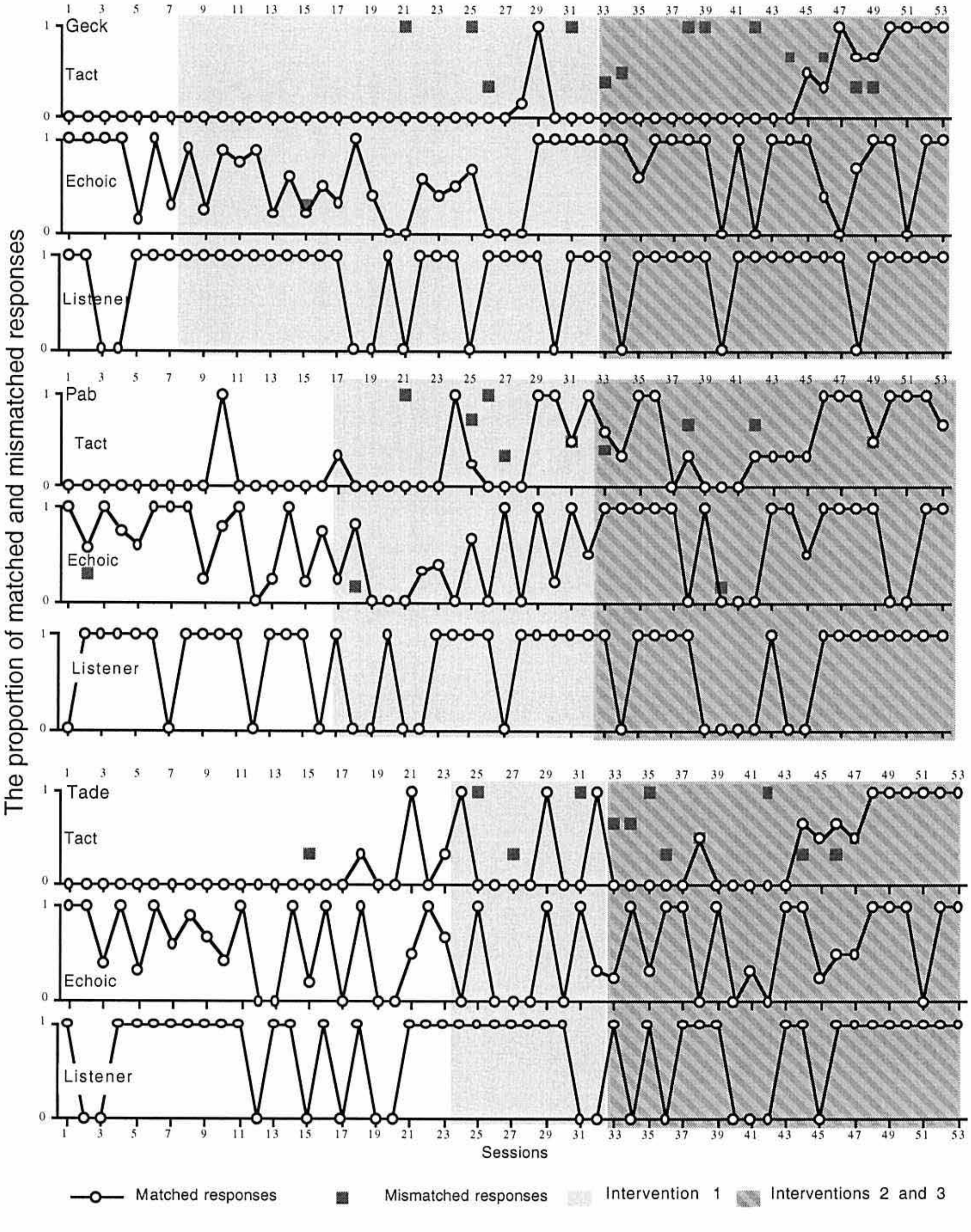


Figure 4.4.5.9 The proportion of WL's matched and mismatched tact, echoic and listener responses to the number of probes in each sessions, shown in relation to the two interventions.

GROUP RESULTS

Five infants began Experiment 4, and four eventually learned to tact all three experimental stimulus objects; the fifth infant learned to tact two of the three objects to the set criterion. All five infants were reinforced for producing a matched response to the tact probe for at least one of the verbal relations.

There was a wide discrepancy in the age at which each participant learned the tact relations. The youngest infant to learn to tact all three experimental stimuli was HC, at 22 months 12 days old, whereas the oldest, WP, learned to tact two of three objects at 27 months old. This widely disparate age range is reflected by the number of experimental sessions required to train the tact relations. After learning to echo to criterion, RR learned to tact in 19 sessions, at 23 months 15 days, whereas WP required a further 71 sessions to learn to tact.

Table 5.4.2 summarises the following information: the age of each participant at the start of the experiment; the number of trials he or she completed in each stage of the experiment, for each target relation; and the age of the infant when criterion tacting of all three target relations simultaneously was first demonstrated. The following information applies: the number of baseline trials is the number of *echoic* trials that were reinforced in the *absence* of the stimulus objects, after criterion echoing was demonstrated; the number of Intervention 1 trials is the number of *echoic* trials that were reinforced in the combined listener-echoic trials; the number of trials of Intervention 2 is the number of trials when reinforcement was available for a combined listener-echoic-*tact* prompt; and finally, the number of trials in Intervention 3 is the number of reinforced *tact* probes, excluding the listener-echoic-tact probes.

Table 5.4.2

Infant	Age At Start	Verbal Relation	Base	Int 1	Int 2	Int 3	Age At End
BR	22;26	01	27	218	108		25;12
		02	59	127	18		
		03	94	80	0		
		ALL	**180**	**425**	**126**		
HC	20;16	O1	32	59	39	25	22;12
		O2	28	81	40	29	
		O3	37	34	33	37	
		ALL	**97**	**174**	**112**	**91**	
WP	22;12	O1	127	61	118	0	27;00
		O2	163	21	33	0	
		O3	159	15	15	345	
		ALL	**449**	**97**	**166**	**345**	
RR*	22;15	O1	72		*52*	78	23;15
		O2	75		*49*	30	
		O3	70		*45*	20	
		ALL	**217**		***146***	**128**	
WL	21;13	O1	47	155	64	105	26;08
		O2	69	81	36	105	
		O3	82	67	54	99	
		ALL	**198**	**303**	**154**	**309**	

RR* - In the tact trials of the "baseline" sessions for RR there was intermittent reinforcement of correct tact responding, all reinforced tact responses are recorded under Intervention 3. In addition, also during the tact trials, the use of the probe "Again!" following some correct responses created the unscheduled intervention of reinforced echoing in the presence of the objects. These, unscheduled Intervention 2 responses, are shown italicised in the column for Intervention 2.

The following conclusions can be drawn from Table 5.4.2:

(a) Echoing in the presence of the corresponding object, as in the combined listener and echoic probes of Intervention 1, was sufficient to establish two target relations in infant BR.

(b) Echoing in the presence of the corresponding object following a combined listener-echoic-"tact" probe, as in Intervention 2, was sufficient to establish one target relation in infant BR.

(c) Reinforcement of all correct tact responses during tact probes, as in Intervention 3, was not sufficient for the establishment of any target relations.

(d) The combined effects of Interventions 2 and 3 were sufficient to establish 11 target relations, 3 for three infants, WL, HC and RR, and two for one infant, WP.

It appears, therefore, that producing the target response in the presence of the corresponding object is necessary but not generally sufficient to establish criterion responding during tact probes; the explicit reinforcement of correct responses to echo-"tact" probes is required to establish reliable tacting.

During this experiment, echoic responses and listener responses were also monitored, and any unprompted production of the target responses was noted.

Having already learned to echo, none of the infants experienced any difficulty in producing matching responses, that is, there were no inexact or poor approximations of the auditory stimuli. Echoic responding remained at or close to criterion for four of the five infants, BR, HC, RR, and WP; all showed both prompted and unprompted echoic behaviour during the echoic trials. Yet for WP, unprompted vocal behaviour virtually disappeared from the echoic trials after Intervention 2 was applied to the first verbal relation. Only WL fell significantly below the echoic criterion; for her, the availability of social praise and supplementary social reinforcers was insufficient to maintain the frequency of echoic responding at criterion level, she recorded many no responses. Similarly, she produced the fewest unprompted vocal responses during the echoic trials.

Listener responding was maintained at or close to criterion by HC, WP, and RR. WL showed moderately good listener behaviour, which steadily improved as the tact relations were learned. She also produced many unprompted vocal responses during the listener trials.

BR struggled to maintain her listener behaviour. She responded to */pab/* — O3 at criterion, and importantly, she learned the tact relation O3 — "pab" first. The other listener relations were below the mastery criterion throughout this experiment, and did not return to criterion until after the tact relations had been learned.

Interestingly, BR produced no unprompted "pab" responses after she had learned to tact O3 — "pab", but continued to produce unprompted echoic responses of the other auditory stimuli. There was some evidence that both BR and WL responded to listener probes with echoic responses.

The fewest unprompted matched responses were produced by RR, and by BR for "pab". Both these infants had learned to tact the corresponding stimulus objects. This suggests, once the tact is established, that the auditory stimulus may become a weaker discriminative stimulus for vocal production. However, with so few participants this must remain an empirical question.

HC and RR showed strong listener and echoic behaviour and strong unprompted echoing in the echoic trials. Both these infants learned to tact before 24 months of age. BR showed weak listener behaviour and did not learn to tact until after she was 25 months old, whilst WL showed only moderate listener and echoic behaviour and did not learn to tact until she was over 26 months old. Thus, there was evidence to suggest that well established listener behaviour may facilitate tacting, once an appropriate echoic repertoire is established.

WP showed strong listener and echoic behaviour and strong unprompted echoing in the listener trials, but she did not learn to tact until 27 months old. However, this was not contrary to the hypothesis that unprompted echoing in the listener trials might give rise to tacting, because her vocalisations were purely echoic. WP was highly vocal during the listener trials, she produced many echoes that were contingent only on the modelled auditory stimulus or were perseverated, self-echoic, responses. These target responses only rarely occasioned orientation to the corresponding object, and in addition, when echo-tacting did occur it was often mismatched.

DISCUSSION

The results of Experiment 4 have shown that the tact did not emerge from listener and speaker behaviour alone, but from learning to say the corresponding word contingently upon seeing the stimulus object. Thus, untrained "bi-directional" responding was not demonstrated by these infants. In order for them to learn to tact it was necessary to "close the circle" of the name relation by reinforcing production of the appropriate word whilst orienting to the corresponding object (see Horne and Lowe, 1996, p.200).

In addition, the results of the concurrent listener and echoic probes have pointed to interesting variations in the operant level of previously learned behaviours. These suggest that there are established schedules of reinforcement operating within the verbal community, which are often but not necessarily overt. The effect of reinforcement on the operant level of previously acquired behaviours will be addressed first.

Echoic responses

All the infants had previously acquired separate listener and echoic relations to three auditory stimuli before beginning this experiment. It was therefore unequivocal that the experimental listener and echoic responses were within their behavioural repertoires. The results reported here have shown that for all the participants there were periods when some of these relations were demonstrated at less than criterion level. This appears to bring into question the value of social praise and token rewards as reinforcers, particularly for frequently prompted behaviours.

It is essential for an analysis of behaviour that the response contingencies are clear. Once established, echoic repertoires are clearly available responses, however, the production of any response is dependent upon the strength of the reinforcer. In this experiment, four of the five infants were unable to maintain criterion echoing for the echoic relations. This was most noticeable in the early stages of the experiment when the tact responses were not reinforced. Once reinforcement for tact responding was made available, echoic responses returned to criterion for three of the four infants. This correlation may be important.

Listener responses

Listener responding was also disrupted for three of the infants. RR and HC who both learned to tact before 24 months of age were able to maintain listener responding to criterion. However, for BR, WP, and WL listener responding, whilst above chance levels, was not maintained to the criterion of ≥8/9 consecutive correct responses.

Disruption of listener behaviour was correlated with the production of mismatched vocal responses, particularly in the tact tests. All three infants had previously established listener behaviour, but once disrupted, listener responding did not return to criterion until tact responding was evident. The temporal relationship between listener and tact relations is difficult to establish. There was no clear order effect; rather for these three infants, the two relations appeared to reach criterion simultaneously for all the relations in question.

These results suggest that having a vocal response to an auditory stimulus, to which he or she first responded as a listener, might have changed the way the infants responded as listeners. The echoic response is "the simplest case in which verbal behavior is under the control of verbal stimuli", (Skinner, 1957, p. 55), because it corresponds so closely to the auditory stimulus. This may have provided the conditions in which response competition would favour the echoic response over the listener response. However, once having learned to tact, the resulting self-produced auditory stimulus so resembled that of the experimenter produced version of that stimulus that it evoked orienting to the object, so closing the circle.

In Experiment 4, described here, learning to name was greatly facilitated by learning to produce temporally consecutive listener and speaker behaviour in the presence of the corresponding object. The listener–echoic–"tact" training was successful in bringing about matched responses to the tact probes in the training trials of all of the four infants who progressed to this intervention. Initially this was seen only in the responses in training trials. Once a tact response had been reinforced in the training trials, this raised the probability of responding appropriately in the following Tact Test 3. As the individual results show, matched responding to probes in the tact tests first generalised to the Test 3 situation. However, prior to reinforcement of these responses in Intervention 3, in this experiment, tact responding did not attain criterion level for all participants, nor did responding always generalise to the Tact Test 1 situation. Only when reinforcement of responding in the tact test trials was introduced did four of the five participants show criterion responding in the criterion Tact Test 1.

Initially it seemed that there was an exception to this pattern of responding. One infant, RR, appeared to learn to tact two stimuli in the absence of any scheduled reinforcement for doing so. However, to prove that tacting had not been reinforced it would be necessary to show that his target responses were not reinforced. This was not the case. On the contrary, there was evidence of unprompted echoic and echo-tact responses during the reinforced listener trials; reinforcement scheduled for listener responses could easily have unwittingly reinforced these unprompted and temporally contiguous echoic-tact responses. In addition, although there was no scheduled overt reinforcement of tact responding, when RR produced a target response during the tact probe trials the experimenter abbreviated the probe to "Again!" rather than "What is it?" thereby evoking RR's self-echoic repetition of the target response in the presence of the corresponding object — unplanned training trials resembling those of Interventions 1 and 2. Finally, in reviewing RR's audio-visual session recordings, the experimenter observed that she had unintentionally reinforced each of the three target responses on occasion before the scheduled introduction of such, in Intervention 3.

Naming

The five infants described here have demonstrated three verbal behaviours for each of the name relations learned. Horne and Lowe have stated that these were the necessary and sufficient condition for naming. However, all these relations were directly trained and were tested as trained. Experiment 5 was designed to test whether these name relations would generalise to novel exemplars.

EXPERIMENT 5

THE TEST OF THE NAME RELATION

The five participants who completed Experiments 1 – 4 had learned listener, echoic, and tact relations and so theoretically had learned a name relation for each of three experimental stimulus objects. Experiment 5 was designed to test whether these relations were the necessary and sufficient determinants of naming.

Horne and Lowe (1996) have stated that the name relation implies listener, echoic and tact behaviour. The previous experiments were designed to teach these three behaviours. Each of the five children successfully demonstrated each of these behaviours to a strict criterion of ≥8/9 consecutive correct responses. However, it might be argued that, for each putative name relation, having learned these behaviours in the context of a particular experimental object, naming might not generalise to other similarly shaped objects.

Harris (1992) has discussed the development of vocabulary as a series of stages. In the first stage, she describes, the child learns vocabulary slowly and individual children learn at very different rates. Nelson (1988) submits that the main development in this stage is the understanding of what words are. Harris states that early words are under-extended in two ways. The first she describes as context bound, for instance, saying "teddy" only when playing with one particular teddy. She suggests that a second use of under-extension is necessary to show referential use of the word:

> . . . this is the use of a word that is restricted, not to a particular situation, but to a particular referent or subset of referents (irrespective of the situation in which they occur). Under-extension of this kind is not context-bound but contextually flexible and it would appear that, in cases of this kind, children are using words in a way that is genuinely referential (1992, p. 71).

Other researchers have also identified specific criteria for when a word should be classed as a word. Vihman and McCune (1994, p 517) have set out a detailed list of these criteria. Importantly, they argue that "context-bound words can be trained by focussing on *eliciting* language, but that the timing of context-flexible word use remains independent of such training" (italics added). However, it must be noted that they were referring to their research with infants under 16 months old, thus this constraint might not necessarily apply to the infants studied here. Bates (1979, p.40) said of symbolic naming "Such behaviour is truly symbolic activity, wherein the vehicle is differentiated from its referent though simultaneously standing for, suggesting, or evoking its referents". Thus both psycholinguistic and developmental researchers recognise that there is more to understanding a word than simply producing the name in a strictly prescribed context.

If Horne and Lowe's theory of naming is to re-vitalise and extend Skinner's *Verbal Behavior* it must show that learning theory can provide an adequate account of how *flexible* language is acquired. Thus, it is necessary to show, having trained the necessary verbal relations (i.e., listener, echoic and tact behaviour), that the names, so established, are not context-bound but can be functionally extended to similar objects.

The trained names were produced reliably in response to corresponding stimulus objects, but exactly what quality of the stimulus object was discriminative for the vocal responses. Competing qualities were identified by Gathercole, Cranmer, Somerville & Jansen op de Haar (1995) as shape, and substance (i.e., colour, and texture). Landau, Smith and Jones (1998) suggest that young children "generalise the name by object shape". All these researchers report that children do not generalise objects by function, as adults do, but are more likely, in the absence of syntactic cues, to extend meanings by whole object shape.

The series of experiments described here trained novel verbal relations by reinforcing correct responses. Experiment 5 tested whether the names learned in Experiments 2 - 4 would generalise to novel exemplars on the basis of common shape.

METHOD

The *Participants*, and *Experimental Setting* were the same as those described in Experiment 4.

Apparatus

Novel stimulus objects were used in this experiment. They were the same shape as the trained stimuli, but varied from the trained objects in one of two ways, that is, by colour or by texture.

All the infants were tested with objects that were of a different colour from the trained stimuli. This was done in such a way that the colours of the three originally trained objects were present in the array but that each test object was a different colour from that trained. This would test if the infants were naming the stimuli by colour. Some of the infants were also tested with novel objects that varied in texture but not in colour. This would test if the infants were naming the stimuli by substance. The trained objects were all shiny plastic kitchenware. The novel objects were covered in metallic dust (glitter), coloured sawdust, or fur-fabric.

Procedure

Each participant was presented with completely novel objects that varied from the trained objects in either colour or texture. For each infant a series of generalisation trials of each name were given. In each session, three objects were presented one by one in random order. As each object was presented, the experimenter said, *"What's this?" What is it? What's this?"* This constituted one trial. When the child produced a vocal response, the trial was terminated. There was no reinforcement available for correct responding. Each object was presented once in each session.

The experimental hypotheses can be stated as follows:

H^1 – if the infants, by learning listener, echoic, and tact relations, had learned the name relation for the whole object, they would be able to extend the name to similarly shaped novel exemplars without further training.

H^0 – if listener, echoic, and tact relations do not constitute the full name relation, the infants would *not* be able to extend the names to similarly shaped novel exemplars without further training.

RESULTS

The results of these tests were consistent with the hypothesis that infants would show shape-based generalisation of previously trained tact/name relations. Figure 5.5.1 shows the percentage of matched tact responses for each of the three novel relations for each participant.

Learning to Tact

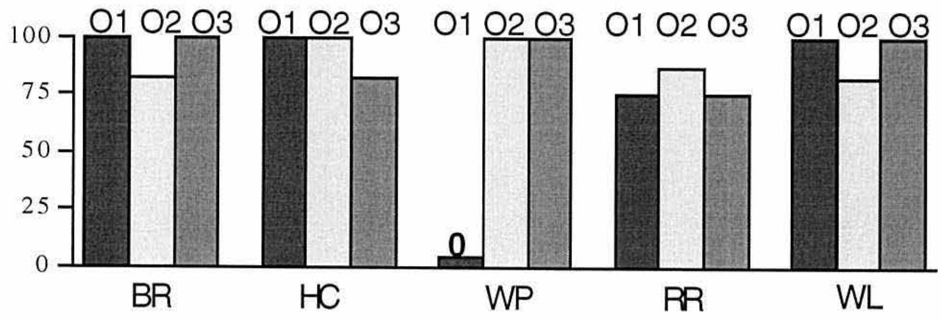


Figure 5.5.1 The proportion of matched responses to tact tests for three novel stimuli.

It can be seen that the name generalised to novel exemplars in over 75 percent of trials for 14 of the 15 trained relations. This supports the hypothesis that learning to name, in accordance with criteria drawn from the developmental psycholinguistic domain, can be demonstrated empirically using behaviourist methodology.

Participant BR

BR was tested with three novel stimulus objects of a different colour, and three of a different texture, from the objects she had learned to name. She correctly named each of the novel coloured objects in 3/3 test trials. That is, her tact responses generalised in accordance with the relation between the shape of the trained and tested objects. Similarly, she correctly named two of the texture variant objects (i.e., O1 and O3) in 3/3 test trials and was correct in 2/3 trials of O2. Thus, she correctly extended the trained names to novel exemplars in 17/18 trials. BR was 25 months and 27 days old when these generalisation tests were completed.

Participant HC

HC was tested with three novel coloured objects on six separate occasions; in the final three sessions, she went on to complete listener and echoic trials as in Experiment 3. She named the novel objects correctly in 35/36 trials (i.e., her responding generalised along the domain of shape). In the test trials, that is the first trial in each session, she named the novel objects correctly in 6/6 trials for bidge and gav, and 5/6 trials of jeck. This was achieved when HC was 22 months and 12 days old.

Participant WP

WP's ability to generalise the newly trained names was tested over three consecutive sessions. The complete echo-tact procedure was repeated with novel coloured objects. In all listener-echoic-"tact" trials, she responded correctly for all three novel relations. The generalisation test trials were her responses to the first tact test in each session (i.e., prior to any training that might result from exposure to prompting in the listener-echoic-tact trials.

Recall that at the end of Experiment 4, WP did not show criterion tacting of O1. In this experiment, during the tests of generalisation to novel coloured but same shaped objects, WP responded correctly in 3/3 Test 1 tact trials of O2 — "geck" and O3 — "pab" but she was incorrect in all Test 1 tact trials of O3 — "tade". During the probes for the latter relation, she produced two "pab" responses and one "geck" response.

In Tact Test 3, in the first session, she said "pab-tade". In the second session, she responded correctly at Test 3, but she refused to answer in Test 3 in the third session. Her poor responses to the colour variant of O3 cast further doubt on the strength of the name relation O3 —"tade", which as discussed earlier may have been confounded by her generalisation of this name to all the experimental stimuli. This account is further supported by her "pab-tade" response, reported above. She was 27 months old on completion of testing.

Participant RR

To see if the newly learned names generalised to novel exemplars a test of naming of different coloured and different textured objects was conducted. In the five test trials for novel coloured objects, RR scored 4/5 for O2 — "geck" and O3 — "pab" and 3/5 for O1 — "tade". In the three test trials for novel textured objects, he scored 3/3 for each of the objects. Thus, he extended the trained names, on the basis of common shape, in 20/24 trials. He was 24 months and 12 days old.

Participant WL

WL was tested with novel coloured and novel textured exemplars of the stimulus objects employed during training. She showed shape-based extension of the names to novel coloured objects in 7/7 trials of O1 and O3 and in 6/7 trials of O2. A similar pattern was seen for the novel textured objects when she was correct in 5/5 trials of O1 and O3 and 4/5 trials of O2. She was 26 months and 9 days old.

DISCUSSION

The results of all five infants sustain the hypothesis that listener, echoic, and tact relations constitute (i.e., are necessary and sufficient for) the name relation. In Experiments 2 and 3 the children were unable to produce tact responses; that is, neither when they had learned listener relations alone (Experiments 2a and 2b), nor when they had learned echoic and listener relations separately. In Experiment 4, the infants learned to produce tact responses to 14/15 objects, by learning combined listener, echoic, and tact relations, to criterion.

Despite having learned echoic speaker behaviour and listener behaviour for three target relations, WP failed to tact all of the three objects to criterion concurrently. She was able to meet the criterion for two of the tact relations, but her previously indiscriminate production of "tade" did not give rise to tact responding for her O1 tact relation. Thus, this name relation was not established in full.

In addition, each name relation, learned by these infants in the manner described by Horne and Lowe (1996), generalised to novel exemplars of similar shape. That is, fourteen name relations were learned and all fourteen names were extended to novel exemplars of similar shape. This suggests that naming behaviour, established via the principles of learning theory, has the same linguistic properties as "a word", as defined in the developmental and psycholinguistic fields. In the generalisation test for the fifteenth (i.e., unlearned) target relation there was, as predicted by the null hypothesis, no extension to novel exemplars.

The form or shape of an object is a primary discriminatory feature, and largely, defines and prescribes its function. Markman (1993) described the two aspects of the *whole object assumption* thus: (a) the child learns that the name applies, exclusively, to one whole object, and not to a part of the object or to its colour or substance (and see Carey, 1978; Mervis, 1987); (b) having learned the name of one object, thus, the infant next learns to extend that name to other objects of similar form rather than objects which are thematically related (Markman & Hutchinson, 1984).

The experimental objects were simple polypropylene shapes that did not have greatly differentiated "parts". However, Experiment 5 presented novel stimuli of a different colour and of a different texture, and so was able to differentially test that the names were object names and that they were not based on the colour or the substance of the objects. For each infant, each novel test object was a colour that was previously used for a different trained object; for example if the trained objects were O1 — yellow, O2 — red, O3 — green then the novel objects might be O1 — red, O2 — green, O3 — yellow. Thus each tact trial, in addition to testing that name extended to novel exemplars, tested that the name was not a colour name. The substance or texture of the trained objects was similar for all the three trained objects. Thus if the name was not an object name but was a texture name, it would be expected that the infants would not be able to name the novel textured objects. There was no evidence that any of the infants consistently produced the experimentally trained names in response to similar coloured exemplars. Similarly, all the infants were able to name objects that varied in textured from the trained objects.

Thus, the generalisation test showed that when a child had learned a full name relation, the name was produced in response to similar shaped objects but not to similar coloured or similar textured objects. For Markman & Hutchinson (1984), the shape of objects is thus, the basic taxonomic classifier. However, common naming, as described by Horne and Lowe (1996) enables objects to be classified by virtue of their shape; even when the name has been experimentally controlled in such a way that it comprises one single object, naming is thus seen to be the basic classifying behaviour. In addition, naming may also allow mutually exclusive object labelling at a higher taxonomic level by providing names for discriminating colour, texture, and functional categories.

GENERAL DISCUSSION

Skinner has defined the tact as "a verbal operant in which a response of given form is evoked (or at least strengthened) by a particular object or event or property of an event" (1957, pp. 81 –82). In the sense that language is a system for communicating, tacting "permits the listener to infer something about the circumstances" (p. 83) of the speaker. In this sense, the meaning of a tact is the property or properties that give rise to its production. Skinner proposed the importance of the minimal echoic repertoire in learning speaker behaviour. However, he did not define listener behaviour as being a necessary pre-requisite of the tact relation. For Skinner, the listener was the audience whose presence may be discriminative for the emission of verbal behaviour such as tacting, and whose responses may reinforce such behaviour. Skinner's tact relation does not include the self as listener, and Skinner excluded listener behaviour from his taxonomy of verbal behaviour. In this matter, his description of the tact differs from Horne and Lowe's description of a name.

Learning to Tact

Horne and Lowe (1996) argue that a name relation arises when listener, echoic and tact behaviours are in intra-individually interconnected. The name relation, which in humans with no sensory deficits, incorporates seeing and hearing as well as saying, is described as the basic unit of verbal behaviour. This description of naming as a speaker-listener relation is an important development from the account of the tacting behaviour described by Skinner.

According to Horne and Lowe, for a child to learn the first words in his or her vocabulary requires a complex process of learning, separately, listener, echoic and tacting repertoires. However, each new name relation is constituted by the same three behaviours. Thus, with increasing experience of new name relations, economies in learning may be achieved in two ways: (a) through the extension of an echoic repertoire an infant learns to produce accurate echoic responses quickly. The highly echoic infant is then able to learn to respond to his or her own speaker behaviour as a listener, and quickly learns new name relations, which were formerly only listener relations. In addition, because of an echoic repertoire, each new listener relation becomes a new name relation. (b) The infant also learns the higher-order behaviour of how to learn names (Catania, 1998). This type of higher–order behaviour was described by Harlow (1949). In her experiment, monkeys were taught successive sets of differentially reinforced discriminations. At first there were many new things to learn about the experimental situation; and after six trials with the first eight problems the monkeys were still responding at less than 80 percent correct. However, over subsequent sets of eight problems, the learning rate increased. This is because, over the course of the whole experiment, the monkeys had learned many of the common features of the experiment; for example, there were two cups, that under one of the cups and not under one of the cups there was always food. Thereafter, the monkeys needed only to find the food (i.e., at the first or second trial) for them to respond correctly on 100 percent of subsequent trials. Thus, the monkeys had learned the higher-order searching behaviour specific to this task. Similarly infants learn the three basic behaviours in the name relation; how to look for an object in response to hearing a name, how to produce an echoic response which matches the name, and how to produce the vocal response in the presence of the object so that the object itself becomes discriminative for producing a tact response. These behaviours are learned slowly and are at first unrelated. However, with greater experience of learning names the infant learns that names, as verbal responses correspond with objects or events. Thereafter, a name may be learned when any novel verbal response corresponds with a previously unnamed object or event, in one single trial. This account explains why early vocabulary learning is slow and why there may be an exponential rise in vocabulary acquisition once the first 30 – 50 words have been learned.

This series of experiments did not sustain the assumption that in human infants stimulus equivalence is prior to language. Consequently, it could not sustain the corollary that stimulus equivalence is the basis of language. According to Saunders and Spradlin (1996), in learning corresponding listener and echoic relations, the necessary unidirectional relations exist for stimulus equivalence to be demonstrated by the "emergence" of the corresponding tact relation. If bi-directionality, or "symmetrical" responding, was genetically determined then we should have expected the infants studied here to be able to produce "symmetrical" responses without further training. This was not so. In order to demonstrate "symmetrical" responding each constituent relation of naming, that is, the listener, echoic and tact relations, had to be directly and overtly trained. This provides support for the assertion of Horne and Lowe (1996) that the circular higher-order name relation is a pre-requisite for success in tests of stimulus equivalence.

S.C. Hayes (1996) has suggested "that naming is one example of a frame of co-ordination" (p 310). He goes on to assert that none of the proposals of naming theory is incompatible with RFT, yet the reverse is not true. This is because Naming Theory, unlike RFT, provides a detailed history of the experiences required to establish the basic classifying behaviour, which RFT calls a "frame of co-ordination". However, Hayes (1996) is strangely unwilling to provide such a detailed explanation of how such a frame of co-ordination such as naming is established; he appears to prefer, as a general principle, a simpler specification, equivalence, which has not been shown to be effective without prior language development. Again, the findings of Lipkens, Hayes, and Hayes (1993) are used to claim that "symmetrical" responding is evident without naming. However, this type of "emergent symmetry" has been criticised in detail earlier, especially with regard to ensuring that the initial trained relations were, in practice, unidirectionally trained. With this consideration, when the issue of symmetry is put to one side, what does the Lipkens et al. study show other than how listener responding is learned. This issue will be discussed further in Chapter 7 *The General Discussion.*

Perhaps because of the difficulties in providing an adequate description of how humans learn language, there has been a recent move to dissociate from the assumption that there can be a continuous description of the behaviour of organisms (Barnes et al., in press). It may be that behavioural science can explain how humans behave at a higher level by appealing to the categorising behaviour of the competent language user. However, without an adequate description of how a human infant comes to be a competent language user, these theories would be built on sand. Horne and Lowe have proposed a theoretical account of how naming comes about in the human cultural environment. These experiments have substantiated their claims. Thus, unlike the proposals of RFT, they provide a fully-fledged behavioural account of how naming is learned and the experiments thus far described provide empirical support for the latter.

CHAPTER 6

ESTABLISHING NAMING WITH A SUCCESSIVE 2-STIMULUS PROCEDURE

This chapter reports and discusses Experiment 6. In Experiments 2 – 5, the infants learned to name each of three stimulus objects. In Experiment 6, by contrast, the determinants of infants' naming of each of a pair of stimulus objects was investigated. Once all training had been completed for the latter, a new stimulus pair was targetted, and so on until the experimental procedures had been implemented for several pairs of stimuli.

Horne and Lowe have stated that when an infant has learned to select a particular object upon *hearing* its spoken "name" and to *echo* the "name" while so doing, "the echoic relation serves to set the conditions for the object itself to enter into direct control of the child's verbal behavior, thereby occasioning naming" (1996, p.199). In Experiments 3 and 4, learning of the listener responses was arbitrarily separated from learning of the echoic responses in an extended experimental paradigm. Under these experimental circumstances, separately learning listener and the corresponding echoic relation did not occasion naming.

Children are not normally taught to echo in the absence of the object being named. Even so, in subsequent training phases of Experiment 4, when listener and echoic responding were brought together, many trials of echoing the auditory stimulus and then orienting to the corresponding stimulus object were needed before the object itself came to evoke a tact. For three infants in Experiment 4, echo-tact training was required over several months to establish tacting.

In order to learn to name the experimental stimuli, all the participants in Experiment 4 needed some reinforcement of their tact responses. Though contrary to the predictions of the stimulus equivalence account, the necessity of reinforcement in the development of the tact relation following training of the corresponding listener and echoic relations is not a surprising finding, within a radical behavioural framework. During "tact training" the verbal community, and in particular the primary caregiver, normally displays great delight when an infant shows any such communicative ability (Fernald, 1992; Schaffer, 1985; Stern, 1977). However, in order to show that the echoic relation is critical for the establishment of the tact component of the corresponding name relation, selective reinforcement for any correct tact responding was not available, by design, until very late in the procedure.

The long term lack of reinforcement for the infants' vocal responses during the tact tests might, albeit non-selectively, have inhibited speaker behaviour in these contexts. That is, any early vocal responses, including correct or incorrect putative tacts, may have been inadvertently extinguished. This aspect of the procedure deserves further investigation, all the more since the average age of the five infants on completion of Experiment 4 was 25 months and 24 days, by which time they had a mean productive vocabulary of 170 words. This level of language learning suggests that these infants had established higher-order naming, and once the contiguity of listener and echoic responding was procedurally established, might have been expected to rapidly learn to name the experimental stimulus objects.

In Chapter 3, it was reported that the infants in Experiment 2b were able to learn two listener relations more readily than three listener relations (cf. Devany, Hayes, and Nelson, 1986; Augustson & Dougher, 1992). To produce conditions that minimise negative reinforcement of any speaker behaviour in the tact probes in Experiment 6 listener and echoic training was conducted on only two stimuli at a time. In this way, the learning of the listener and echoic components of the corresponding name relations under investigation was accelerated, and exposure to non-reinforced tact tests was reduced considerably.

However, the reduction in the number of stimuli that must be discriminated in the training procedures raises two potential problems. First, in a 2-stimulus discrimination procedure the infant may respond correctly by chance in 50 percent of test trials; and second, having learned one of the two relations, the infant may respond correctly in tests of the second relation on the basis of exclusion or disambiguation (see Wilkinson, Dube, & McIlvane, 1996; 1998; Wilkinson & Green, 1998). This form of responding, fast-mapping, may or may not reflect true learning of the latter relation. Fast-mapping however, requires a degree of verbal sophistication; it has not been universally demonstrated in verbally able young children (Dollaghan, 1985), nor even in older language impaired participants (Wilkinson & Green, 1998).

In Experiments 2 – 4, in the 3-stimulus comparison array listener trials, the infants could select the correct object only 33 percent of the time, if they were responding purely by chance. Having learned three echoic responses to criterion, in Experiments 3 and 4, it could be argued that, in any tact probe, the infants also had a 33 percent chance of producing an experimentally trained vocalisation that matched the target tact response. When, as in Experiment 6, the chance probability of selecting the correct object or producing the correct vocal response increases to 50 percent, it becomes necessary to investigate the determinants of naming with not just one but a succession of novel stimulus pairs, in order to assess the role of chance responding in tests for "emergent" relations. Thus, in this experiment, for each infant, the procedure was successively implemented for between two and five different stimulus pairs; that is, between four and ten different target name relations.

The problem of exclusion based responding can be investigated by examining, for each stimulus pair, whether having learned the first target relation to criterion, in the multiple baseline procedure, the second target relation appears *without training* in immediately following test trials for the latter.

As an additional measure, designed to minimise any possible negative effects of repeated testing, the number of test trials per trial type was reduced (see *Procedure*) as compared with Experiments 2 – 5.

EXPERIMENT 6

METHOD

Participants

Five infants, three boys (CJ, TE and RB) and two girls (TH and HS), took part in this experiment. All were normally developing infants of middle income families and were in regular attendance at the Tir Na-n'Og nursery. Several of the infants had previously participated in an experimental procedure to maximise their phonetic repertoires. However, none had participated in any conditional discrimination procedure prior to commencing this experiment. The procedure was explained to the infants' parents; they were then free to give or withhold their consent. Written consent was given by all.

Table 6.1 shows for each infant: the age at the start of the experiment, in months and days; the preferred language of the home; and the gender. Where available the Griffiths GQs and MCDI comprehension and production vocabularies are also presented.

The ages of the infants ranged from 12 months 19 days to 16 months 18 days at the start of the experiment. Their MCDI production vocabularies ranged from 0 - 11 words and comprehension from 23 - 150 words. The Griffiths GQ was within normal limits for the four participants who were tested. CJ was not available for testing. Although the infants heard both Welsh and English when at the nursery, TE heard mainly Welsh at home whereas the other four heard mainly English. The parents of TE did not return the MCDI at this stage. They claimed that he had no productive language at the start of the experiment.

Table 6.1.
Participants' age, home language, gender, Griffiths GQ, and MCDI comprehension and production scores, at the start of the procedure.

Infant	Age in months; days	Language of parents	Gender	Griffiths G.Q.	MCDI Comp.	MCDI Prod.
TE	16;18	Welsh	Male	108	N/A	0
TH	14;05	English	Female	114	23	0
HS	14;04	English	Female	138	25	1
RB	14;00	English	Male	131	150	11
CJ	12;19	English	Male	N/A	71	4

N/A = data not available; Comp. = comprehension; Prod. = production.

Apparatus, Materials and Setting

All experiments took place in OR2, as described in Chapter 3, Experiment 2a, *Setting*, and all sessions were recorded and scored by two independent scorers; 100 percent agreement was achieved, as described in Experiment 2a, *Procedure.*

The learning criterion in this experiment was set at ≥7/8 consecutive correct responses, for both members of each pair of target relations simultaneously. At the appropriate points in the procedure, this criterion was applied to the listener, echoic, and tact relations.

The stimulus objects were chosen from a selection of small plastic objects which could be comfortably held by the infants in one hand. These are shown next to a 12" (30 cm.) ruler in Figure 6.1.

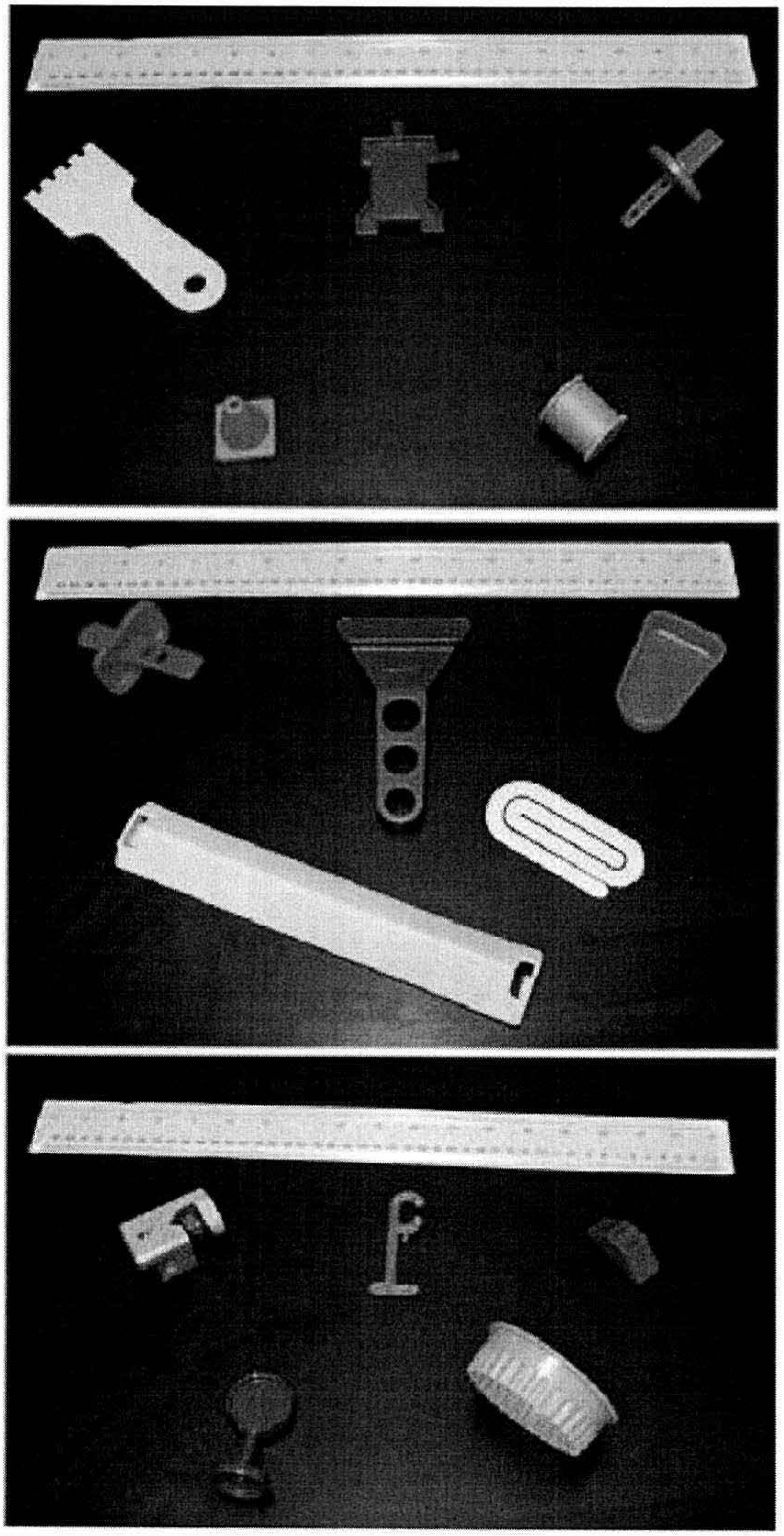


Figure 6.1 The experimental stimulus objects, shown in relation to a 12" ruler

The auditory listener and echoic stimuli were cvc(v) non-words that were chosen from the list derived in Experiment 1. As the infants were vocally immature, non-words comprised of the very first phones infants produce were chosen. For each infant, any two of the three non-words *pab*, *doot*, and *geck* were selected as the first auditory stimuli. These had the added advantage of being phonetically distinctive: the vowels are open front, open-mid front, or closed back, respectively; the consonants are labial, apical, or coronal, respectively.

In later stimulus training sets, when the infants showed evidence of a more extensive repertoire of echoic behaviour, the selected auditory listener and echoic stimuli contained a wider range of consonants. They were also derived from the set of phones initially identified in Experiment 1.

Procedure

There were five stages to Experiment 6. These corresponded to those successively developed and employed in Experiments 1 - 5, respectively.

In Stage 1, whilst the infant was becoming familiarised with the experimental setting, all vocalisation was reinforced. A phonetic inventory of each infant's speech sounds was recorded to ascertain that each participant could produce the range of phones used to create the non-words in Experiment 1.

In Stage 2, the infants were taught to respond as listeners to each of two non-word auditory stimuli.

In Stage 3, the infants were taught to respond echoically to the same two auditory stimuli.

In Stage 4, the listener and echoic responses were procedurally brought together, in order that the participant echoed while orienting to the corresponding object.

Finally, in Stage 5, generalisation of naming was tested.

Subsequent Pairs of Name Relations

Training of the Set 1 relations was terminated as soon as criterion tacting emerged.

In subsequent stimulus training sets, all the infants received listener training for each subsequent pair of name relations, beginning at Stage 2, Step 5, pairwise discrimination of novel stimuli. If tacting did not emerge when listener responding was demonstrated to criterion level, Stage 3 was implemented. However, if tacting appeared to be increasing during the Step 1 baseline echoic trials, the Step 2 intervention was not implemented.

The Stage 3, Step 2 intervention, of reinforcement of echoing, was implemented if echoing remained below criterion following baseline echoic trials.

The Stage 4 training was implemented in subsequent pairs only when listener and echoic responses were at criterion and there was no evidence of tacting.

The Stage 5 testing was conducted for each pair of subsequent name relations in one of two conditions: (a) immediately after learning one pair of name relations, and again after the infant had learned all the pairs of name relations; or (b) only after learning all pairs of name relations to criterion.

Stage 1: Recording the Phonetic Repertoire

The experimenter had been a frequent visitor to the nursery in the course of her earlier research, and, as such, was known to all the infants. Several of them had previously participated in a similar procedure to maximise phonetic production. To acquaint the participants with the experimental setting, they each took part in a number of familiarisation sessions. In these they were gradually introduced to the room, and to the highchair and baby harness. While they were in the observation room, they played with a number of toys suitable for their age. During play, each infant's vocalisations were reinforced by praise and imitation. A video recording of the familiarisation sessions was made. Using a phonetic inventory sheet, all the identifiable phones produced by each infant were noted using a tick system. In this way a phonetic inventory was accumulated for all the infants. The inventories so derived are recorded in *Appendix 1.*

For each infant, the familiarisation sessions continued until all the phones, of which the early non-words were comprised, had been observed. Confirmation of the required phonetic repertoire was obtained within 2 - 9 such sessions.

Stage 2: The Listener Training

The procedure is described for the first pair of listener relations. In subsequent stimulus training pairs, the Steps 1-4 were omitted.

Step 1. First, the infants were taught to give and take one familiar object, as described in Experiment 2b. This was to ensure that they could respond to the instructions employed during the listener trials. Once again, the ball or the roller was used as a familiar non-experimental object. One of the aforementioned objects was rolled towards the participant, who was then asked by the experimenter to return it, saying, for example, " Where is it? Can I have it? Give it to me?" All giving behaviour was reinforced. This step continued until the infant could give the familiar object on request in ≥7/8 consecutive trials.

Step 2. The infant was taught to select a named object by its familiar name (e.g., "sailor sam", from an array of two objects which were to be targetted using their familiar names (e.g., sailor sam and teddy). The number of trials per session varied according to the complicity of the participant, however, all named and unnamed trials were randomised and counterbalanced. The infant was asked to give one object by name, for example, "man, man, where's the man?". The unnamed object was requested using the term "that one". Again, training continued until a criterion of ≥ 7/8 correct consecutive responses for the target object was demonstrated.

Step 3. The infant was taught to select the second, now also named, object in a similar manner as for the first. There were four pairwise discrimination trials in each session, two for each listener relation. Only the first trial of each listener relation was the test trial. The second trial, per trial type, was given to control for position bias: each object was presented in the left of midline position, and in the right of midline position, in every session. The position of the target object in the test trial, left or right of midline, was quasi-randomly varied, as was the order of presentation of the listener stimuli. All correct responses were reinforced. A criterion of ≥7/8 correct responses in accord with each familiar listener relation was required.

Step 4. When listener relations for the two familiar objects had been demonstrated to criterion, the first novel experimental stimulus object was substituted for one of the familiar objects, and this listener relation was trained to a criterion of ≥7/8 consecutive trials. Again, there were two counterbalanced listener trials for the familiar object and two for the unfamiliar object in each session.

Step 5. Finally, the second novel experimental object was substituted for the latter familiar object and the corresponding listener relation was trained as described in Step 3, to criterion.

Testing Listener Relations

During the preliminary training, using the familiar stimuli, there were no probes for the tact relation. The tact relation was probed before and after the listener trials in which both experimental stimuli were presented.

The Tact Test 1. The tact responses were probed in respect of each stimulus object. All other objects were removed from the table and one of the stimulus objects was offered to the infant in the give and take method, as described in Experiment 2b. The experimenter asked, "What's this, what is it, what's this?" She allowed a five second response period before taking back the object and placing it out of sight. The trial was terminated after the five second response period had elapsed, or if the infant made a response, matching or otherwise, at any time during the probe. This single tact probe was introduced in order to minimise the number of unreinforced test trials per session (i.e., that were not scheduled for delivery of contingent reinforcement).

The second stimulus object was presented and the tact response probed in the same way. No reinforcement of vocal responses was available. The order of presentation of the stimuli during the tact tests was randomly varied across sessions.

The Listener Test. This was conducted in the manner described in Step 5 of the listener training. The stimulus objects were placed equidistantly one on either side of the midline of the table in such a way that either object could be touched by reaching but both objects could not be reached at the same time. Each stimulus object featured in two trials to the left and two to the right of the midline; this applied both in trials when it was the target object, and in trials when it was the comparison object. The first response in respect of each trial type was the test trial. An example of the four types of trial conducted in every session is shown in Figure 5.2.

The criterion for having established the two listener relations was ≥7/8 correct responses for both listener relations in one block of eight trials. On attaining the criterion the infant progressed to the Echoic Training Stage.

The experimenter recorded whether or not each participant echoed the auditory stimulus in each trial; the number of echoic responses per trial was not scored, since any echoics greater than one were classed as self-echoics or echoic perseverations.

The Tact Test 2. This was conducted in the same way as the Tact Test 1.

Stage 3: The Echoic Training Stage

In the echoic training stage the Tact Test 1, the Listener Test trials, and the Tact Test 2 were conducted as in the listener training stage. These trials were followed by the echoic training trials and a further tact test. Thus at each session, tact responses were probed before and after listener trials and after echoic trials.

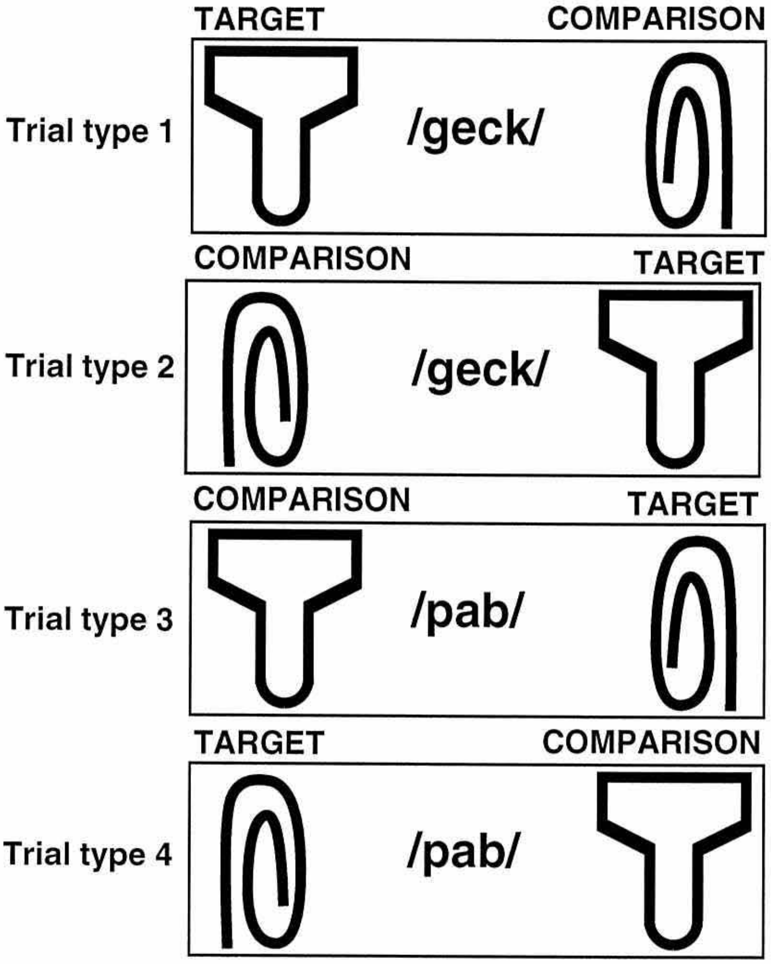


Figure 6.2 An example of the four types of listener trial conducted in each session. In this example, only Trials 1 and 3 would be scoring trials.

The Echoic Training. This consisted of two steps. In Step 1 responses to echoic probes were not reinforced. In Step 2 matching responses during the echoic probes were reinforced in accordance with the multiple baseline procedure.

Step 1. In the absence of the stimulus objects, each auditory stimulus was modelled and echoic responses were probed. For example, in the case of the target echoic responses "pab" and "geck", the experimenter said, "*Name* can you say pab?" After five seconds she then sang or recited the verse: "Pab, pab, can you say pab, dolly says can you say pab? Pab, pab can you say pab, dolly says can you say . . . ? . . . Pab!"

Five seconds later, this was followed by a further probe, "*Name* say pab." The same procedure was then followed for the echoic response "geck". When the infant produced a matching vocal response contingent upon the auditory stimulus, this was scored as an echoic response. In this experiment, in each session, the presentation of echoic probes was terminated when a response, whether matched or mismatched, was produced. Thus if the child produced a vocal response after the first probe the song probe was not presented; if he or she responded after the song, the third probe was not presented. The first vocal response, in the scheduled succession of echoic probes, in respect of each echoic relation was the scoring response. Thus the scores indicate whether, given a maximum of three echoic probes, the infant produced one response in respect of each of the echoic relations per session. The aim here was to reduce the number of echoic probes per session to the minimum necessary for the production of one vocal response, whether correct or incorrect, per echoic relation in each session.

In the Step 1 baseline condition, no reinforcement for echoing was provided. A baseline echoic response rate was established over one block of eight experimental sessions. However, in later sets, the baseline stage was extended if tact responding was becoming evident.

Step 2. The first intervention, reinforcement of echoing, was made available for echoing of one echoic relation only. The second echoic relation continued to be probed without reinforcement in the same way as in the Step 1 baseline condition. A block of eight sessions was conducted in this way. There were thus eight reinforced trials for the first echoic relation and eight unreinforced trials for the second echoic relation. This procedure continued, in blocks of eight trials, until there was evidence that the first echoic relation had reached criterion (≥7/8 correct echoic responses over consecutive sessions).

The intervention was then extended to the second echoic relation. In this condition reinforcement of echoing of the first echoic relation was continued as before.

Echoing was deemed to have been established if it was in evidence for each of the auditory stimuli in ≥7/8 trials in one block of eight sessions.

The Tact Test 3. This was conducted in the same way as the Tact Tests 1 and 2.

Stage 4: Bringing together the Listener and the Echoic Behaviours

If, having separately established listener and echoic relations, there was no evidence of tacting to criterion, a further multiple-baseline intervention of echoing whilst acting upon the referent was introduced, as in Experiment 4, Stages 2 - 4.

The session began with a tact test for each stimulus object (as described above).

Next, a probe for one listener relation, for example */pab/* — O1 was made, but once the correct referent was selected the subject was immediately prompted to echo its name. For example:

"Pab, pab, give me the pab. That's right good girl. Pab, pab can you say pab". This was followed by a counterbalancing trial in which the same stimulus object was placed in the alternative location (right or left of midline) and a further combined listener-echoic trial was conducted. Any echoic response made during these combined listener-echoic trials was scored as such. As there was no opportunity to test the tact relation between the listener trial and the echoic trial, the second tact probe was omitted during such listener echoic trials in Stage 4.

This was followed by two trials of the alternative listener relation, for example, */geck/* - O2, one to the right and one to the left of midline. These were completed and the stimulus objects removed from view prior to probing for echoing of */geck/* in the absence of O2. The final probe for tacting, Tact Test 3, was conducted in the usual way.

One block of eight sessions was conducted in which the listener-echoic intervention was implemented for the first echoic relation only. After these eight trials the intervention was extended to the second listener-echoic relation. Thus reinforcement for correct responding was not criterion led in this experiment. Each intervention was introduced as early as possible, following assessment of the baseline response frequency, in order to avoid the negative consequences of zero reinforcement seen in Experiments 3 and 4.

The listener-echoic procedure was continued, in blocks of eight trials, until responding at Tact Test 1 reached the criterion of ≥7/8 consecutive correct responses for each target relation. The Tact Test 1 was deemed to be the criterion test because it was conducted, for both tact relations in every session, before the infant was exposed to either of the auditory stimuli employed in the experimental procedures.

Generalisation of the newly trained names to novel exemplars

On learning the name relations to criterion, a test was conducted to see whether the newly trained name relations would generalise to objects that were similarly shaped but differently coloured or textured. There is much documented evidence to suggest that young children generalise names to new objects of similar shape, only later learning to generalise names on the basis of function (e.g., Gathercole, Cramer, Somerville, & Jansen op de Haar, 1995; Landau, Smith, & Jones, 1998). It would therefore be expected, if the infants in Experiment 6 had learned novel name relations as a consequence of learning listener and tact responses to criterion, that the names would extend to novel exemplars on the basis of shape. Thus, the infants' experimentally established tact responses were tested with objects they had never seen before, to test whether they would generalise on the basis of shape, or some alternative feature.

Generalisation tests were conducted, for some infants, after the first pair of names had been trained, and for all infants, after the individually assigned stimulus pairs had been named. To ensure that all the trained names were maintained during training of subsequent sets intermittent tact tests, for previously trained sets, were conducted throughout the period of training for three of the four infants. The fourth infant (RB) was not tested for the previously learned relations until he had learned to tact five pairs of stimuli. On testing for tacting of the ten stimuli, his responses fell below criterion. Thus they were minimally retrained until criterion responding was re-established.

The maintenance tact tests and the generalisation tests took the same form, except that the maintenance tests used only the trained objects, whereas the generalisation tests employed only the novel exemplars. This is reported, as applicable, in the individual results section.

The Generalisation Test.

Novel variants of all the experimental objects, that is, those which had been trained to criterion at the time of the test, were presented for naming. The manner in which the novel object varied from the trained object was constant in each test. Thus if the first trial was to name a colour variant of O1, for example, then the second trial was to name another colour variant (e.g., of O3), and so on until all the trained names had been tested with a colour variant. Similarly, if the first trial was a texture variant of O1, then the second trial was another texture variant of (e.g., of O2), and so on. One tact trial of each texture and/or colour variant was tested. There was no reinforcement scheduled for matched responding.

Several scenarios were available for disclosing the object to be named. Prior to presentation it was hidden in a box, or under a cloth, or in the sleeve of the experimenter. The experimenter hid the object to be named wherever she had learned that the infants would show interest. The infant was encouraged to "discover" and explore the new object while the experimenter probed "What's this? What is it? What's this?" Following a vocal response by the infant or after a five second response period had elapsed, the experimenter held out her hand for the object to be returned. The first object was removed and a novel variant of the second trained object was presented. Novel exemplars of all the trained objects were presented in this way. Thus, in the final generalisation test, two infants were presented with ten, one was presented with six, and one was given four novel objects to be named. This constituted one trial of each generalised name relation.

The infant was then allowed to play with non-experimental toys for a period of several minutes. Typically this play period involved an activity book in which stickers could be placed to reflect the storyline. The experimenter would then read the corresponding section of the story to the infant. After approximately five minutes the generalisation test could be repeated. Thus it was possible to present several generalisation trials of each name relation in one session. However, if the child became distressed or showed any indication of reluctance to participate, the test was discontinued. A further sticker interlude was given and then the session was terminated. Thus, for all infants, the generalisation test was conducted over several experimental sessions. If the inter-session period exceeded one week, maintenance trials were conducted before continuing with the generalisation trials.

Learning Serial Pairs of Names

RESULTS

Participant TE

Set 1.

TE began Stage 1 of the experiment when he was 16 months 9 days old. He was already familiar with the experimenter and the experimental setting from an earlier study, which assessed his phonetic repertoire when he was between 10 and 13 months old, (see *Appendix 1*). One re-familiarisation session was conducted, during which TE's phonetic repertoire was re-assessed (see *Appendix 1*). All the target phonemes were in evidence; however, it was observed that he was very shy, and frequently he spoke through clenched teeth, such that, on these latter occasions, the front vowels were retracted towards the centre. To maximise the difference between the vowel sounds in TE's production repertoire, the non-words pab and doot were selected as auditory stimuli. The stimulus objects were a 14 cm x 5 cm yellow adhesive spreader (Figure 6.1 upper panel) and a 11 cm x 4 cm large blue paper clip (Figure 6.1, centre panel).

As TE attended the nursery on only two days in each week, several sessions were conducted each day. Between each session, TE returned to his nursery group and participated in routine nursery activities, meal-times or sleep periods. The inter-session interval was typically in excess of 60 minutes and was never less than 30 minutes.

TE was over 16 months old and could readily give familiar objects on request. Stage 2, Step 1 listener training began on the first and next two sessions; TE gave (on the request "Give it to me?") six different objects presented in random order on 25/25 trials. The trials were as follows: Session 1 — four trials of ball; Session 2 — four trials of token, four trials of ball; Session 3 — two trials of ball, four trials of roller, 4 trials of brick, one trial of teddy, two trials of sailor sam. Thus, he had given a different object on the first trial it was requested in 8/8 trials. Step 2 was, therefore, omitted.

In Step 3, the familiar objects, teddy and sailor sam, where presented in 16 pairwise trials, over the next three sessions, until seven consecutive correct responses were obtained. He was correct in 14/16 Step 3 listener trials; that is, 7/9 trials of teddy (i.e., he was wrong on the first two trials) and 7/7 trials of sailor sam.

Only three trials of Step 4, the mixed familiar and novel trials, were conducted at this stage (but see later retraining). He was correct in three trials where pab was the target and teddy was the distracter. This stage was not completed at this point, due to experimenter error. However, the stage was complete in full at a later date (see below).

Step 5, pairwise discrimination of two novel stimuli, began when he was 16 months 25 days. Six training sessions were conducted during which the auditory stimuli */pab/* and */doot/* were both introduced. Eight test trials were conducted in these sessions (in two sessions a repeat test trial was conducted after a short interlude). He responded correctly in 7/8 test trials of */pab/* — O1, and 7/8 trials of */doot/* — O2; in total he produced 21/33 correct responses to */pab/* — O1, and 28/35 correct responses to */doot/* — O2. Unprompted echoing of both listener stimuli was evident in this block of trials. He echoed */pab/* in four sessions and */doot/* in all six sessions.

TE became upset and eventually cried every time he heard */doot/*. Consequently, a new auditory stimulus, */geck/*, and a new stimulus object, a 8 cm x 4.5 cm red ice lolly holder (Figure 6.1, upper panel) were employed. Pairwise discrimination training with these stimuli began when TE was 17 months 9 days old. In the following eight sessions, TE received Step 5 listener training only. His first responses were correct in 8/8 trials of */geck/* — O1, but in only 3/8 trials of */pab/* — O2. Over the eight sessions he responded correctly in 51/62 (mrr = 0.82) trials of */geck/* — O1 and 42/65 (mrr = 0.65) trials of */pab/* — O2. Unprompted echoes of */pab/* were observed in two sessions and of */geck/* in four sessions.

Listener *testing* began in Block 2, when TE was 18 months 6 days old. During this stage, tact tests were conducted before and after the listener training trials, see *Procedure*. Four blocks of listener training were conducted before he responded, to criterion, to both listener relations simultaneously. Following a short holiday, there was a period of eight sessions, when TE showed reluctance to respond. This occurred between Blocks 3 and 4, when he was 19 months 8 days old. To re-establish conditional discrimination, a period of Step 4 training was instigated; that is, learning to select only one experimental stimulus paired with a familiar object. Thus Step 4 training was completed at this point. During this period he experienced 6 pairs of counterbalanced trials of */pab/* — O2 when teddy was the non-target comparison. He responded correctly in 12/12 trials. Similarly he was correct in 12/12 trials for teddy when O2 was the non-target comparison.

Following these Step 4 trials he had two pair of trials of */pab/* — O2 when O1 was present but never requested, he responded correctly in 4/4 trials. Similarly, on the following session, he had 4 trials of */geck/* — O1 when O2 was the non-target and never-requested comparison, but he responded correctly in only 1/4 trials. During this period he produced two unprompted putative echoic "pab" responses, and two putative "pab" tact responses.

Table 6.1.1

The number of correct listener responses (numerator) and listener trials (denominator) for each type of listener trials during the Set 1 listener training stages. The target relations are shown in bold type.

Listener Relation	*/pab/* **O2** v teddy	*/pab/* **O2** v O3	*/doot/* O2 v **O3**	*/pab/* O1 v **O2**	*/geck/* **O1** v O2
Training	15/15	21/33	28/35	96/141	106/140
Testing				34/40	29/40
Total	15/15	21/33	28/35	130/181	135/180
mrr	1	0.64	0.8	0.72	0.75

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Pairwise discrimination of the experimental objects was resumed when he was 19 months 25 days old. Table 6.1.1 specifies the number of listener training and testing trials experienced by TE, prior to establishing the Set 1 listener relations to criterion.

TE's responses to the tact tests, listener test, and echoic training trials, during the Set 1 training, are shown in Figure 6.1.1.1. The first response in respect of each relation in each session, that is, the test responses only, are shown. The first listener trial in respect of each target relations was deemed to be a test trial because the response was made, in each session, prior to delivery of the CSG_R. In Blocks 1 – 5, TE's listener responses reached the required response rate for each relation, separately, before he demonstrated the criterion for both relations, simultaneously, in Block 5 (see Figure 6.1.1.1). In sum (i.e., including the counterbalanced and subsequent training trials) he produced 135/180 (mrr = 0.75) correct responses to */geck/* — O1 and 130/181 (mrr = 0.72) correct responses to */pab/* — O2, during these 40 sessions.

In Block 2, TE's *unprompted* echoic responses during the listener trials were at the criterion for echoing for both echoic relations (see Figure 6.1.1.1). After Block 2, the frequency of unprompted echoic responses decreased. By Block 4, he was producing unprompted matched echoic responses in only two of the eight listener trials. This frequency was not exceeded in the following blocks of trials. Thus, for both target relations, there was strong evidence of unprompted echoing during listener training.

Figure 6.1.1.1 shows that there was no evidence of tacting during Blocks 1 – 5, the period of listener training. In the Tact Test 1, which was the criterion test, he produced 5/40 matched responses for O1 and 4/40 responses for O2. In the Tact Test 2, he produced 1/40 matched responses for O1 and 5/40 matched responses for O2. These responses were well below the criterion for tacting. Thus there was no evidence of tacting.

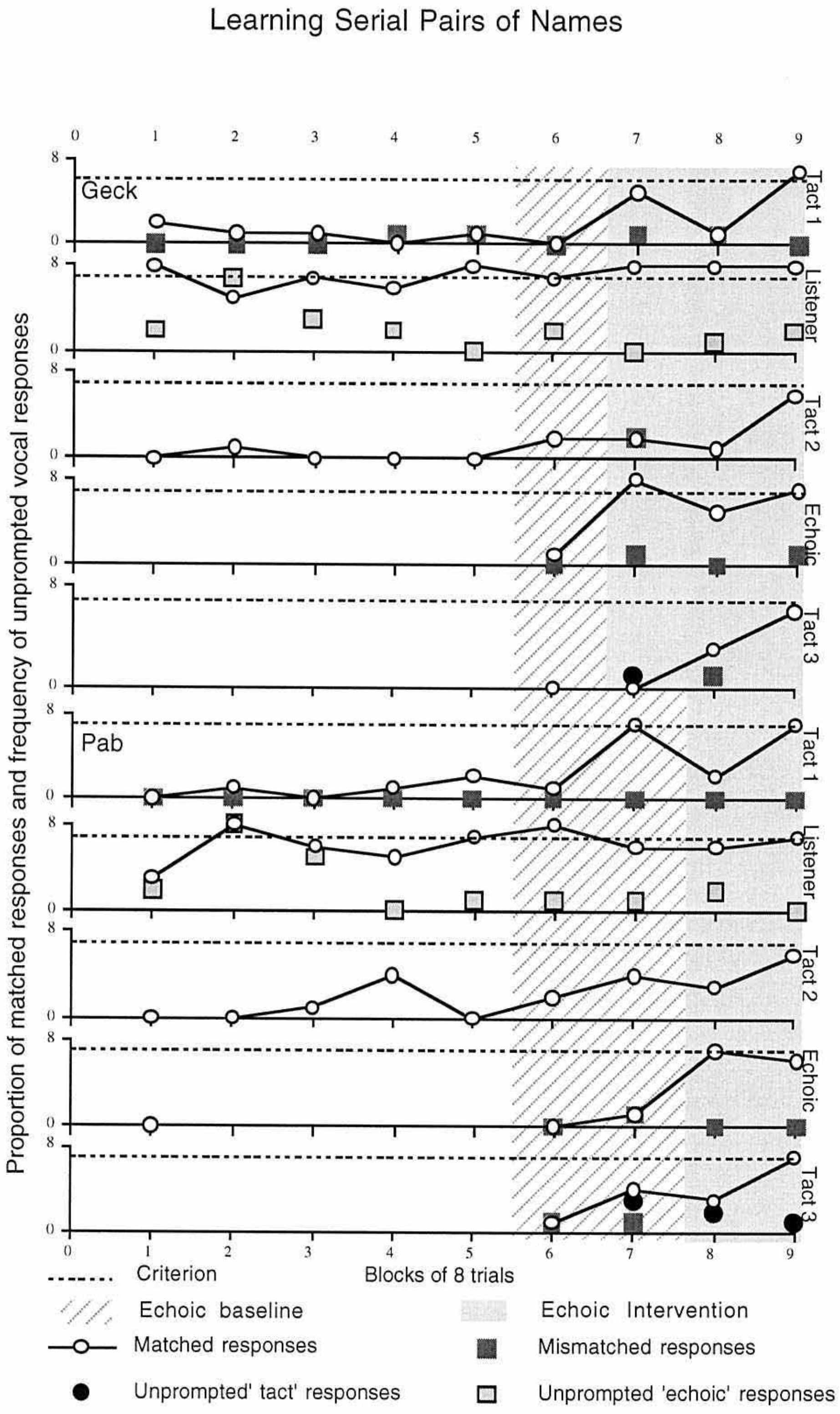

Figure 6.1.1.1 The proportion of TE's (Set 1) matched responses in the tact and listener test trials and the echoic training trials; mismatched tact and mismatched echoic responses are shown in the corresponding tact and echoic sections (labelled on the right axes); unprompted echoic responses are shown in the listener sections; unprompted putative tact responses are shown for each block of trials in the Tact 3 sections.

Baseline echoic training began in Block 6, and the intervention was implemented for the first echoic relation */geck/* — "geck" in Block 7, and the second echoic relation, */pab/* — "pab" in Block 8. In Block 6, in the baseline echoing condition, there was no evidence of echoing when it was probed under unreinforced conditions. Responses in the Listener Test and in all the Tact Tests were unchanged (see Figure 6.1.1.1).

Echoing of */geck/* was reinforced in Block 7, and TE demonstrated this echoic relation to criterion within eight trials (see Figure 6.1.1.1). He made one mismatched response during the echoic trials of */geck/*, this was produced after the matched echoic response in Session 6. He produced only one matched echoic response to */pab/* in this block, and he also produced one mismatched response during the */pab/* trials. Thus with no reinforcement for echoic responding to */pab/,* his responses to probes for the latter relation remained infrequent.

Nonetheless, there was a marked increase in the number of matched responses for both tact relations, not only in the Tact Test 1 but also in Tact Test 2 (see Figure 6.1.1.1). In the criterion Tact Test 1, he produced matched responses to probes for O1 — "geck" in 5/8 trials and made one mismatched response. For O2 — "pab" he was correct in 7/8 trials and made no mismatched responses. Thus reinforcing responses for only one echoic relation is not correlated with correct responding in the second *echoic* relation, but appears to have increased the probability of emitting appropriate speaker behaviour in the unreinforced *tact* trials, for both target relations.

In Block 8, reinforcement was given for echoing both */pab/* and */geck/*, and echoing of */pab/* was demonstrated to criterion. This gives support to the hypothesis that echoing may have been established in the listener trial context during Block 2 but, that this learning was not extended to the echoic trials because it was not reinforced in the latter context, whereas it may have been adventitiously reinforced in the former by virtue of its contiguity to the reinforced listener responses. There were no mismatched responses to probes to echo */pab/* or */geck/* in this block. However, responding to */geck/* was heard in only five of the eight echoic trials. In contrast to the criterion tact responding for O2 — "pab", and close to criterion responding for O1 — "geck", in the previous 8-trial block, there was no evidence of tacting for either target relation during Block 8.

Criterion tacting was demonstrated, for both target relations, in Block 9 (see Figure 6.1.1.1). Responding rose to at, or close to, criterion in all three tact tests in Block 9.

Generalisation

A test of generalisation to four novel variants, two of different colour and two of different texture (as described in Chapter 5, Experiment 5) was made over the next five sessions. There were five presentations of each novel colour variant and four presentations of each novel texture variant. The texture variants were not presented in the first session. TE correctly named a colour variant of O1 in 5/5 trials and the texture variant of O1 in 4/4 trials. He correctly named a colour variant of O2 in 4/5 trials, and a texture variant of O2 in 4/4 trials. His overall score of 17/18 (mrr = 0.94) demonstrated that TE's responding generalised on the dimension of shape, an outcome that psycholinguists would interpret as "context-free" naming, at 22 months and 12 days.

Summary

TE began the experiment at 16 months 9 days and following one familiarisation session and the preliminary conditional discrimination Steps 1 – 4, he experienced one block of eight pairwise discrimination trials with the listener stimuli */pab/* and */doot/*. He started listener training with the listener stimuli */geck/* and */pab/* at 17 months 9 days and had learned both listener relations to criterion at 20 months 9 days. There was evidence of TE having learned to echo in the listener trial context, but there was no evidence of tacting from this training alone. Echoing was trained in the absence of the stimulus objects and was seen to reach criterion for each relation in the block in which the intervention was implemented. Tact relations (and listener relations) for both stimuli were demonstrated to criterion at 22 months 4 days. Following a test of tact generalisation to novel objects, which differed from the trained stimulus objects in colour or texture, the name relations generalised on the basis of shape.

Set 2.

TE began learning the Set 2 target relations at 22 months 17 days. The auditory stimuli that featured in the listener and echoic components of the two target relations were */doot/* and */zog/*. The stimulus objects were a 14.5 cm x 11 cm red adhesive spreader (shown in Chapter 3, Figure 2b.1) and a 9 cm diameter x 3 cm high green jelly mould (shown in Chapter 3, Figure 2a.1) respectively.

As pairwise discrimination had featured in the Set 1 relations, listener training for the Set 2 relations started at Stage 2, Step 5, the listener test stage. Learning two further listener relations required six 8-trial blocks of training. In total, during the 48 listener training sessions, he produced correct listener responses in 95/118 (mrr = 0.8) trials of */doot/* — O3 and in 88/119 (0.74) trials of */zog/* — O4. His responses during the Set 2 training are shown in Figure 6.1.2.1.

During the listener training period tact responding was not in evidence. In the criterion Tact Test 1 he produced 4/48 (mrr = 0.08) matched responses to probes for O3 — "doot" and 2 mismatched "zog" responses; in Tact Test 2 he produced 7 matched responses in 48 trials (mrr = 0.15). For the tact relation O4 — "zog" he produced one matched response in the 48 trials (mrr = 0.02) in the criterion Tact Test 1, and 4/48 (mrr = 0.08) matched responses in Tact Test 2.

Unprompted "echoing" was observed in the listener trials; this was particularly so for "doot". He produced 16 matched "echoic" "doot" responses in a total of 56 listener trials of */doot/* — O3; however, he produced only one matched "echoic" zog response in the total 56 listener trials of */zog/* — O4. Neither response rate reached the criterion for echoing in any block of listener training trials.

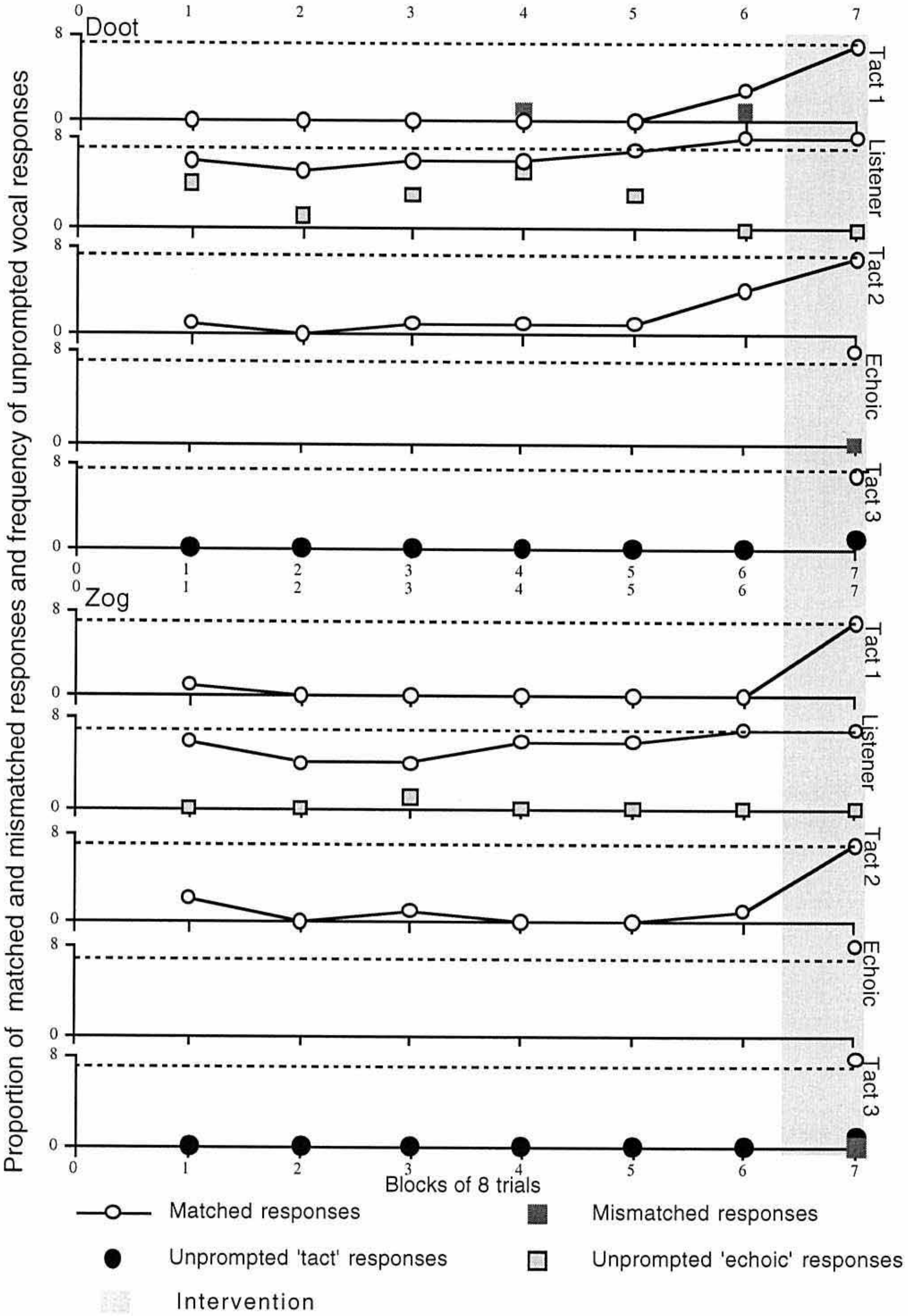

Figure 6.1.2.1 The proportion of TE's matched responses in the tact and listener test trials and in the echoic training trials for the Set 2 target relations. Mismatched tact and echoic responses are shown in the corresponding tact and echoic sections; unprompted echoic responses are shown in the listener sections. Unprompted putative tact responses are shown for each block of trials in the Tact Test 3 sections.

The echoic training for Set 2 began when TE was 24 months 27 days old. The multiple baseline intervention was not implemented for this set of target relations. One block of 8 trials was conducted, in which, contrary to the scheduled procedure, echoing of both auditory stimuli was unwittingly reinforced. During this block of trials echoing was demonstrated to criterion for both target relations. In the Tact Test 1 trials preceding each of the latter echoic trials, TE also showed criterion responding.

There was evidence of a change in his responding for one tact relation in Block 6, when the listener relations were demonstrated to criterion but before echoing was directly prompted. In this block, he produced three matched responses and one mismatched response in Test 1, and four matched responses in Test 2, for O3 — "doot". However, there was no corresponding increase in responding to O4 — "zog"; he produced only one matched response in this block, in Test 2. Interestingly, while his unprompted echoing of the */doot/* listener stimulus was frequent it was virtually non-existent during the */zog/* listener trials.

Tacting to criterion, that is ≥7/8 consecutive matched responses for both relations simultaneously, was demonstrated in Block 7. This was immediately after reinforcement for responding was made available for both echoic relations.

TE's responses in the final two blocks (Blocks 6 and 7) are shown session by session in Figure 6.1.2.2. There was evidence of tact responding in respect of each stimulus object, prior to probing for the echoic relations. Responding began to "emerge" in Tact Test 2 for the O3 — "doot" relation in Session 5, that is, following the corresponding listener trial. Tacting began to appear in the criterion Tact Test 1 in Session 6, and, thereafter, was demonstrated to criterion. Similarly, responding to O4 — "zog" first appeared in Tact Test 2, in Session 7. Tacting of O4 at the criterion Test 1 appeared in Session 9, and, again, was demonstrated to criterion thereafter. Although unprompted echoic responses had been made in earlier listener trials in respect of each target relation, there was no evidence of overt echoing in the last 16 sessions, when listener responding was at the criterion level.

One cannot exclude the possibility that TE was covertly echoing the auditory stimuli in the listener trials. The disappearance of unprompted vocal responses in the listener trials suggests, in the absence of a reinforcing contingency for vocal responding in this situation, that hearing the auditory stimulus did not set the occasion for echoic responding. However, when tacting was probed after the listener trials he was directly requested to produce a vocal response. The power of such a request to evoke a vocal response under these circumstances can be seen from his production of a mismatched response in Session 4, and from his subsequent matched responses. Clearly, once the listener relations were finally established tacting quickly followed.

TE's responses to the echoic probes, from Session 9 onwards, show that he had the necessary minimal echoic repertoire to echo each of the target auditory stimuli to criterion. On re-examination of the video recordings, it was found that TE's echoic responses had been subtly reinforced, even though this series of eight sessions should have constituted the baseline echoic trials. This may have been sufficient to sustain his production of matching tact responses in the tact tests.

Summary

The Set 2 listener relations were not acquired more readily than the Set 1 listener relations; TE required six blocks of training before he was able to demonstrate the required criterion, at 24 months 27 days. Learning the listener relations to criterion did not lead to criterion echoing of the auditory stimuli in the listener trials, or to tacting of the corresponding stimulus objects in the tact tests. Unprompted echoing of */doot/* occurred at a high level during the listener training for the latter relation, and, interestingly, correct responding in the tact test for this target relation began to emerge just prior to scheduled echoic training.

There was no multiple baseline intervention of echoing in this set. Echoing was reinforced for both echoic relations simultaneously without any unreinforced baseline trials. Within one block of reinforced echoing, both echoing and tacting were

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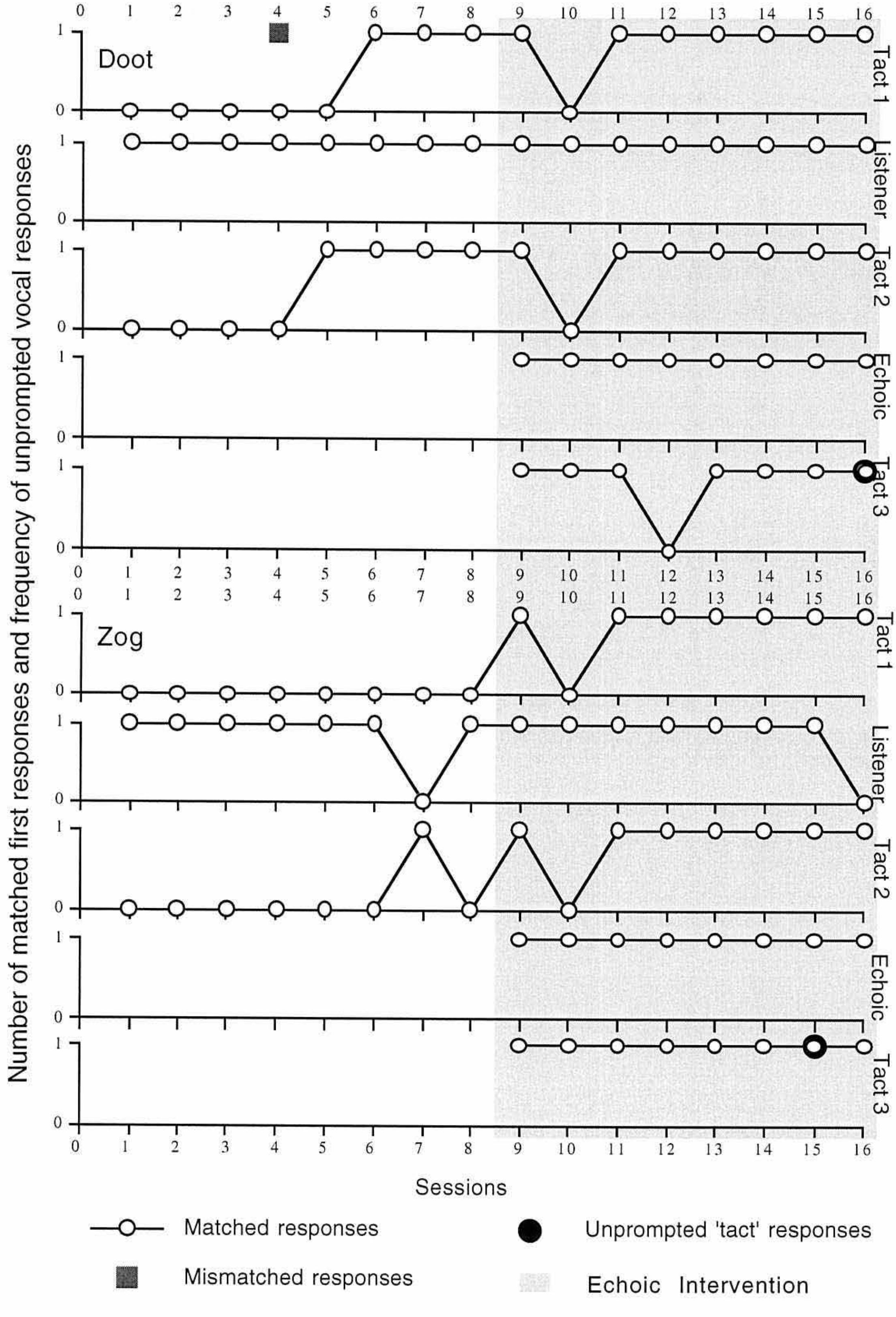

Figure 6.1.2.2 TE's responses in the last 16 sessions of the Set 2 training.

demonstrated to criterion. Thus by 25 months 5 days, TE had learned four novel name relations.

Maintenance of the Set 1 Tact Relations

During the course of Set 2 training, intermittent tact tests of the Set 1 stimuli were conducted. In four sessions, TE was probed for a tact response to the trained stimulus pair, to a corresponding pair of colour variants and to a corresponding pair of texture variants. In one session he was probed for tact responses in respect of the trained stimulus pair and a corresponding pair of colour variants. In the remaining trials, the tact relations for the trained stimuli only were probed.

TE produced matched responses in 29/32 (mrr = 0.91) trials of O1, and in 29/32 (mrr = 0.91) trials of O2. He responded correctly in 5/5 trials of a colour variant of O1 and in 4/4 trials of a texture variant of O1; similarly he produced 5/5 matched responses to a colour variant of O2 and 3/4 matched responses to a texture variant of O2. Thus he showed strong evidence of having maintained the Set 1 tact relations.

Set-3

The auditory stimuli for this pair were initially */bidge/* and */tade/*. */Tade/* was later replaced by */ditta/* because of the similarity between tade and the Welsh word *taid* (grandfather). The stimulus objects were a 8 cm x 5 cm x 1.5 cm orange ice lolly mould (see Figure 6.1, centre panel) and a 8 cm x 6 cm blue piece of a construction toy (see Figure 6.1, upper panel). The lolly mould was replaced with a 8 cm diameter x 3 cm high orange pastry cutter (see Figure 6.1, lower panel).

At 25 months 11 days, TE began learning a third set of name relations. Once again, listener training started at the Stage 2, listener test stage. Figure 6.1.3.1 shows that both of the listener relations, */bidge/* — O5 and */tade/* — O6, were established to criterion within one block of listener training. He responded correctly in 14/16 (mrr = 0.88) trials of */bidge/* — O5 and in 16 /16 (mrr = 1) trials of */tade/* — O6.

Echoic training began when TE was 25 months 18 days old. In the first block of eight trials only the echoic relation */bidge/* — "bidge" was probed; correct responses were reinforced, and responding was at criterion. This was followed by a further block of eight trials when both */bidge/* — "bidge" and */tade/* — "tade" echoic relations were probed and reinforced, and during which, the latter target relation reached criterion.

Echoing to criterion was established in respect of each echoic relation within one 8–trial block when TE was 26 months 15 days old (see Figure 6.1.3.1). This suggests that these non-words were within his minimal echoic repertoire. TE learned the name relation, O5 — "bidge", when the comparison was O6; that is, the tact relation, listener relation and the echoic relation were all demonstrated to criterion level in Block 3 (see Figure 6.1.3.1). There was some evidence of unprompted "echoic" responding to both listener stimuli during Block 1 listener trials. Under conditions of reinforced echoing of */bidge/* in Block 2, unprompted echoing continued to increase and was heard in 5/8 trials in Block 3. The production of reinforced echoic responses in the echoic trials and possibly adventitiously reinforced unprompted putative "echo-tact" responses, in the listener trials was sufficient to give rise to tact responding to criterion in the criterion Tact Test 1 and in Tact Test 3. However, although listener responding to */tade/* was at criterion throughout and unprompted putative "echo-tacts" were also produced during these trials there was no evidence of echoing in either the baseline or the reinforced echoic trials, and no evidence of matched responding in the criterion Tact Test 1. There was some evidence of matched responding in Tact Tests 2 and 3, but mismatched tact responding also occurred. TE was 27 months and 6 days old.

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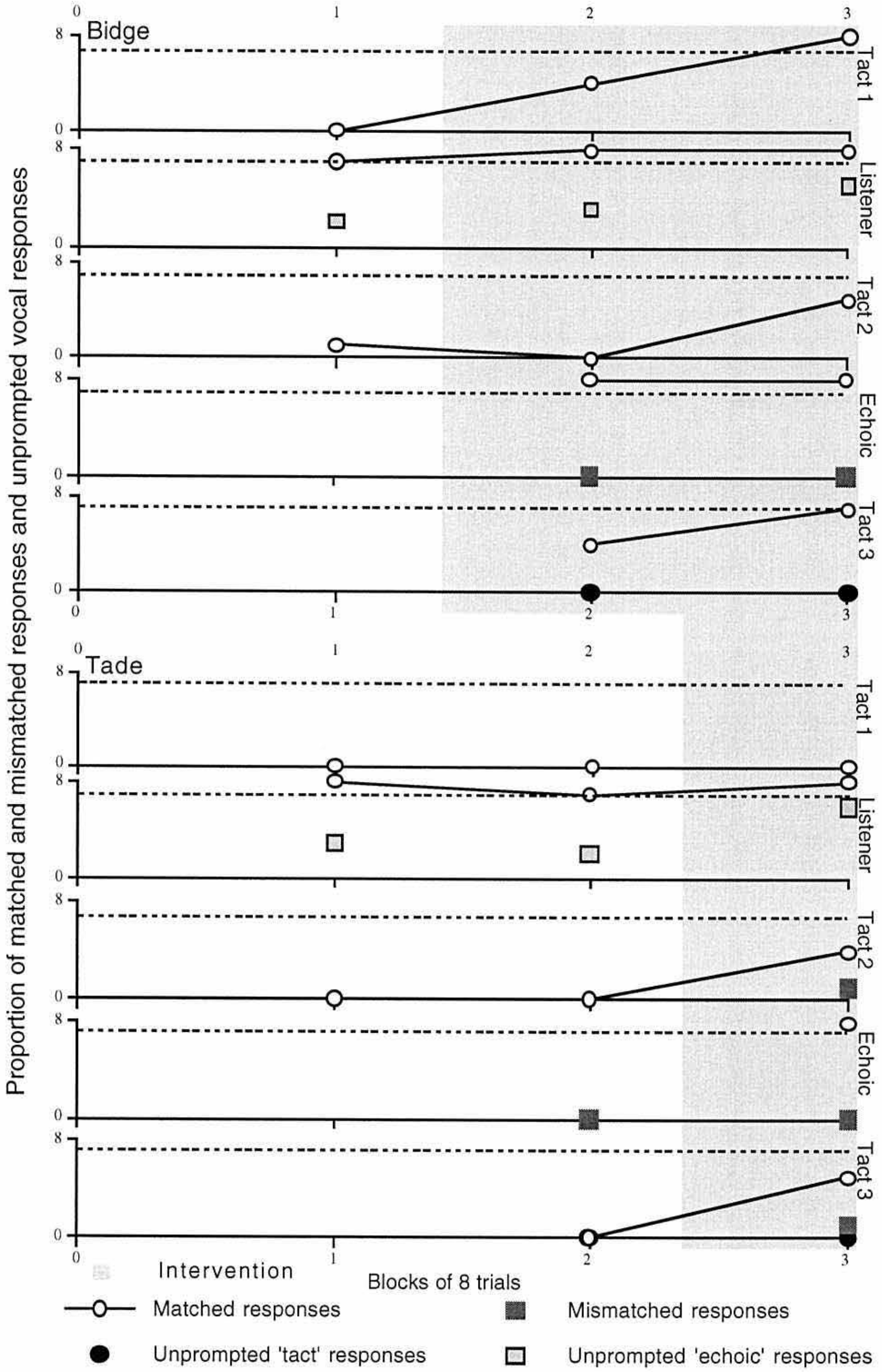

Figure 6.1.3.1, TE's matched and mismatched responses in the Tact Tests, the Listener Test, and the Echoic Training Trials, and unprompted vocal responses.

It appeared that TE had some speaker behaviour in respect of tade, but neither probes to echo the auditory stimulus nor to tact O6 were sufficient to reliably evoke this response. At this point, a non-word/familiar word confound was identified; the Welsh word for grandfather is *taid* (pronounced tide), and it was discovered that TE's name for his grandfather was *teid* (pronounced tade). As TE had an existing verbal relation in respect of */tade/*, he was introduced to a new listener relation, */ditta/* — O7, replacing the latter. He was presented with four trials in which two counterbalanced listener training trials of each listener relation, that is, */bidge/* — O5 and */ditta/* — O7, were conducted. TE produced unprompted echoic responses in both trials when the listener stimulus was */ditta/* and in one of the two trials when the listener stimulus was */bidge/*. These were followed by one block of eight sessions in which Tact Test 1, the Listener Trials, and Tact Test 2 were conducted. TE's responses in these 9 sessions are shown, session by session, in Figure 6.1.3.2.

The new listener relation, */ditta/* — O7, was demonstrated to criterion within one block of 8 trials. TE produced 18/18 (mrr = 1) correct responses to */ditta/* — O7 in the nine sessions. He produced matched responses in all Tact Tests for O7 — "ditta", after only two counterbalanced training trials (see Figure 6.1.3.2). It can be seen that TE produced unprompted echoics in 8/9 reinforced counterbalanced listener trials. It appears that the possible adventitious reinforcement of the echo-tact relation, during the reinforced listener trials, was sufficient to give rise to tacting without further training. It is possible that TE learned this new relation by "fast-mapping" (Carey, 1978), however, the high frequency of matched production of the novel non-word would suggest that he was not responding by stimulus exclusion alone. There were no mismatched responses during this period of training.

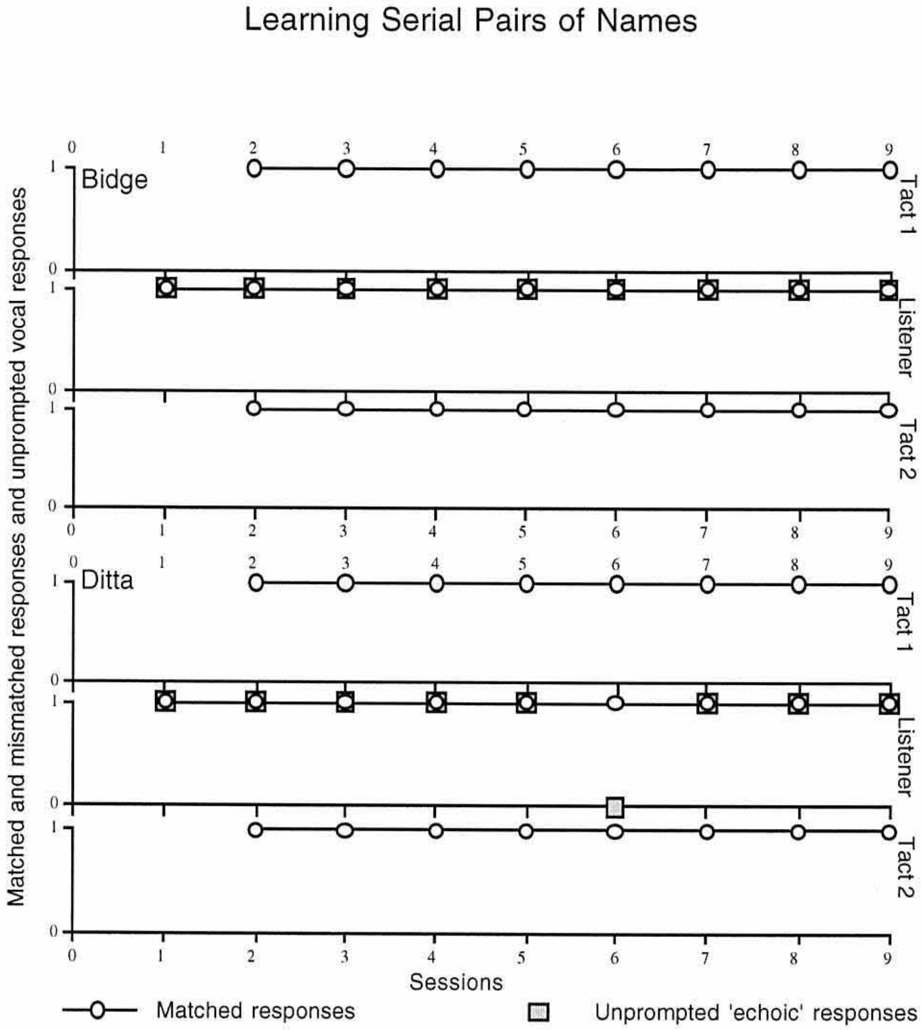

Figure 6.1.3.2 TE's first responses in the nine sessions of the Set 3 listener training with */ditta/*— O7 and */bidge/*— O5.

Summary

At 25 months and 11 days TE began learning a third pair of listener relations. These were demonstrated to criterion within one block of 8 sessions. Echoic relations to two auditory stimuli were learned within one block of eight sessions, in two consecutive blocks of trials. Following established listener and echoic relations for */bidge/*, the tact relation O5 — "bidge" emerged without further training. However, TE did not produce tact responses in respect of O6. It was tentatively assumed that this relation was confounded by an alternative usage of "tade". A new listener relation, */ditta/*— O7, was demonstrated to criterion within one block of eight sessions, which followed one pair of counterbalanced training trials of the latter. The echoic relation and the tact relation emerged, without direct training, in the same sessions for this new target relation. TE was 27 months and 7 days old. Despite the sequential training of the listener and echoic relations, TE showed a high level of unprompted echoing of the listener stimulus during listener training and so brought together listener and corresponding echoic relations. In so doing, he echoed in the presence of the corresponding object — conditions which, Horne and Lowe (1996) argue, would favour contiguous learning of the corresponding tact relation. TE's mastery of the new name relation, in Block 4, suggests higher-order naming of O7. This result may also have been shown if TE had learned to name by exclusion (see, e.g., Wilkinson, Dube, & McIlvane, 1998). However, if a different ordering of targeting is employed in each successive Tact Test 1, exclusion cannot be deemed the most likely interpretation of this result.

Generalisation

A test of generalisation to similar objects of different colour was conducted for all six novel names. TE produced matched responses to the novel colour variants of O1, O2, O4 and O7 in 8/8 trials (mrr = 1). He named the colour variant of O3 in 7/8 trials (mrr – 0.88). For the colour variant of O5 he received only 6 trials and he produced matched responses in all six trials (mrr = 1). Thus overall he produced linguistically correct names in 45/46 novel name tests (mrr = 0.98). This confirms that TE generalised previous naming to all six novel objects on the basis of the common property of shape, and suggests that naming had been established in respect of each target relation.

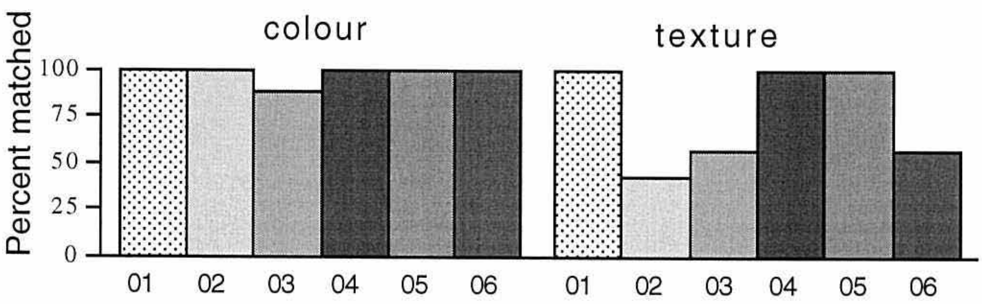

Figure 6.1.4 The proportion of TE's matched responses to the test for generalisation of the tact responses to common shaped objects of different colour and texture from the trained stimulus objects.

However, TE's responses for generalisation to similar shaped objects of novel texture appeared, at first sight, to be less robust. He named texture variants of O1, and O4, in 7/7 trials and O5 in 4/4 trials. He named texture variants of O3 and O7 in 4/7 trials and O2 in 3/7 trials. Thus overall he produced matched responses in 29/39 (mmr = 0.74) novel texture name tests. In total TE was able to generalise linguistically correct responses in 74/85 (mrr = 0.87) trials. Figure 6.1.4 shows TE's responses in the tests for generalisation to similar shaped objects of different colour, and texture, as a proportion of the number of generalisation trials.

In Chapter 3 the binomial distribution was examined to see if it was an appropriate measure for determining listener behaviour. It was reported that under the *related* trials of a learning paradigm the test might be seen as inappropriate. However, under the conditions set out for the generalisation of naming tests, the trials are clearly *independent* and the binomial distribution may be used to indicate the frequency of correct responding which might occur by chance.

The binomial distribution calculates the probability (p) of making a correct response in any single trial, and relates this to the number of trials (n) in any one test. The probability of getting a given number of these responses correct can be denoted as follows; for example, n = 8, p = 0.1617, p(3) = 0.033067, means that there were 8 trials and there were 6 potential name responses (1/6 = 0.1617) so the probability of getting three right, p(3), is 0.033067, or roughly three times in every hundred trials.

The results can be examined in several ways: overall response frequency; by type of variant; by object name; and by type of variant of object name. Table 6.1.2 shows the frequency of matched responses distributed across the varying group of trial types.

Table 6.1.2

The number of correct responses as a fraction of the number of trials in the tests for generalisation of the trained names to novel exemplars of similar shape but of either different colour or different texture from the trained stimulus objects.

VARIANT	O1	O2	O3	O4	O5	O7	TOTAL
colour	8/8	8/8	7/8	8/8	6/6	8/8	45/46
texture	7/7	3/7	4/7	7/7	4/4	4/7	29/39
total	15/15	11/15	11/15	15/15	10/10	12/15	74/85

Using the binomial distribution the chances of responding correctly on this number of trials by chance is extremely remote; for example, the lowest score for the combined colour and texture trials of a single name relation was 11/15; this would occur by chance only once in a million times (n = 15, p = 0.1617, p(11) = 0.000001).

However, whilst the names clearly generalised to the colour variants, there is evidence that, at least for one member of each pair, responding to the texture variants was less confident. TE responded correctly on 4/7 trials of O3 and O7 (n = 7, p = 0.1617, p(4) = 0.014096), and he responded correctly on only 3/7 trials of O2 (n = 7, p = 0.1617, p(3) = 0.073080). Even these "worst case" responses are far from chance response frequencies. Given the number of trials overall, these figures indicate that TE was able to generalise the trained names to all of the novel exemplars.

Conclusion

TE learned to name six novel objects in three serial pairs. Naming was established for Set 1 after listener training and echoic training in the absence of the stimulus objects. However, TE echoed both listener stimuli at a high rate during the early blocks of listener training. Echoing, in response to echoic probes, was established in line with the multiple baseline intervention, but tacting emerged simultaneously for both relations. He was 22 months and 4 days old.

Following this early naming TE required a further 10 weeks of training before he learned two new listener relations. However, once the listener relations were established, both echoing and tacting were demonstrated to criterion, in Block 7, when echoing of both auditory stimuli was reinforced in the absence of the objects. However, once again, echoing of one of the listener stimuli occurred at a high rate during listener trials and this target relation was the first to show correct responding during the tact tests. He had learned four novel names by 25 months and 5 days.

The third pair of names was confounded by a familiar word (that for O6). He learned the listener relations in one block of eight trials. He learned to echo in one block of eight trials and to name the fifth object after listener and echoic training. He did not learn to name O6.

There was only one recorded echo of */zog/*, for all the other new name relations, TE produced unprompted echoing during the listener training trials at a moderate or high frequency. Adventitious reinforcement of such echoic responding may, therefore, have occurred. This supposition is supported by the rapid onset of criterion echoing in subsequent reinforced echoic trials, including for */zog/*. It is also possible that this participant's minimal echoic repertoire was so highly developed that the auditory stimuli were already within his echoic learning repertoire, but for some reason not evoked by the request "can you say…?"

He named O7 after listener training only. He was 27 months and 7 days old. The "generalisation" of tacting to the new referent on learning listener behaviour and the unprompted production of previously learned echoic behaviour suggests that higher-order learning was responsible for completion of the name relation in the 2-stimulus procedure. In common with all the previously trained relations, the name generalised to shape-based novel exemplars, suggesting that this relation, too, was robust.

Participant TH

Set -1

The Set 1 auditory stimuli were */pab/* and */doot/* and the stimulus objects were O1, an 11 cm x 4 cm blue plastic paper clip (Figure 5.2), and O2, a 14.5 cm x 5 cm yellow adhesive spreader (Figure 5.1), respectively.

TH began the experiment when she was 13 months and 21 days old. In the first seven sessions she was familiarised with the experimenter and the experimental setting. Give and take games were then introduced, and at the same time, operant conditioning of speech like vocalisations was introduced. Her phonetic repertoire was recorded over four familiarisation sessions. She produced all the phones which constituted the auditory stimuli during this period (see *Appendix 1*).

TH learned to respond to typical request phrases, for example, "Can I have . . .?", or "Give me the . . .?" in four give and take sessions. She gave the roller in 1/1 trial and teddy in 1/1 trial. At the next session she gave a block in 1/1 trial, sailor sam in 1/1 trial and teddy in 1/1 trial. In the following session she gave a ball in 4/4 trials, a brick in 4/4 trials, a car in 1/1 trial, teddy in 1/1 trial, sailor sam in 1/1 trial and a brick in 4/4 trials. In the fourth session, she gave a brick in 4/4 trials. Thus she had responded correctly in respect of 6 familiar objects on the first (i.e., test) trial on 12 occasions. In total she responded to auditory stimuli, which typically feature in request situations, by giving a series of familiar objects in 24/24 trials.

At 14 months 8 days, she began Step 3, pairwise discrimination of two familiar objects. She selected teddy in the presence of a familiar toy in 9/11 trials, responding incorrectly in Trials 1 and 5, and she selected a brick in the presence of a familiar toy in 9/9 trials. She was first exposed to the auditory stimulus */doot/* and O2 at 14 months 12 days and returned this object on request in 8/8 trials, during which she produced one unprompted vocalisation which matched the auditory stimulus */doot/.*

In the Step 4 listener trials she selected O2 in response to */doot/* in the presence of O2 and man in 7/8 trials, and O2 in response to */doot/* in the presence of O2 and teddy in 11/12 trials. She responded correctly in 5/10 trials in response to teddy in the presence of O2 and teddy, and in 3/4 trials in response to man in the presence of O2 and man. TH's listener responses are shown in Table 6.2.1.

Table 6.2.1

The number of correct listener responses and listener trials for each type of listener trial during the Set 1 listener training. The target relations are shown in bold type.

Listener Relation	***/doot/*** ***O2*** *vs teddy*	***/doot/*** **O2** v s man	***/pab/*** O1 v **O2**	***/doot/*** **O1** v O2
Training	11/12	7/8	68/95	77/116
Testing			27/32	25/32
Total	11/12	7/8	95/127	91/136
mrr	0.92	0.875	0.74	0.67

TH began learning the first pair of novel listener relations when she was 14 months 15 days. Figure 6.2.1.1 shows all of TH's tact test, listener, and echoic responses during the period of Set 1 training with *both* the novel target relations.

The target listener relations were trained over a period of 10 weeks. In the first 10 sessions simple discriminations and pairwise discriminations with familiar distracters were conducted, as described above. In the following 32 sessions, pairwise

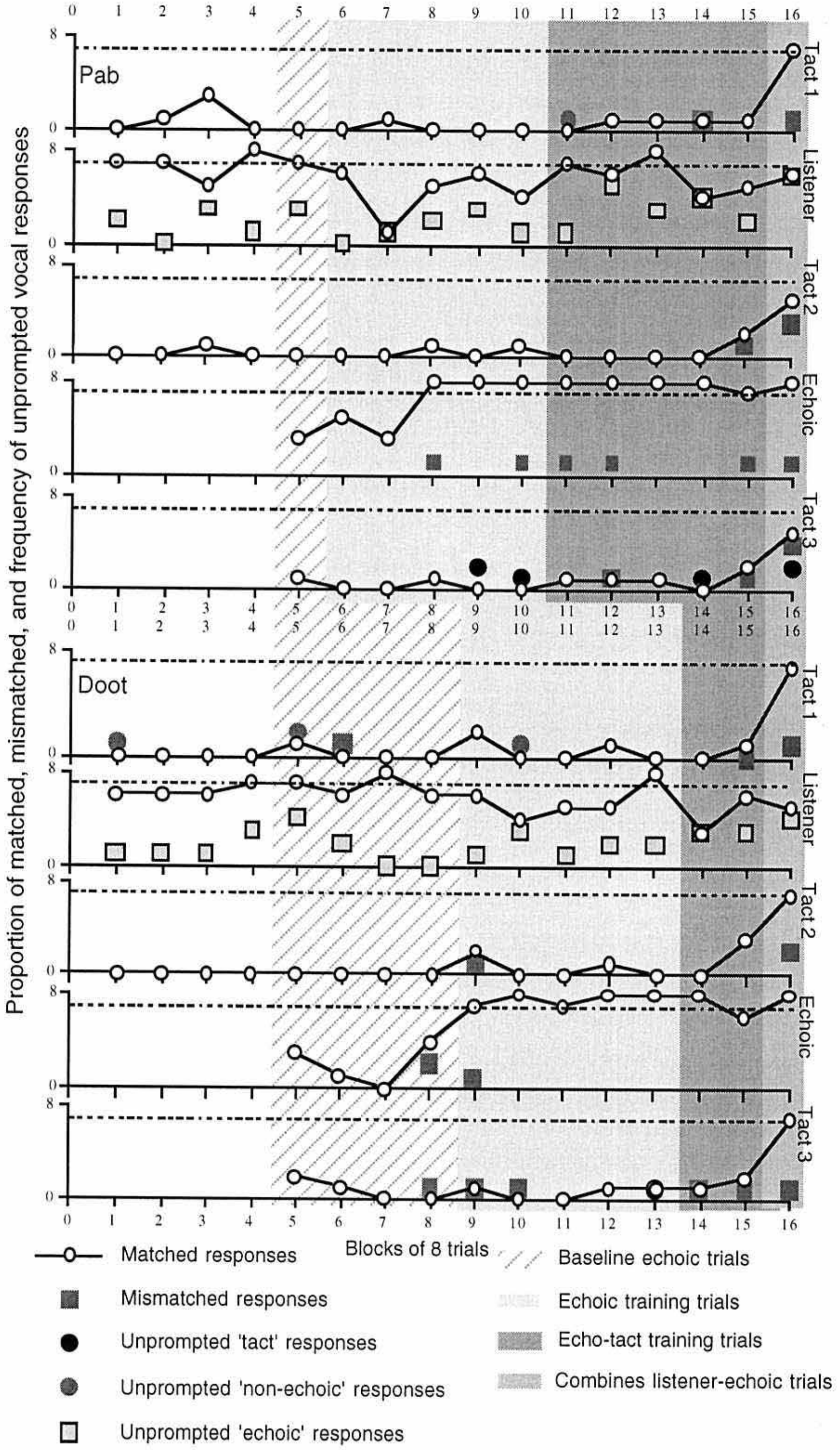

Figure 6.2.1.1 The proportion of TH's matched tact, listener and echoic responses for the Set 1 target relations. Mismatched responses, and unprompted responses (see legend) are shown in the corresponding sections.

discrimination of the two novel stimuli were presented, in which the distracter was always the alternative novel stimulus. In these 32 sessions the first trial of each listener relation was the scoring trial. In the 32 pairwise discrimination sessions, she responded correctly in 91/136 trials (mrr = 0.67) of */doot/* — O2 and in 95/127 trials (mrr = 0.75) of */pab/* — O1 (see Table 6.2.1).

Criterion listener responding for the Set 1 target relations was demonstrated in Block 4, when she was 16 months and 27 days old (see Figure 6.2.1.1). Unprompted echoing in the listener trials was infrequent during this period. TH produced three vocalisations which matched */doot/*, in the 10 preliminary sessions, two were echoic and one was a non-echoic vocalisation. In the 32 pairwise discrimination sessions in which both novel stimuli featured in the comparison array, she produced vocalisations which matched */pab/* in six sessions and vocalisations which matched */doot/* in six sessions.

She produced 4/32 (mrr = 0.13) matched responses to the criterion Tact Test 1 probes for O1, and 1/32 (mrr = 0.031) matched responses in the Tact Test 2. She produced no matched responses to any of the tact probes for O2 — "doot". These responses were well below the criterion frequency for tacting. Thus, when the first pair of listener relations had been demonstrated to the criterion there was no evidence of corresponding echoing of the auditory stimuli or tacting of the corresponding stimulus objects.

Echoic training began when TH was 16 months 28 days. During this stage, all echoing was probed in the absence of the stimulus objects. In the first eight sessions, Block 5, echoing was probed in the unreinforced baseline condition for each of the target echoic relations. Echoic responding was well below criterion level. TH produced 3/8 matched responses in the */pab/* trials and 3/8 matched responses in the */doot/* trials (see Figure 6.2.1.1). In the baseline echoic trials in Block 5, TH produced three unprompted "echoic" responses in the listener trials for */pab/*— O1 and four unprompted "echoic" responses in the listener trials of */doot/* — O2. In addition she produced one matched response to tact probes for O1 in Tact Test 3, and three matched responses to the tact probes for O2, one in Tact Test 1, and two in Tact Test 3. Thus, although there were occasional matched responses in respect of each echoic relation, there was no evidence of echoing or tacting to criterion, as a consequence of probing for the echoic relations in the unreinforced baseline condition (see Figure 6.2.1.1).

The intervention, reinforcement for matched responding to echoic probes, was implemented for */pab/* — O1 in Block 6, and echoing of */doot/* continued to be probed without reinforcement. Echoing of */pab/* attained criterion frequency in Session 8. There was no evidence of tact responding, to O1, during these three 8-trial blocks. Listener responding declined sharply in Block 7, but showed signs of recovering in Block 8. There was no change to the frequency of responding to */doot/*; listener relations remained at or close to criterion and there was no evidence of echoing nor of tacting.

In Block 9, the intervention was extended to the echoic relation */doot/* — "doot". Echoing of */doot/* attained the criterion frequency in Block 9. Each echoic relation was seen to increase to criterion in line with the implementation of the intervention, and they were demonstrated simultaneously in Blocks 9 – 10. However, there was no corresponding increase in the tact responses; in the tact tests for O1 — "pab", TH produced one matched response in the 48 tact trials in Blocks 9 and 10, and in the tact tests for O2 — "doot", she produced five matched responses in 48 trials (mrr = 0.1) and three mismatched responses.

Contrary to the predictions of stimulus equivalence, following training of the listener and the echoic relations, there was no evidence of tacting. Consequently, the echo-tact intervention, that is, probing for echoing in the presence of the stimulus objects, began when TH was 19 months old. This intervention was introduced in a stepwise manner as follows:

In Blocks 11 – 13, echoing of */pab/* in the presence of O1 was reinforced, and echoing of */doot/* was reinforced in the absence of O2. Echoing of */pab/* remained robust, and listener responding returned to criterion level. There was evidence of a high frequency of unprompted echoing in the reinforced listener trials in Block 12. However, TH continued to produce very few responses, matched or mismatched, to the tact probes for O1 (see Figure 6.2.1.1). Echoing of */doot/* remained at or above criterion during the period, but again there was little evidence of matched or mismatched responding to any of the tact probes. Listener responding remained just below the criterion level but returned to criterion in Block 13; however, unprompted echoing in the listener trials, for */doot/* — O2, remained sporadic.

In Blocks 14 – 15, echoing in the presence of each of the corresponding stimulus objects was reinforced. There was some evidence of an increase in matched responding to the tact probes in Test 2 and Test 3 in respect of each target relation; however, there was no evidence of an increase in responding in the criterion Tact Test 1 for either relation, in these two blocks.

In Block 16, the listener and echoic trials were combined, that is TH was directed to select an object immediately before being asked to echo the corresponding auditory stimulus. Correct responses were reinforced and followed by an unreinforced tact probe. Following the implementation of this intervention, simultaneously for both target relations, tacting to criterion emerged in Block 16. TH was 21 months and 16 days old. However, it should be noted that each listener relation was below criterion at this time, and there was evidence of mismatched tact responding, particularly in the Tact Test 2 (see Figure 6.2.1.1).

Summary

TH began listener training at 14 months 8 days. She learned two listener relations to criterion, at 16 months 27 days, but showed no evidence of echoing or of tacting. She then learned two corresponding echoic relations to criterion, without evidence of tacting. Next, echoing to criterion in the presence of the stimulus objects was demonstrated, and TH began to produce matched and mismatched target responses in

Test 2 and Test 3, following the listener and echoic trials. She demonstrated criterion responding for both tact relations following the combining of listener and echoic trials in Block 16.

However listener responding was below criterion, and there was evidence of mismatched responding in the later tact tests. In subsequent sessions, the full procedure could not be completed and only the Tact Test 1 was consistently conducted. Mismatched tact responses gradually diminished over the next 16 sessions. She was correct in 100 percent of the listener trials that were completed (8/8). It was, therefore, tentatively claimed that she had learned the Set 1 name relations.

Set 2

The Set 2 auditory stimuli were */zog/* and */geck/.* The Set 2 stimulus objects were O3, a 3 cm high x 9 cm diameter green jelly mould (see Figure 2a.1) and O4, a 7.5 cm long x 4.5 cm diameter red ice lolly stick (see Figure 5.1).

The Listener Training Stage

TH began learning the listener relations of the Set 2 stimuli at 21 months 26 days old. As TH had already learned to respond as a listener by learning the Set 1 relations, no preliminary training was given in respect of the Set 2 listener relations. In Block 1, TH learned to respond to */zog/* — O3, she responded correctly in 7/8 trials; in Block 2 she learned to respond to mixed trials of */zog/* — O3 and */geck/* — O4, in which she responded correctly in 7/8 trials of each listener relation. Thus, each listener relation was learned to criterion within one block of reinforced training; TH was 22 months 6 days old.

TH's responses in the Tact Tests, the Listener Test, and the Echoic trials are shown in Figure 6.2.2.1. Mismatched responses are shown as filled squares, unprompted

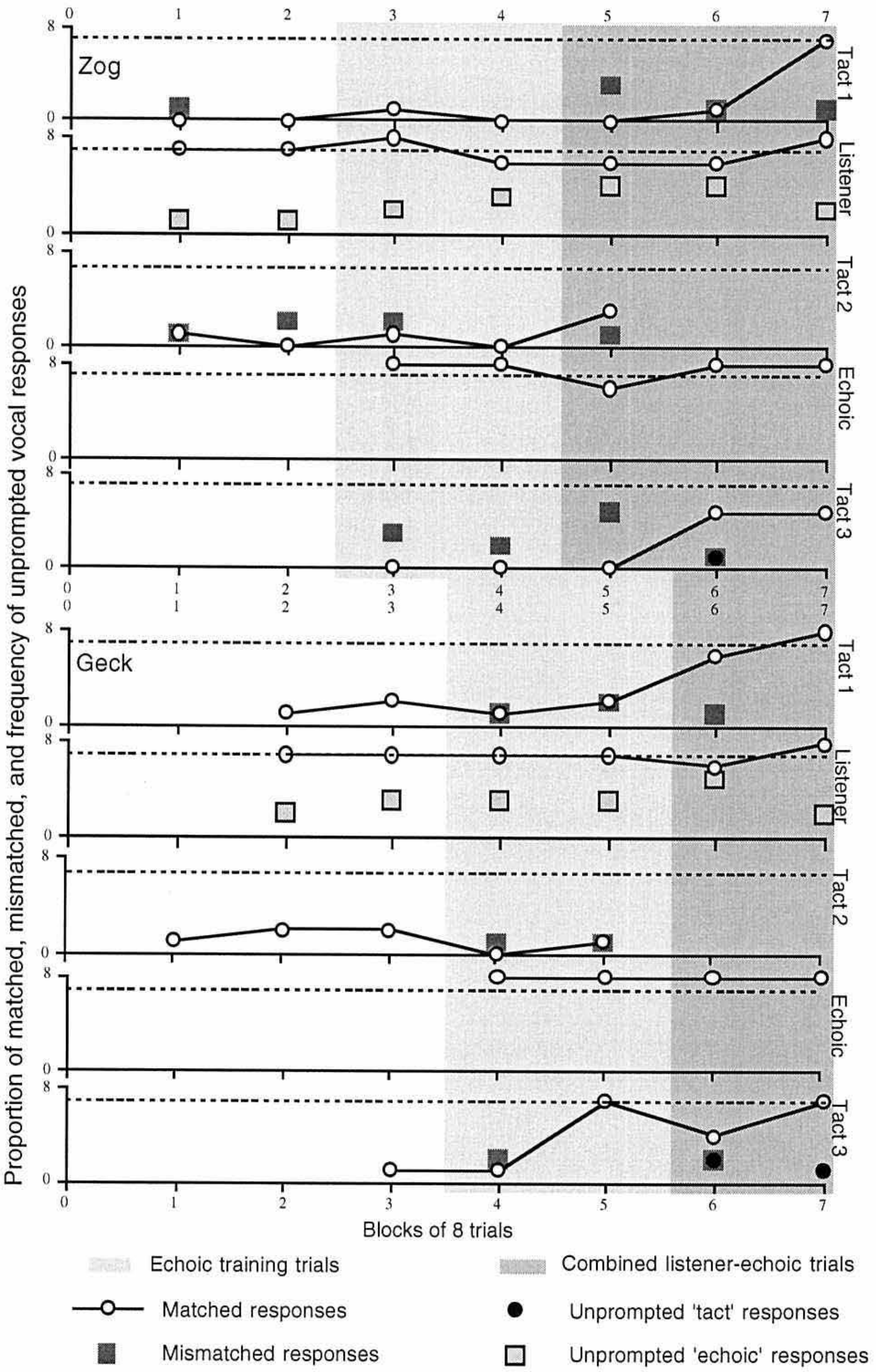

Figure 6.2.2.1, TH's matched and mismatched responses in the Tact Tests, the Listener Test and the Echoic trials for Set 2. Mismatched responses and unprompted responses are shown as filled circles and squares (see legend).

"echoic" responses are shown as hollow squares, and unprompted "tact" responses are shown as dark circles.

In the two 8-trial blocks, TH produced unprompted echoes in two */zog/* listener trials and in two */geck/* listener trials. Thus there was no evidence of having learned to echo, to criterion, as a consequence of learning these listener relations.

In the tact tests, TH produced one matched response to O3 — "zog" and four mismatched (Set 1) responses (three "doot" responses, and one "pab" response). She produced matched responses to O4 — "geck" in 4/32 trials, in Blocks 1 and 2. Thus there was no evidence that she had learned to tact either of the stimulus objects as a consequence of learning the listener relations to criterion (see Figure 6.2.2.1).

TH began learning to echo the Set 2 auditory stimuli at 22 months 7 days. In Block 3, the echoic relation */zog/* — "zog" was probed in the absence of the O3, and matched echoic responses were reinforced. Echoing was demonstrated to criterion within one 8-trial block. There was no change to her tact or listener responding in respect of this target relation; she produced 2/24 matched responses and five mismatched responses. Her responding in respect of the geck target relations remained unchanged; she produced 5/24 matched responses and no mismatched responses (see Figure 6.2.2.1).In the Block 4, the echoic relation */geck/* — "geck" was probed in the absence of the corresponding stimulus object, and matched echoic responses were reinforced. Echoing of this auditory stimulus was demonstrated within the 8-trial block. Thus echoing of each auditory stimulus emerged in line with the intervention; echoing to criterion was attained at 22 months 29 days.

Learning the echoic relations was correlated with a slight increase in TH's production of echoic responses in the listener trials. She produced unprompted "echoic" responses in 5/16 listener trials of */zog/* and in 6/16 listener trials of */geck/* in Blocks 3 and 4. However, these responses were still well below the criterion for echoing.

Responding in the tact tests remained minimal. She produced matched responses in 2/48 trials of O3 and seven mismatched responses, and she produced matched responses in 7/48 trials of O4 and four mismatched responses. This frequency was well below the criterion for tacting, and there were as many mismatched as matched responses.

Listener and echoic imitation trials were combined for the first target relation (zog) in Block 5, when TS was 22 months and 29 days old. The intervention was extended to the geck target relation, in Block 6. Tacting to criterion, for both target relations, was demonstrated in Block 7, when TH was 23 months 28 days old.

Following the combined listener echoic trials for the first target relation (zog), in Block 5, there was a slight increase in her matched responding to tact probes in Tact Test 2. However, in all the tact tests there was an increase in mismatched responses. There was a slight increase in her production of responses in the Block 5 tact tests for the second target relation (geck). However in Tact Tests 1 and 2 these were mismatched as often as matched; interestingly, following the combining of listener and echoic trials for the first target relation, tacting at Tact Test 3 for the second target relation was seen to criterion. When the intervention was extended to */geck/*, in Block 6, responding at Tact Test 1 approached criterion level, and unprompted "tacting" of O4 — "geck" was observed on two occasions. Criterion responding at Tact Test 1 was demonstrated for both relations simultaneously, in Block 7; listener responding and echoic responding were at criterion level, in respect of each target relation, in this block. TH's responses in the last three blocks of trials are shown session by session in Figure 6.2.2.2.

Tact responding was first seen in Tact Test 3 for the second target relation O4 — "geck". It emerged, following the combining of listener and echoic trials for the first target relation, when only reinforcement of echoing in the echoic trials and possible adventitious reinforcement of echoing in the listener trials was implemented, for this

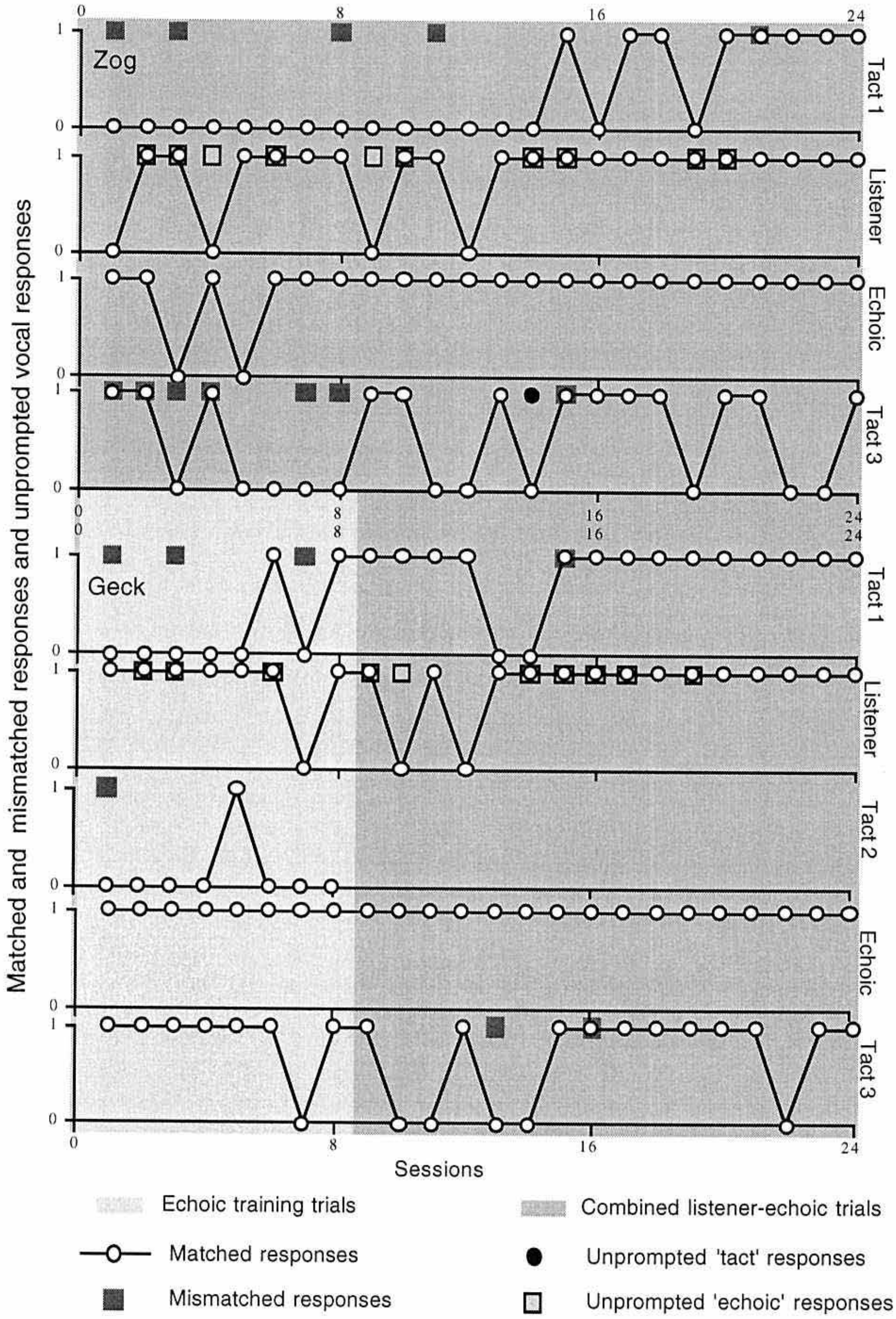

Figure 6.2.2.2 TH's matched and mismatched tact, listener and echoic responses in the last 24 sessions of the Set 2 training. Mismatched responses, and unprompted vocal responses are shown as filled circles and squares (see legend).

second target relation. Responding began to appear in the Tact Test 1 trials in this period but TH's responses were often mismatched. By the end of the echoic training trials, her responses in the Tact Test 1 trials were becoming increasingly accurate. When listener and echoic trials were combined so that echoing was reinforced while TH was attending to the corresponding stimulus object, tacting to criterion was demonstrated in Test 1 within two blocks of trials.

For the first target relation (zog) there was some evidence of responding, in Tact Test 3, during the first block of combined listener and echoic trials. However there was also evidence of mismatched responding in these trials, and in the Tact Test 1 trials. TH became increasingly likely to produce unprompted echoic responses in the listener trials, producing seven such "echoics" in nine sessions between Session 2 – 10 of this period (Trial 2, Block 5 – Trial 2, Block 6). Thereafter, TH's tact responses became increasingly accurate at the Tact Test 3, and appeared at Tact Test 1 following an unprompted putative "tact" response in Session 14 of this period (i.e., Trial 6, Block 6). Mismatched responding virtually disappeared from Session 16 onwards and criterion responding was evident for each target tact relation in Sessions 17 – 24 (Block 7).

Summary

TH demonstrated naming of the Set 2 stimulus objects, at 23 months 28 days old, after two months of training. For this participant, even after learning the Set 1 relations and contrary to the predictions from stimulus equivalence, listener responses and echoic responses were seen to be separate behaviours until they were combined under a reinforced training intervention. However, in line with Horne and Lowe's (1996) theory of naming, following reinforcement of listener-echoic training tacting emerged to criterion.

Maintenance of the Set 1 Relations

Tact responses were tested for the Set 1 relations at the end of the Set 2 sessions, on an intermittent basis. One trial of each relation was tested, as described in the procedure, (*Tact Test 1*). Listener training trials were given in four sessions, when her responding had been incorrect for either relation on four consecutive occasions. TH responded correctly in 41/54 trials (mrr = 0.76) of O1 — "pab" and in 38/54 trials (mrr = 0.70) of O2 — "doot". The frequency of matched responses suggests that she had maintained these tact relations.

Generalisation

To test for generalisation of the four trained name relations, naming of novel colour and novel texture exemplars was tested. Figure 6.2.3 shows the proportion of TH's correct responses in respect of each generalisation test.

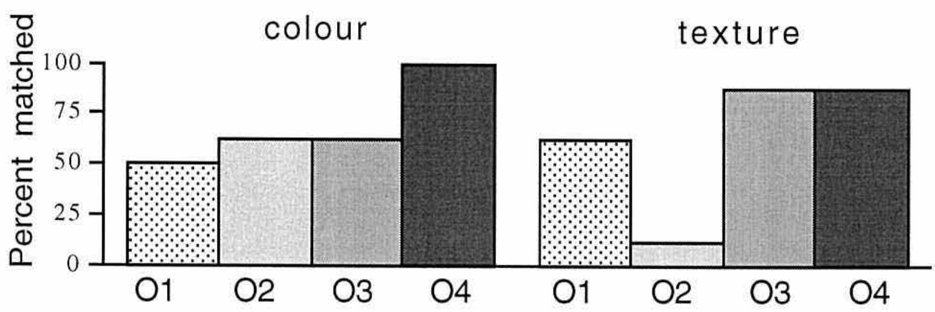

Figure 6.2.3 The proportion of TH's matched responses in the test for generalisation of the tact responses to common shaped objects of different colour and texture from the trained stimulus objects.

TH named the novel coloured exemplar of O4 in 8/8 trials, and she named the colour variants of O2 and O3 correctly in 5/8 trials per object. She was correct in 4/8 trials of a colour variant of O1. Overall she responded correctly in 22/32 trials (mrr = 0.69) of generalisation to novel coloured exemplars.

She named the novel textured variants of O3 and O4 correctly in 7/8 trials and the novel textured variant of O1 in 5/8 trials. However, she named the fur covered adhesive spreader "doot" in only 1/8 trials, responding "brush" in 7/8 trials. She responded correctly in 20/32 trials (mrr = 0.625) of generalisation to novel textured variants.

The probability of making matched responses in a series of trials in which there are a number of potential responses has been evaluated using the binomial distribution. TH learned four name relations, thus on every trial there were four potential responses. The probability (p) of her making a correct response in any one trial was therefore 0.25. TH's responses in respect of the name relations, the type of variant trial are shown in Table 6.2.2.

The probability of her responding correctly in 22/32 colour trials by chance (n = 32, p = 0.25, p(22) = 0.000000) is nil; the probability of responding correctly in 20/32 texture trials by chance (n = 32, p = 0.25, p(20) = 0.000007) is remote. Thus there is evidence that the names TH learned in the experiment generalised to novel shape-based exemplars of different colour, and different texture from the trained stimulus objects.

Table 6.2.2

The number of correct responses as a fraction of the number of trials in the tests for generalisation of the trained names to novel exemplars of similar shape but of either different colour or different texture from the trained stimulus objects.

VARIANT	O1	O2	O3	O4	TOTAL
colour	4/8	5/8	5/8	8/8	22/32
texture	5/8	1/8	7/8	7/8	20/32
total	9/16	6/16	12/16	15/16	42/64

TH's responses in respect of each name relation appear, on first inspection, to show weak responding to the O2 variants. Her responses to the texture variant of O2 were confounded by two factors: (a) the adhesive spreader was covered in fur fabric, making its shape less distinct than the shape of the trained stimulus object; and (b) she preferred a name in her existing vocabulary, "brush", in 7/8 trials. It appears that the combination of shape and furriness evoked "brush" more strongly than the experimental name. Thus responding in respect of the texture variant of O2 was not inappropriate, it was simply in accord with a previously established, non-experimental, verbal response.

In respect of the colour variant of O2, she produced matched responses in 5/8 trials, the probability of this level of responding, by chance alone, (n= 8, p = 0.25, p(5) = 0.023071) is significantly less than chance. For the combined scores for each of the remaining name relations, O1, O3, and O4, TH scored 9/16 trials or better. The probability of this rate occurring by chance (n = 16, p = 0.25, p(90 = 0.005825) is very small. Thus generalisation of all the name relations was demonstrated to better than chance criterion.

However, it is interesting to note that her responses in respect of O1 and O2, for which listener responding was not demonstrated to criterion simultaneously with tact responding, appeared to be less robust than those for O3 and O4, for which both listener and tact relations were demonstrated to criterion, simultaneously, in the last 8-trial block (see Figure 6.2.2.2). She produced only 4/8 matched responses to the colour variant of O1 (n = 8, p = 0.25, p(4) = 0.086517) which may occur by chance once every 11.5 occasions. However, taken together, there is strong evidence that the name relations that TH learned in Experiment 6 generalised to the novel exemplars.

Conclusion

TH learned to tact four novel objects in two serial pairs, before she left the nursery at 24 months 14 days old. As Horne and Lowe (1996) predict, tacting was established, for Sets 1 and 2, when the listener and echoic trials were combined, such that TH was reinforced for producing an echo-tact response in respect of each target relation.

For the Set 2 target relations, listener, echoic and tact relations were all demonstrated to criterion for each relation in the final block of trials. However, for the Set 1 target relations, whilst echoic and tact responding were demonstrated to criterion in respect of each target relation, listener responding was not demonstrated to criterion in the final three blocks of training, for either of the relations. This may have contributed to her slightly less robust performance in tests of shape-based generalisation to novel variants of O1 and O2, as follows.

A name, as defined by Horne and Lowe (1996), is not simply tact responding, it includes both speaker and listener behaviour, such that a name invokes or means the class of listener responses to which it relates. When a young infant learns listener responses they may be restricted, initially, to the limited context in which they are learned. In this series of experiments, each discriminative stimulus object consists of at least three variables, shape, colour and texture, any or all of which may become discriminative for a corresponding tact relation. If listener responses are only weakly related to the discriminative auditory stimulus, it is possible that all three variables, that is, shape, colour, and texture, may be required to evoke a corresponding vocal response (cf. Landau, Smith & Jones, 1998).

Participant HS

HS had previously participated in a procedure which operantly conditioned her speech-like vocal responses (see Appendix 1). However, she had not participated in any experimental procedure for three months prior to beginning Experiment 6, when she was 14 months 4 days old. In four Stage 1 sessions, she was re-familiarised with the experimental setting and her phonetic repertoire was revised. In the following four sessions she learned to give and take familiar objects and to select one from two familiar objects, Steps 1 — 3 of Stage 2. At 14 months 11 days, she began Step 4 of the listener training. The novel auditory stimulus */pab/* and the experimental stimulus object O1, a large blue paper clip (see Figure 6.1, centre panel), were introduced. She responded correctly in 5/5 trials in which O1 was paired with ball. Finally, the second novel auditory stimulus */doot/* and O2, a yellow adhesive spreader (see Figure 6.1 upper panel) were introduced. She gave O1 in response to "give me the pab" in 6/6 trials, and O2 in response to "give me the doot" in 8/8 trials.

The pairwise discrimination procedure, Step 5, began later the same day. In the next three sessions HS selected O2 in response to "give me the pab" in 10/15 trials, when O2 was paired with O1; similarly, she selected O1 in response to "give me the doot" in 10/12 trials, when O1 was paired with O2.

At 14 months 15 days, she began the experimental conditional discrimination listener training trials, in which the comparison array was always O1 and O2, (see *Procedure*). After six blocks of 8 test trials, HS simultaneously demonstrated the two novel listener relations to criterion. She had experienced a total of 424 pairwise listener trials, see Table 6.3.1.

Table 6.3.1

The number of correct listener responses and listener trials in each type of listener trial during the Set 1 listener training stages. The target relations are shown in bold type.

Listener Relation	*/pab/* **O2** v ball	*/pab/* O1 v **O2**	*/doot/* **O1** v O2
Training	5/5	123/167	111/156
Testing		34/48	31/48
Total	5/5	157/215	142/204
mrr	1	0.73	0.70

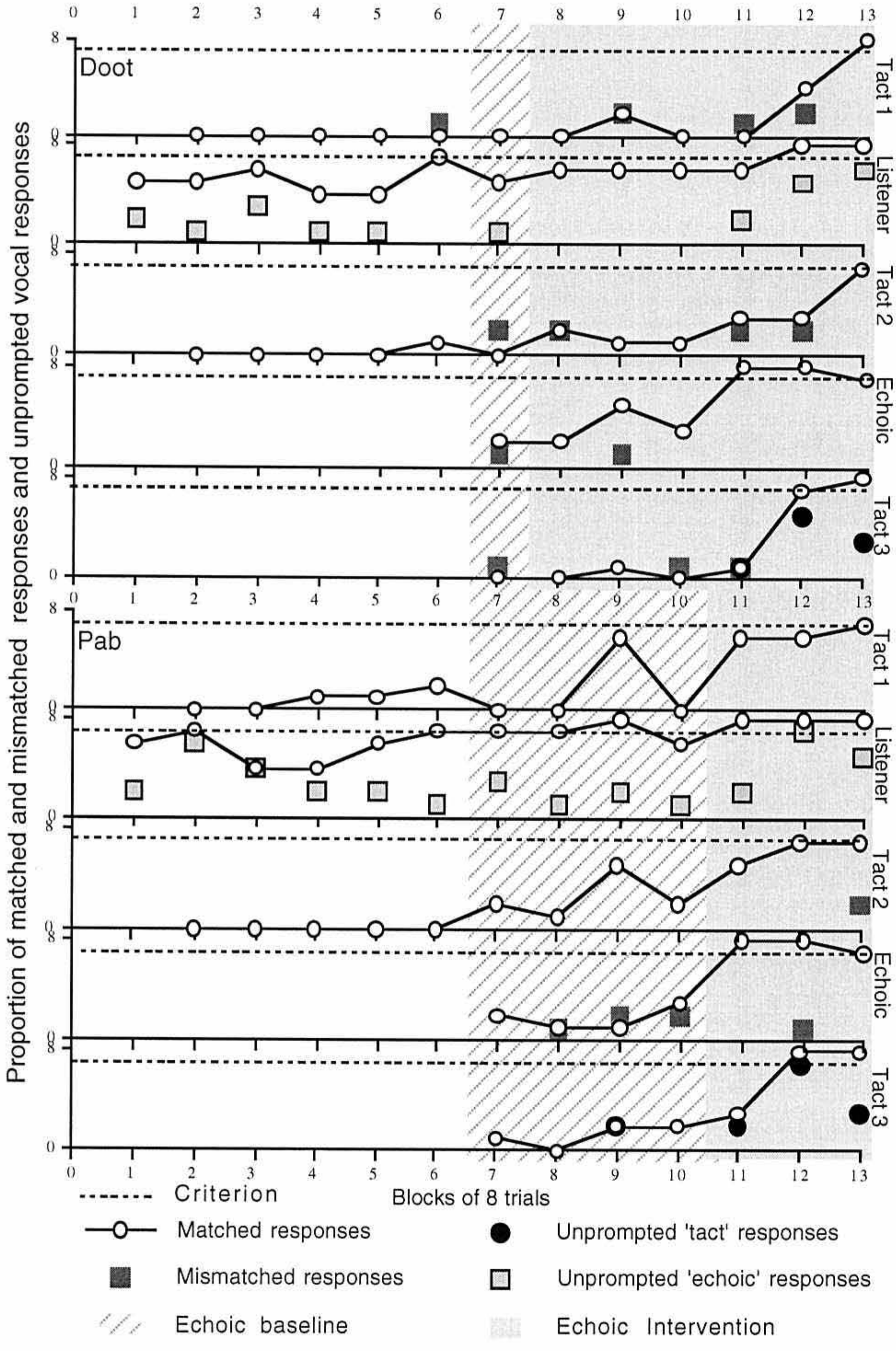

Figure 6.3.1.1 HS's responses in the Tact Tests, the Listener Test, and the Echoic trials for the Set 1 relations, shown in relation to the intervention. Mismatched responses and unprompted vocal responses are shown as filled circles and squares (see legend).

HS's responses in the Tact Tests, the Listener Test and the Echoic training trials are shown in Figure 6.3.1.1. Mismatched responses and unprompted putative "echoic" and "tact" responses are shown as filled circles or squares.

Listener responding was demonstrated to criterion level for both relations simultaneously in Block 6. There was no evidence of matched responding in the criterion Tact Tests. HS produced one matched response in forty trials of O1 — "doot" and one mismatched response, in Tact Test 1; she also produced 1/40 matched responses in Tact Test 2 (see Figure 6.3.1.1). Similarly, she produced 4/40 matched responses to O2 — "pab" in Tact Test 1, and no matched responses in the forty trials in Tact Test 2. Thus HS's responses to the tact probes were well below the criterion for tacting, in these six blocks of trials.

There was evidence of unprompted "echoic" responding during the listener trials, in respect of each auditory stimulus. HS produced 8 "echoic" vocal responses during the 48 listener trials of */doot/* — O1, well below the criterion for echoing. However, she produced 17 "echoic" vocal responses during the 48 listener trials of */pab/* — O2; there was a high frequency of production of the latter response in Block 2, but this diminished in subsequent blocks (see Figure 6.3.1.1). Thus, learning to respond to criterion to the first pair of listener stimuli did not give rise to tacting of the corresponding stimulus objects or to criterion levels of echoing of the corresponding auditory stimuli.

One block of eight unreinforced trials of echoing was conducted, in Block 7, prior to implementing the intervention of reinforcement for the echoic relation */doot/* — "doot", in Block 8. The intervention was extended to the second echoic relation, and echoing was demonstrated to the criterion of ≥7/8 for each echoic relation, in Block 11. HS was 20 months and 3 days old.

There was no evidence of echoing in the baseline block of trials (i.e., Block 7). HS produced matched responses to */doot/* in two trials and to */pab/* in two trials. She also produced a mismatched echoic response in one *doot* trial. There was no change to her pattern of responding in the tact and listener trials. Following the implementation of reinforcement of echoic responses in respect of the */doot/* — "doot" relation there was a gradual increase in responding and criterion echoing for this relation was demonstrated in Block 11. The corresponding listener relation was maintained at just below criterion frequency and there was no evidence of tacting the corresponding stimulus object.

Echoing of */pab/* continued to be probed in the baseline condition in Blocks 8 - 10. HS produced occasional matched and mismatched responses to these probes. There was some evidence of increased responding to the tact probes in Tact Test 1 and Tact Test 2, but criterion tacting was not demonstrated during this period. Thus, reinforcement of echoic responding to */doot/* together with unreinforced probing for echoing */pab/* appeared to be correlated with a temporary rise in her production of "pab" responses in the Tact Tests, but not in the unreinforced echoic trials. Although criterion echoing had not been demonstrated for the first echoic relation, the intervention was extended to the second echoic relation in Block 11. There were few opportunities to reinforce echoing because of her infrequent responding; targeting the second relation might evoke vocal responding if the response was within her echoic repertoire, thus allowing the contingency to take effect.

Echoing reached criterion in respect of each echoic relation in Block 11. Thus, when echoic responses in respect of */pab/* were reinforced, there was a corresponding increase in production of "doot" echoics, which were then also reinforced. Echoing was seen to attain criterion frequency under these conditions.

Learning to echo had little effect on HS's responses to tact probes for O1, but tact responding was almost at criterion level in respect of O2. Two further blocks of trials were therefore conducted without further intervention.

In Blocks 12 and 13, listener responding was robust, and there was increased evidence of unprompted matched vocalisations in the listener trials. These reached the criterion for echoing of */pab/* in Block 12 and just below criterion for */doot/* in Block 13. Although there was no scheduled intervention it was found that, in Blocks 12 and

13, having learned to produce echoic responses to the auditory stimuli, HS became increasingly likely to produce her typical matching echoic vocalisations during the listener trials. Tact responses began to increase in Block 11 in Test 2, following the listener trials, and in Block 12 they were increasingly evident in Tests 2 and 3. Criterion tacting, of both stimulus objects simultaneously, was demonstrated in Block 13.

HS's typical approximations differed from the auditory stimuli in that they were reduplicative and produced in a sing-song tone, that is, pab-pab (similar to parp-parp, of a car) or doot-doot (toot-toot, of a train). When she was prompted to select the pab she would hear "Are you ready? Where's the ....pab?" She would then select pab and say pab-pab. The selection of pab was, as always, reinforced. In Block 13, there was increasing evidence of experimenter "drift" towards HS's typical vocal response, so that in the listener trials HS would hear, for example, "Are you ready? Where's the ....pab-pab?" To which HS would respond vocally "pab-pab" and then select the object O1 and receive reinforcement. Thus in Block 13, she was, in effect, reinforced for echo-tacting. She demonstrated criterion tact responding at 20 months 17 days.

Summary

HS learned the first pair of listener relations in 64 sessions (15 weeks), and learned to echo both auditory stimuli in 40 sessions (9 weeks). At 20 months and 3 days she demonstrated listener and echoic relations for both stimuli to criterion but did not show tacting to criterion. Tacting emerged, without further scheduled intervention, after 16 further sessions. There was however, evidence of criterion echoing during the listener trials for the echoic relation */pab/* — "pab", and increasing evidence of matching vocalisations of */doot/,* also during the listener trials, and recall that unprompted echo-tacting is adventitiously reinforced when it occurs in the listener trials. This appears to have created the necessary conditions for the tact to become established for each of the first pair of target relations.

Set 2

HS began learning the second set of name relations at 20 months and 17 days old. The Set 2 auditory stimuli were */zog/* and */geck/*. The Set 2 stimulus objects were O3, a 3 cm high x 9 cm diameter green jelly mould (see Figure 2a.1) and O4, a 7.5 cm long x 4.5 cm diameter red ice lolly stick (see Figure 6.1 upper panel).

There was no preliminary training of conditional discrimination in respect of the Set 2 stimuli, as this had been established for the first set of target relations. Listener relations were established to the new listener stimuli within one block of listener training. There was evidence of unprompted echoing of each of the auditory stimuli and matched vocalisations were produced in response to the tact probes. However, neither of these speaker behaviours were demonstrated to criterion following the learning of listener relations, alone.

Echoic training began when HS was 21 months and 14 days old. She experienced one 8-trial block of unreinforced echoic trials. After this baseline block of unreinforced echoic trials, HS refused to participate in the scheduled procedure. In the subsequent sessions, it was possible to conduct one test of each tact relation, only. Tacting was demonstrated to criterion after a further 16 sessions. Her responses in the Tact Test 1, the Listener Tests, and the Echoic trials are shown in Figure 6.3.2.1. Unprompted "echoic" responses are shown as scattered squares in the corresponding listener sections. There were no mismatched responses.

Listener responses were demonstrated to criterion in Blocks 1 and 2. HS was correct in 16/16 trials of */zog/* — O3 and in 16/16 trials of */geck/* — O4. There was evidence of matched vocal responding in the listener trials in 6/16 trials of */zog/* — O3 and in 8/16 trials of */geck/* — O4. She produced matched responses to the Tact Test 1 probes in 8/16 trials of O3 — "zog" and in 6/16 trials of O4 — "geck".

Learning Serial Pairs of Names

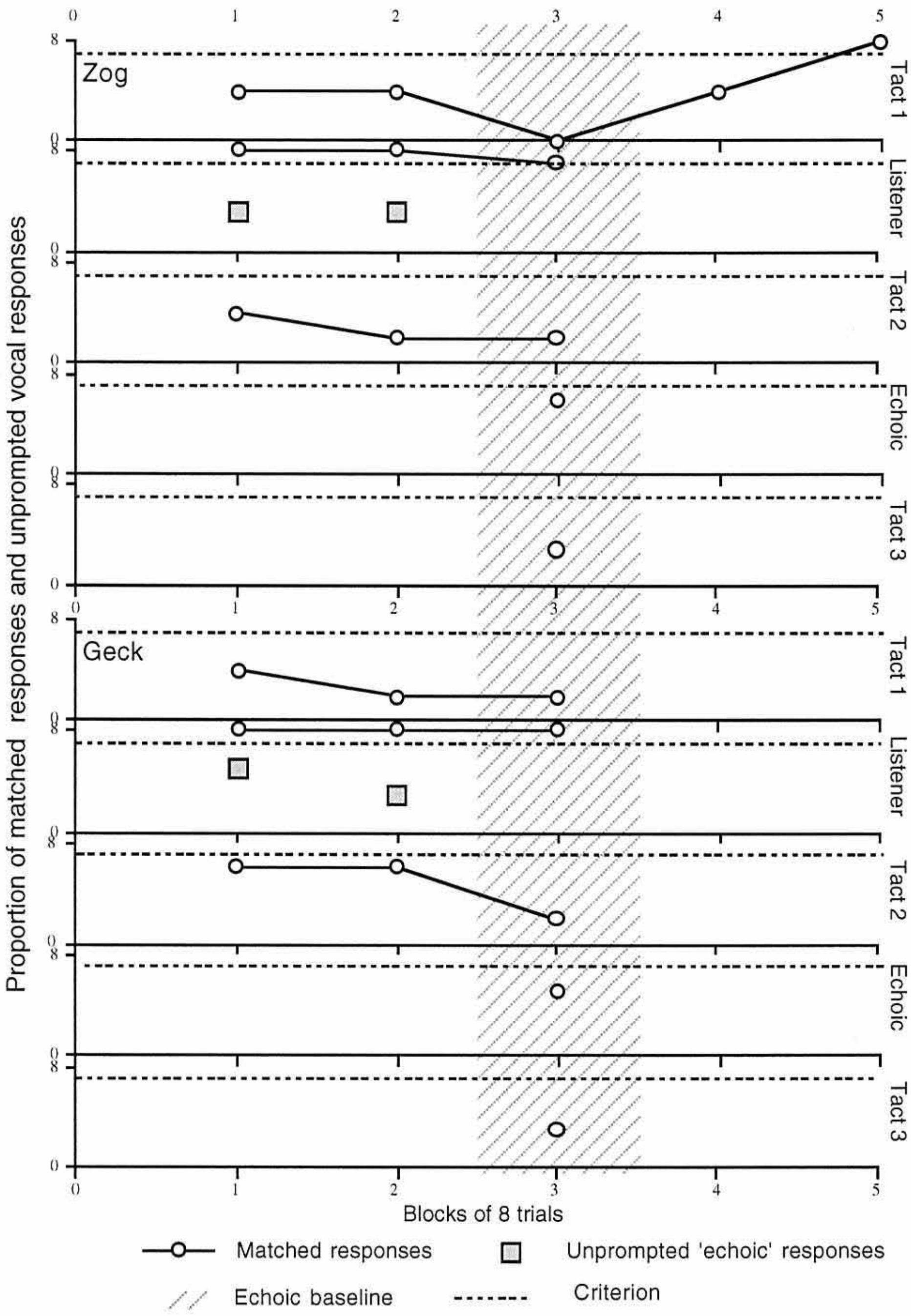

Figure 6.3.2.1 HS's matched responses and unprompted "echoic" vocalisations in the Tact Tests, the Listener Test and the Echoic trials of the Set 2 relations. Unprompted "echoic" responses are shown as filled squares.

Baseline echoic responding was probed in Block 3. She produced matched responses in 6/8 trials of */zog/* — "zog" and in 5/8 trials of */geck/* — "geck". Thus in the unreinforced condition echoing was not demonstrated to criterion. Listener responses remained robust, but there was no evidence of unprompted echoing in the listener trials, in Block 3. She produced no matched responses to the tact probes for O3 — "pab" and only two matched responses to the tact probes for O4 — "geck". Thus the introduction of the echoic probe resulted in a marked decrease in HS's vocal responding in the tact and listener trials.

In Blocks 4 and 5, only Tact Test 1 was conducted. Tacting to criterion was demonstrated in Block 5.

Thus for the Set 2, HS demonstrated tacting, but she was unable to comply with the full procedure. Consequently, although the listener relations had been demonstrated to criterion, echoing was not *demonstrated* to criterion.

There was no evidence to suggest that tact responding appeared first in the Test 2 trials. On the contrary, matched tact responses were first produced in Block 1, Trial 2, in the Test 1 trials, for each target relation, following one listener trial during which an unprompted echoic response was produced in respect of each target relation.

Summary

HS learned to name the Set 2 stimulus objects after learning both listener relations and being prompted to echo the corresponding auditory stimuli in the unreinforced condition. During the baseline echoic intervention phase, she did not produce any unprompted echoic responses during the listener trials. This was in contrast to the previous two blocks of listener trials, in which a high rate of echoing of the listener stimuli was observed. Tacting to criterion was evident at 22 months and 13 days. HS had learned four novel name relations.

Set 3

HS began to learn a third set of verbal relations at 22 months, 20 days. The new auditory stimuli were */bidge/* and */tade/.* The stimulus objects were O5, an 8 cm x 6 cm piece of plastic construction toy overall and blue in colour (see Figure 6.1 upper panel), and O6, a 5.5 cm x 8cm orange coloured iced lollipop mould, (see Figure 6.1, centre panel). Tacting was demonstrated for this pair of objects after listener training only. HS's responses in the Tact Test 1, the Listener Test, and the Tact Test 2 trials are shown, in Figure 6.3.3.1, for each test trial.

In the first four trials, tact responses to O5 and listener responses to */bidge/*were probed. In the following 12 trials tact and listener responding for both target relations were probed. Tacting was evident for both target relations from Trial 6 onwards.

In Tact Test 1 she produced 15/15 matched responses to O5 — "bidge". In the listener test trials, she produced 16/16 matched responses to */bidge/* — O5, during which she produced seven unprompted echoic responses. In the Tact Test 2, she produced 16/16 matched responses. The first matched tact response was produced, in Tact Test 2 in Trial 1, following a listener trial in which there was no evidence of echoic responding. Thereafter, her responses to all probes was faultless.

For the tact relation O6 — "tade", she produced 11/12 matched responses at Test 1 and 12/12 matched responses at Test 2. In the listener trials she was correct in 11/12 trials, during which she produced unprompted echoic responses in four trials. Her first correct tact response was produced in Tact Test 2, Trial 1; that is, following the listener trial, when, again, there was no evidence of echoing in the listener trial. Again, her responses in all subsequent trials was faultless.

Figure 6.3.3.1 shows that, for each target relation, tacting and listener responding were evident within one listener training trial. This suggests that, for HS, naming had become an higher-order behaviour.

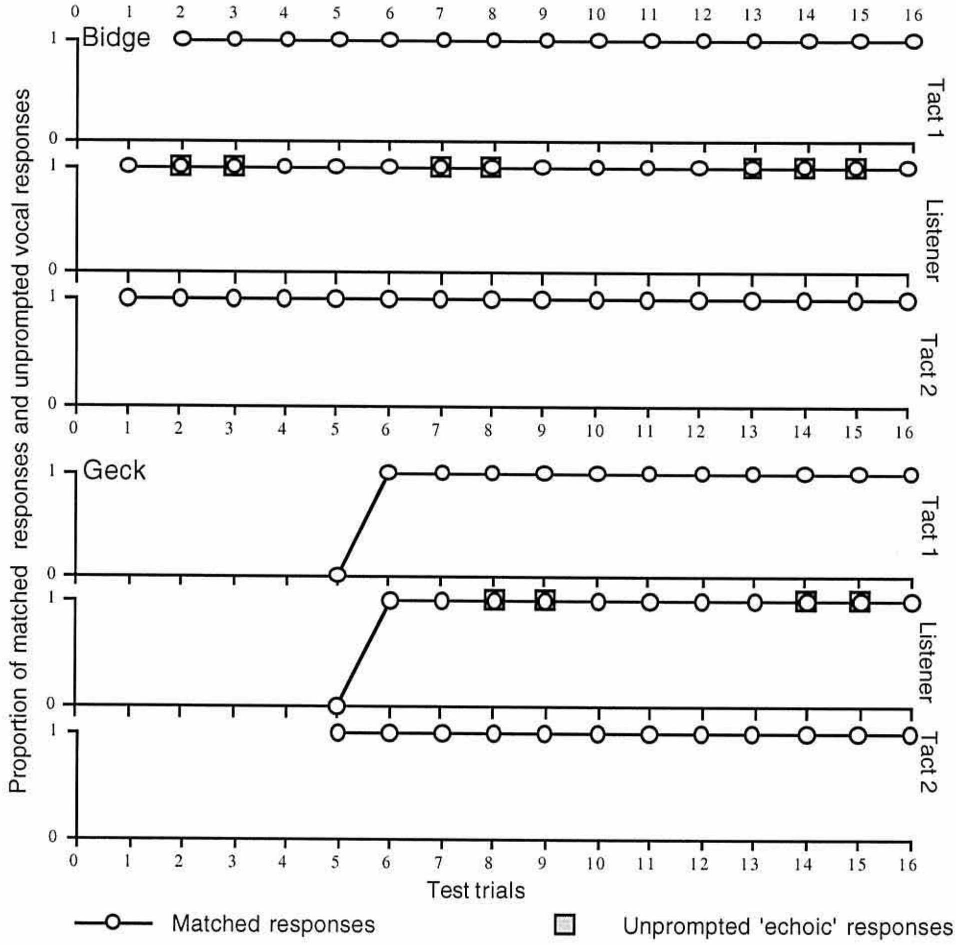

Figure 6.3.3.1 HS's matched responses, and unprompted echoic responses, in Set 3.

HS had learned six novel name relations by the age of 23 months. She had named the Set 3 stimuli after being directly reinforced only for correct listener responding. It appeared that she had learned a higher-order, or generalised, naming behaviour in which hearing a listener stimulus was discriminative for selecting a corresponding object while also responding echoically to the former, resulting in rapid learning of the tact and so the complete name relation.

If this was the case, then it would be expected that further name relations could be learned with comparative ease. Two further sets of name relations were trained. This was to examine whether this rate of learning would be maintained for further sets of names, or if there was a finite limit to the number of experimental name relations that an infant of less than two years could learn.

Set 4

The Set 4 auditory stimuli */veck/* and */lom/* were chosen to be a little more difficult to learn. The stimulus */veck/* varied from the stimulus */geck/* in only one consonant; this practice parallels that of the verbal community, but has been reported to occur only rarely in the first words of younger children (see Charles-Luce, & Luce, 1995; cf. Dollaghan, 1985). The non-word, */lom/* is a cvc non-word which differs from previous auditory stimuli in that the consonants were not stop consonants. *Lom* has a lateral approximant consonant and a bilabial nasal consonant. These are less precise than the stop or plosive consonants used to create the early non-words, and, although they are frequently produced in early infant phonetic repertoires, they appear to require careful articulation when produced echoically. The stimulus objects were also less common, and could not be named by many adults. They were an LED identification marker, that is, a 5cm x 2cm x 2cm yellow toggle shaped plastic object (see Figure 6.1, lower panel), and a 6cm x 3cm x3cm metal rod bender, a metallic blue light alloy irregular object (see Figure 6.1, lower panel).

HS began to learn the listener relations */veck/* — O7 and */lom/* — O8 at 23 months, 5 days. Sixteen sessions of listener training were conducted in which the tact relation was probed before and after the listener trials. The stimulus objects were presented together, that is as a pairwise discrimination test, from Session 1.

Figure 6.3.4.1 shows HS's first responses in the Tact Test 1, the Listener trials, and Tact Test 2, for these 16 sessions. Mismatched responses and unprompted "echoic" responses are shown as scattered squares in the corresponding sections of the graph.

For the listener relation */veck/* — O7, HS responded correctly in 16/16 trials showing that she had learned this listener relation. She produced unprompted echoic responses in 15 /16 trials showing that she had also learned to echo this auditory stimulus. She produced matched responses to the Test 1 tact probes in 5/8 trials in Block 1 and in 8/8 trials in Block 2. In the Test 2 probes, she responded correctly in 6/8 trials in Block 1 and 7/8 trials in Block 2. She produced three unprompted "tacts" in Block 1 and one in Block 2. These results suggest that HS had learned this name relation.

For the listener relation */lom/* — O8, HS responded correctly in 14 /16 trials. She had demonstrated criterion responding for this listener relation. She produced matched echoic responses in 15 /16 trials showing that she had already learned to echo this auditory stimulus (i.e., outside the experimental setting). In the Tact Test 1 she produced matched responses in 5/8 trials in Block 1 and 8/8 trials in Block 2, showing that she had learned to tact O8. In Test 2, she produced matched responses in 5/8 trials in Block 1 and in 8/8 trials in Block 2. She produced four unprompted tacts in Block 1 and five in Block 2.

Thus for Set 4, it required four test trials of the listener relation during which the echoic response was also demonstrated, for her to produce a first matched response in the tact tests. This was true of both name relations. Matched tact responses for each tact relation were produced in every trial from Trial 5 onwards. The listener relations were readily demonstrated and the listener stimuli, though chosen to be less easy to articulate, were echoed in almost every trial. HS was 23 months and 11 days when she demonstrated these name relations to criterion. She had learned these target relations in just 6 days.

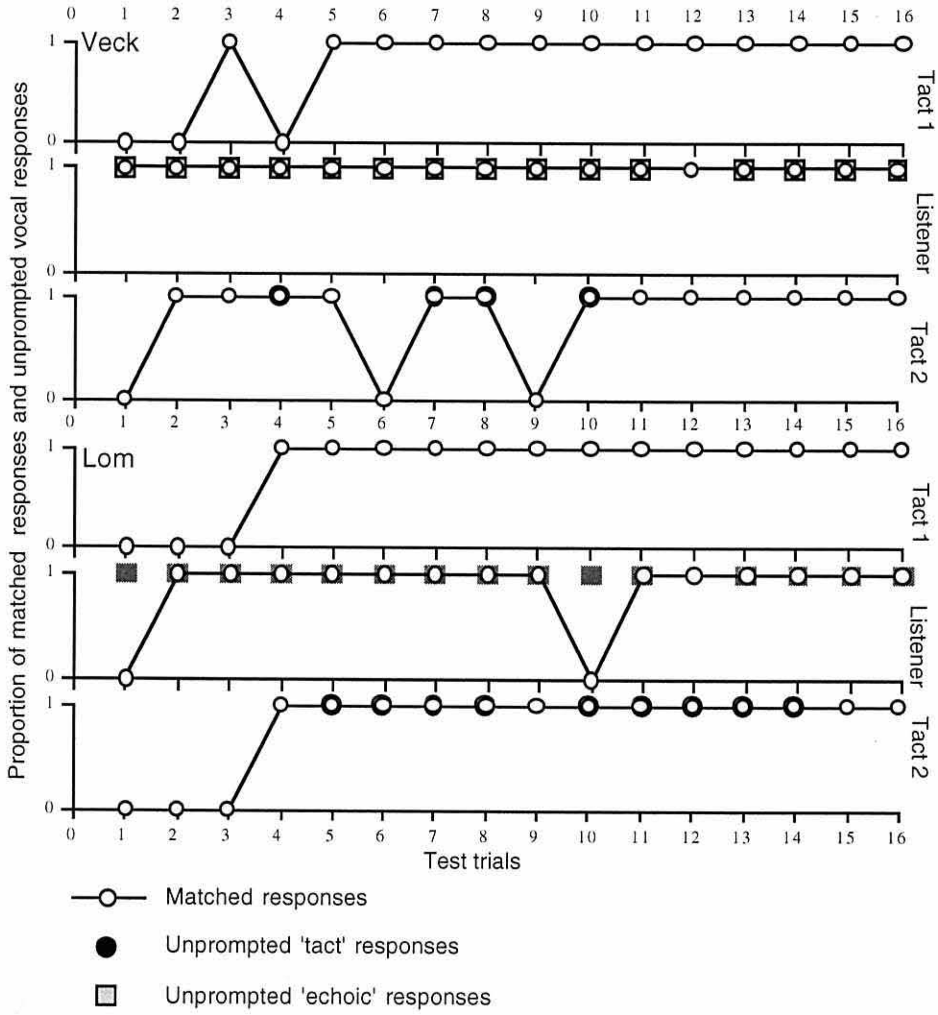

Figure 6.3.4.1 HS's responses in the Tact Test1, the Listener Test and the Tact Test 2, for the Set 4 target relations. Unprompted vocal responses are shown as filled circles and squares (see legend).

Set 5

The Set 5 auditory stimuli were */ditta/* and */toma/*. The stimulus objects were O9 — a 8.5 cm in diameter and 3 cm high orange pastry ring cutter (see Figure 6.1, lower panel) and O10 — a 3 cm diameter x 3cm high green plastic cotton reel (see Figure 6.1, upper panel).

Learning Serial Pairs of Names

HS began to learn the listener relation */ditta/* — O9 and */toma/* — O10 at 23 months 11 days. Tact responses were tested before and after every listener trial. A single block of listener training was followed by one block of tact testing only. Her responses are shown in Figure 6.3.5.1.

For the listener relation */ditta/* — O9, she responded correctly in 8/8 trials, showing that she had learned this listener relation. She produced matched echoic responses in 6/8 trials showing a high rate of echoing of this auditory stimulus. In the Tact Test 1 she produced matched responses from Trial 4 onwards, and was correct in 5/8 trials in Block 1. In the Tact Test 2, she produced matched responses in 7/8 trials. She produced no unprompted tacts.

For the listener relation */toma/* — O10, listener responses were correct in all eight trials of Block 1 showing that she had learned this listener relation. She produced unprompted echoic responses in all eight trials, showing that she had learned the corresponding echoic relation without direct training. In the Tact Test 1, she produced matched responses from Trial 4 onwards and was correct in 5/8 trials in Block 1. In the Tact Test 2, she produced matched responses in 8/8 trials. She produced no unprompted tacts.

In Block 2, she produced matched responses in 8/8 tact trials for both tact relations. Thus HS had learned two further name relations. She was 23 months and 15 days old and had learned a total of ten novel names.

The Set 3 – 5 name relations were learned through being directly reinforced for listener responding and contiguous unprompted echoic responding only. This sustains the hypothesis that she had acquired higher-order naming during the period in which she learned to name the Set 2 stimuli.

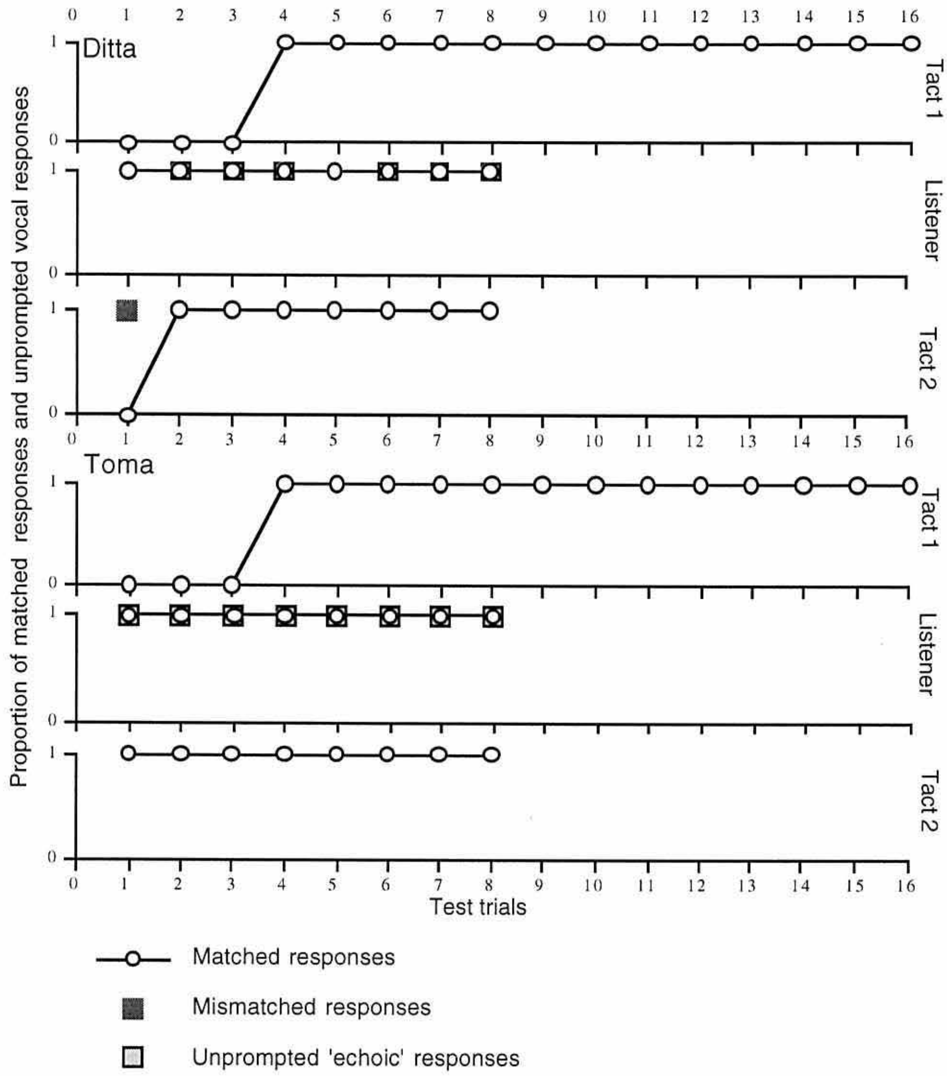

Figure 6.3.5.1, HS's matched, mismatched and unprompted responses in the Tact Test 1, the Listener Test, and the Tact Test 2, for the Set 5 relations.

Maintenance of the Tact Relations

During the training of subsequent pairs of name relations tact tests for earlier trained relations were conducted at the end of most experimental sessions. In the Set 2 period, she responded correctly to 10/13 tact probes for O1, and 12/13 tact probes for O2. In the Set 3 period, she responded correctly in 15/15 trials of each previously trained tact relation (i.e., O1, O2, O3, and O4). In the Set 4 period, she produced matched tact responses in 15/15 trials of O1, O2, O3, O4, and O6, and in 14/15 trials of O5. In the Set 5 training she produced 7/7 matched responses to O1. O2, O3, O4, O6, O7, and O8, and in 5/7 trials of O5. Following the Set 5 training she produced matched tact responses in 6/6 trials for each of the ten trained relations. These results strongly suggest that HS had learned all ten novel name relations.

Generalisation

Having learned ten names to criterion it was important to test whether these names would generalise on the basis of common shape, as suggested by Landau, Smith, and Jones (1998). Novel exemplars of the trained stimulus objects were tested in a massed naming test, as follows.

First ten novel coloured objects were placed in a box with eight non-experimental objects. Four of the non-experimental objects were readily nameable and four were difficult to name. The easy to name objects were a fish, a spoon, a car, and a boat. The difficult to name objects were unused experimental stimuli, two toy road traffic signs, a complex hook, and a paint scraper.

In the test the objects were removed from the box one at a time and shown to HS. She was then asked, "Do you know what this is?" When she produced a vocal response, or after five seconds had elapsed, the object was placed on the table and another object removed and the process repeated until all the items had been presented for naming.

Two trials were usually conducted in each session. In the second trial HS was given the object and after producing a response, or the usual response interval, she was asked to put it back in the box.

Tests for texture variants were conducted in a similar way.

Eight trials were conducted for each set of novel variants. Figure 6.3.6 shows the percentage of HS's matched responses in the test for generalisation of tact responses.

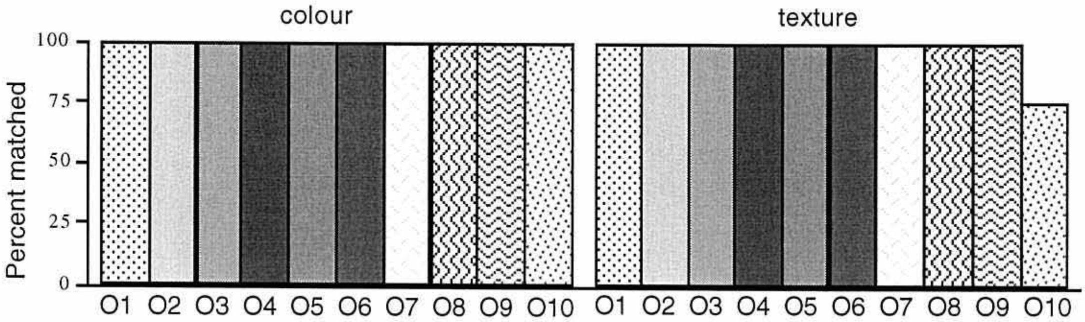

Figure 6.3.6 The proportion of HS's matched responses to the test for generalisation of the tact responses to common shaped objects of different colour and texture from the trained stimulus objects.

HS produced matched responses in 8/8 of the colour variant trials for all ten name relations. She produced matched responses in 8/8 of the texture variants for nine of the ten name relations. She was correct in 6/8 trials of the texture variant of toma. The binomial probability of producing a matched response by chance in 6/8 trials (n = 8, p = 0.1, p(6) = 0.000023) is extremely unlikely. In all, she produced 158/160 matched responses (mrr = 0.99). HS's responses in the generalisation test are shown in Table 6.3.2. They strongly suggests that all these name relations were generalised on the basis of common shape.

Table 6.3.2

The number of correct responses as a fraction of the number of trials in the tests for generalisation of the trained names to novel exemplars of similar shape but of either different colour or different texture from the trained stimulus objects.

VARIANT	O1	02	03	O4	O5	O6	O7	O8	O9	O10	TOTAL
colour	8/8	8/8	8/8	8/8	8/8	8/8	8/8	8/8	8/8	8/8	80/80
texture	8/8	8/8	8/8	8/8	8/8	8/8	8/8	8/8	8/8	6/8	78/80
total	16/16	16/16	16/16	16/16	16/16	16/16	16/16	16/16	16/16	14/16	158/160

Conclusion

HS began the experiment when she was 14 months and 4 days old. She learned to name the first pair of objects after learning listener and echoic responses separately, but after producing unprompted, but adventitiously reinforced, echoic responses in the listener trials. She learned the second pair of name relations after learning the listener relations and responding echoically in the unreinforced echoic trials, and, consequently, producing unprompted but reinforced echoic responses in the listener trials. At this point HS refused to participate in the full procedure and, in the last two blocks, would only respond to the tact probes. Tacting was demonstrated without further training. Her reluctance to participate coincided with the appearance of a generalised naming response. She learned six further name relations from minimal exposure to listener training. The first pair of name relations were learned in 6 months, the second pair in 2 months, the third, fourth and fifth pairs were learned in 15, 6, and 4 days respectively. Generalised untrained echoing was evident in all five sets, in the listener training.

Participant RB

RB began the experiment when he was 13 months and 28 days old. His phonetic inventory was recorded over four familiarisation sessions. During these trials he gave a familiar object on request in 6/6 trials and was able to place a toy character in a toy vehicle in 16/16 trials. He began to learn to respond to the familiar objects as a listener, in the Step 2 pairwise discrimination setting, at 14 months and 4 days old. He selected a train in 3/4 trials when it was paired with an unnamed car. He selected a spoon correctly when it was paired with an unnamed fish in 12/18 trials, selecting correctly in the last seven trials. He learned to discriminate the familiar objects to criterion, in the Step 3 pairwise comparison, when he was 15 months and 27 days old, after one block of pairwise trials with a fish and a spoon. Finally, in one block of Step 4 trials, when listener responding to one novel object was probed, he responded correctly in 8/8 trials.

Learning Serial Pairs of Names

Set 1

The auditory stimuli were */paba/* and */ditta/* and the stimulus objects were a 8.5 cm x 15 cm blue scraper (see Figure 6.1, centre panel), and an 8.5 cm in diameter and 3 cm high orange pastry ring cutter (see Figure 6.1. lower panel).

RB began pairwise discrimination of the Set 1 experimental stimuli at 16 months 7 days. Tact responses were probed before and after the listener trials. Listener responding was demonstrated to criterion within one block of eight listener training trials. RB's pairwise listener training, to this point, is shown in Table 6.4.1.

Table 6.4.1

The number of correct listener responses and listener trials for each type of listener trial during the Set 1 listener training and testing stages. The target relation is shown in bold type.

Listener Relation	*/ditta/* **O2** vs spoon	*/paba/* **O1** v O2	*/ditta/* O1 v **O2**
Training	19/19	8/8	7/8
Testing		8/8	8/8
Total	19/19	16/16	15/16
mrr	1	1	1

During the listener training period, there was very little evidence of responding to the tact probes. RB produced no matched responses to tact probes for O1, and matched responses in 3/32 probes to tact O2. He produced two unprompted echoic responses in the Block 2 listener trials of */paba/*, but there was no evidence of unprompted echoing of /ditta/. Thus, learning the listener relations to criterion did not give rise to corresponding speaker behaviour, as echoing of the listener stimuli, or as tacting of the corresponding stimulus objects, for either of the target relations. RB's responses in the Tact Tests, the Listener Test, and the Echoic trials are shown in Figure 6.4.1.1. Unprompted vocalisations and mismatched responses are shown as scattered squares.

Learning Serial Pairs of Names

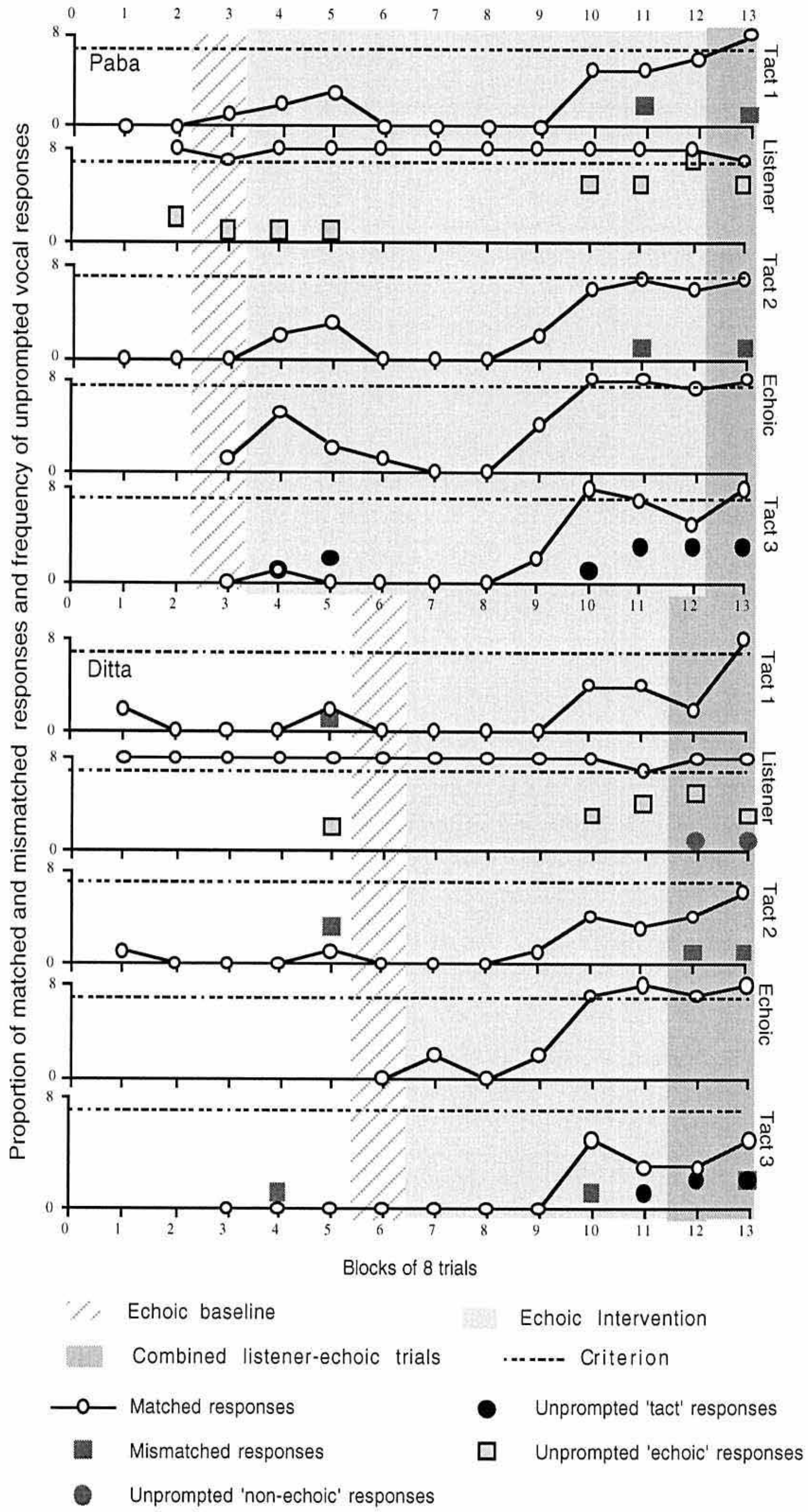

Figure 6.4.1.1 RB's matched and mismatched responses and his unprompted target responses in the Tact Tests, the Listener Test, and the Echoic trials for Set 1.

In Block 3, eight trials were conducted when echoing of */paba/* was probed in the unreinforced (i.e., baseline) condition and in the absence of the stimulus object. RB produced only one echoic response in this 8-trial block. His tact and listener responses remained unchanged. He produced one matched response in the 24 probes to tact O1 and no matched responses to probes to tact O2. Listener responses were correct in 7/8 trials of */paba/* and he produced one unprompted echoic response in this 8-trial block.

Listener responses to */ditta/* were correct in 8/8 trials but there was no evidence of unprompted echoing of this latter auditory stimulus (see Figure 6.4.1.1). This was followed, in Blocks 4 and 5, by two 8-trial blocks in which reinforcement of matched responses to the echoic probes for */paba/* was available. The Tact Tests 1 and 2 and listener trials for both name relations were tested in every session, prior to the echoic probes and Tact Test 3 for */paba/* only.

Responding to the echoic probes increased in Block 4, but despite the availability of reinforcement for echoic responding, in Block 5, echoing was very infrequent. RB produced two unprompted echoes of */paba/* and two of */ditta/* in these two 8-trial blocks. He produced 11 matched responses to the 48 probes to tact O1 (mrr = 0.23) and three unprompted "tact" responses during this period. He also produced three matched responses to the 48 probes to tact O2 (mrr = 0.063), and five mismatched responses. Thus, although there was an increase in the production of target responses, responses were sometimes mismatched; RB's response rates were well below the criterion for tacting.

As echoic responding was becoming increasingly infrequent, the echoic training was extended to the second target relation. In Block 6, echoing of */ditta/* was probed in the baseline condition and in the absence of the stimulus object. There was no evidence of echoic responding to */ditta/*, in the baseline condition. Listener responding remained at criterion and there was no evidence of unprompted echoing. There was no tact responding. Similarly, there was no change in respect of the first echoic relation. Echoic responding continued to be infrequent, and was recorded in only one of the eight sessions. Listener responding was maintained at criterion level but there was no unprompted echoing. Again, there was no evidence of tacting (see Figure 6.4.1.1).

Reinforcement for matched echoic production of "ditta" was available from Block 7 onwards. Echoing began to emerge in Block 9, for both target relations simultaneously, and RB demonstrated echoing to criterion for both target relations in Block 10. Having learned to echo, RB also began increasingly to produce echoic responses in the listener trials. Tact responding also began to increase from Block 10 onwards, and was particularly evident in Tact Test 3 for O1. There was a correlated increase in the production of unprompted "tact" responses.

The Block 11 trials were conducted to see if tacting to criterion would be demonstrated without further intervention. In these eight trials, the listener and echoic relations continued to be probed separately for both name relations. However, despite the increased production of tact responses in respect of both target relations, production of matched responses in Tact Test 1, the criterion test remained below criterion.

In Block 12, listener and echoic responding were combined for */ditta/* but remained separate for */paba/*. That is, the intervention was implemented for the second target relation. This was because tact responding in respect of O1 was at, or just below, the criterion level in Tests 2 and 3, and such tact responding had frequently preceded attaining criterion at Tact Test 1 for earlier participants. Finally, in Block 13, listener and echoic responses were combined for both target relations.

In the last two blocks of trials, there was evidence of a high frequency of target vocalisations in all sections of the procedure. In Block 12, listener and echoic trials were combined for */ditta/* such that echo-tacting was reinforced; but unprompted echoing was at criterion level in the listener trials for */paba/*, resulting in similar, albeit adventitious, reinforcement of echo-tacting for this relation, too. There was evidence of unprompted tacting of each stimulus object, and there was some evidence of intraverbal responding (i.e., saying "ditta, paba, ditta", or similar intraverbal strings) during the listener trials of */ditta/.* He had learned the Set 1 name relations by the age of 21 months 28 days.

Summary

RB learned to name the first pair of novel objects following listener training, echoic training and combined listener–echoic training.

Following training with the familiar objects, the Set 1 experimental listener relations were learned in one block of eight trials, when RB was 16 months 15 days old. Both listener relations were maintained, to criterion level, throughout the experiment.

Echoing did not emerge as a result of listener training. Learning to echo required considerable training under reinforced conditions before it was demonstrated to criterion when he was 21 months 10 days old. As echoing reached criterion level, in Block 10, an increase in the production of unprompted matched echoic responses was observed. This occurred in both the listener and the echoic trials. There was a corresponding increase in unprompted putative tacts. RB demonstrated tacting to criterion for both target relations in Block 13, after being reinforced for echo-tacting as a scheduled intervention for ditta and adventitiously for paba.

Tacting did not emerge as a result of learning the listener relations nor as a result of learning the listener and echoic relations separately. Matched responses to the tact probes began to increase from Block 10, when echoing was established. However, the frequency of the matched responses remained below criterion level, and there was evidence of mismatched responding.

Tacting to criterion was demonstrated in Block 13, after the listener and echoic responses had been combined for both target relations. At this stage echoic and listener responding were also at criterion level. Thus RB was able to demonstrate the full name relation for both O1 — "paba" and O2 — "ditta" at 21 months 28 days old.

Set 2

RB began to learn the Set 2 verbal relations at 21 months and 29 days old. The Set 2 auditory stimuli were */zog/* and */geck/.* The Set 2 stimulus objects were a O3, a 3 cm high x 9 cm diameter green jelly mould (see Figure 2a.1) and O4, a 7.5 cm long x 4.5 cm diameter red ice lolly stick, (see Figure 6.1, upper panel).

RB learned the Set 2 listener relations within one block of eight trials. Echoing was prompted in the unreinforced baseline condition in Blocks 2 and 3. The echoic relations were demonstrated in two blocks of unreinforced echoic probes. It would appear that, at 22 months of age, RB's minimal echoic repertoire was sufficiently well developed for him to produce the correct responses to the echoic probes. Tacting emerged in line with his echoic responding. Figure 6.4.2.1 shows his first responses in the Tact Tests, the Listener Test and the Echoic trials, session by session. Unprompted matched responses and mismatched responses are shown as filled circles and squares (see legend).

In the first eight trials, RB demonstrated both listener relations to criterion. He produced 8/8 correct responses to */zog/*, in which he produced unprompted matched echoic responses in four trials; and he produced 8/8 correct responses to */geck/*, in which he produced unprompted echoic responses in three trials. He produced no matched responses but produced three mismatched "ditta" responses in the Tact Test 1 for O3, and he produced two matched responses and one mismatched response in Test 2. However, he produced matched responses in 6/8 trials of O4 at the criterion Test 1, and 7/8 matched responses in Test 2 (see Figure 6.4.2.1).

Echoing was probed in the unreinforced baseline condition in Sessions 9 - 24. In Block 2 (i.e. Sessions 9 – 16), RB produced 6/8 matched responses to probes for the echoic relation */zog/* — "zog" and one mismatched "geck" response. He produced 8/8 matched responses to probes for the echoic relation */geck/* — "geck".

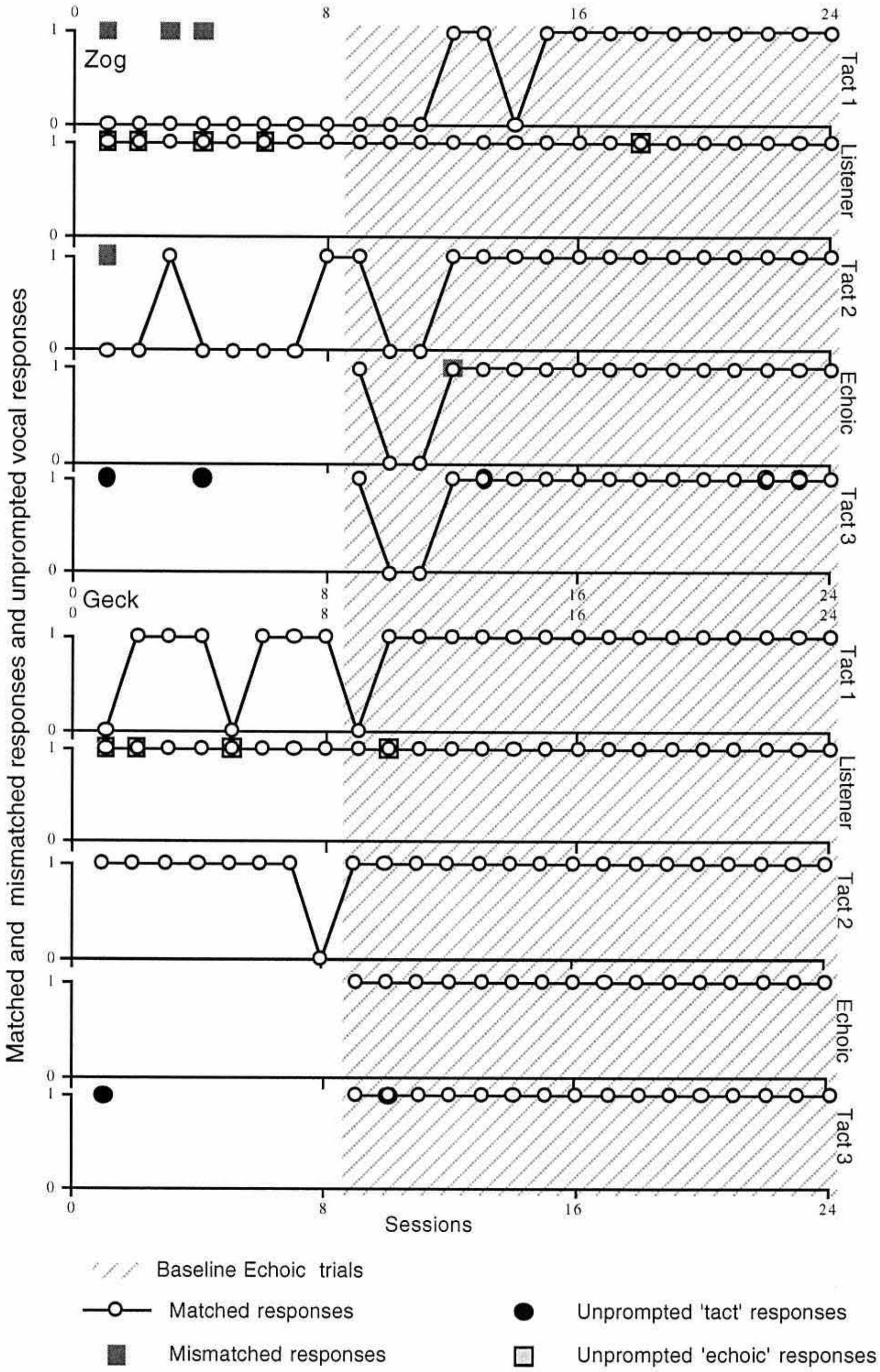

Figure 6.4.2.1, RB's matched and mismatched responses and unprompted matched vocalisations, in the Tact Test 1, the Listener Test and the echoic trials for the Set 2.

Listener responding, in Block 2, was maintained at criterion level for each listener relation. However, there was evidence of unprompted echoic responding in only one session, in respect of */geck/*. There was increasing evidence of matched responding in the tact tests. In the Tact Test 1 of Block 2, RB produced matched responses in 4/8 trials of O3 — "zog", but he produced 6/8 matched responses in each of Tests 2 and 3. In Tact Test 1, of O4 — "geck", he produced matched responses in 7/8 trials, demonstrating this relation to criterion. He also produced 8/8 matched responses in each of Tests 2 and 3.

In Block 3 he produced matched responses in 8/8 trials for all the tested relations, that is the Tact Test 1, 2 and 3, in the Listener Test and in the Echoic trials for both zog and geck. Thus, RB learned to name the Set 2 stimuli in three weeks; at 22 months 20 days old he had learned four novel name relations.

Summary

RB began to learn the Set 2 verbal relations at 21 months 29 days. He learned the listener relations in one block of eight trials. This enabled him to produce speaker behaviour for one auditory stimulus only. However, when probed to echo in the unreinforced condition he demonstrated that he could also echo the second auditory stimulus. This suggests that his pre-existing generalised echoic repertoire was sufficient for him to be reinforced by hearing his own approximations to the target verbal response (see discussion). Under this speaker-listener control, even in the absence of overt unprompted echoing in the listener trials, tacting of both stimulus objects was immediately available. That is, as predicted by higher-order naming, the availability of, first listener behaviour, and then speaker behaviour (as echoing), was sufficient for him to produce the corresponding verbal response when probed to tact the stimulus objects. Thus he had learned all the verbal relations entailed in naming of the Set 2 stimuli. He was 22 months 21 days old.

Set 3

RB began to learn the verbal relations for Set 3 at 22 months 22 days. The Set 3 auditory stimuli were */bidge/* and */lom/*. The stimulus objects were a 15.5 cm x 6 cm yellow adhesive spreader (Figure 6.1, upper panel), and a 9.5 cm x 4 cm pink paper clip (Figure 6.1, centre panel). He was given a baseline name test to ensure that he did not already have names for the stimulus objects. In four trials of each tact relation, he produced no responses.

Listener training began immediately after the baseline name test; responding was demonstrated to criterion in Block 1. Without further training, tacting was demonstrated to criterion in Block 2. However, listener responding was not maintained to criterion for the bidge target relation. One further block of eight trials was completed, after which both tact and listener relations were demonstrated to criterion for both target relations. Figure 6.4.3.1 shows the number of matched responses in Tact Test 1, and Tact Test 2, and the Listener Test responses and unprompted echoic responses, session by session.

In the Block 1 (Sessions 1 – 8) trials of the listener relation */bidge/* — O5, RB produced eight correct listener responses, and he produced five unprompted echoic responses during these listener trials. During this period, he produced four matched tact responses in Test 2, but only one matched tact response in Test 1. He also produced several mismatched tact responses, four in Tact Test 1, and four in Tact Test 2. This suggests that tact responding was increased as a consequence of hearing and echoing each of the auditory stimuli in the listener trials, but that, at least initially, the vocal responses were indiscriminate.

Similarly, listener responding to */lom/* reached criterion within one block of training, in Block 1. RB produced 7/8 correct responses for this relation and produced unprompted echoes in 4/8 trials. Following orienting to the stimulus object in the reinforced listener trials, RB's tact responding to O6 was correct in 7/8 trials in the Tact

Test 2 and there was evidence of unprompted tacting of this object, in Session 8. After producing one mismatched tact in Session 2, RB began to produce matched responses, in Tact Test 1, from Session 4 onwards.

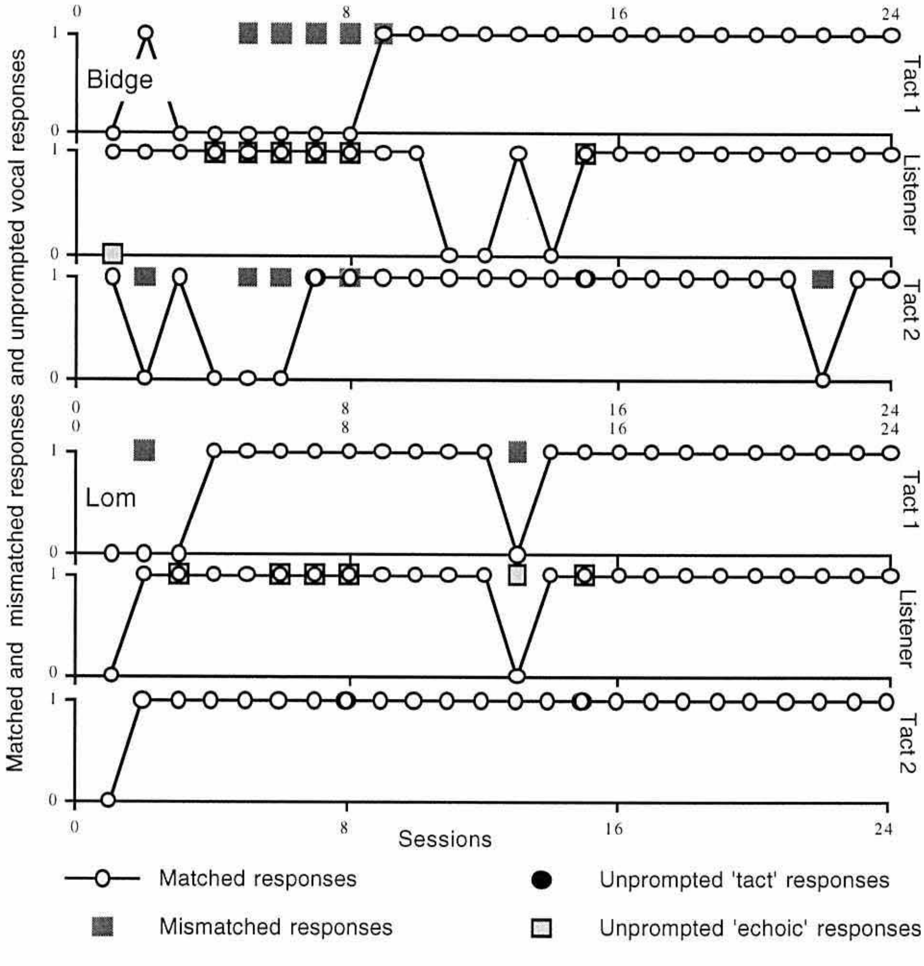

Figure 6.4.3.1 RB's responses in the Tact Test 1, the Listener Test, and the Tact Test 2, for the Set 3 target relations. Mismatched responses and unprompted responses are shown as filled circles and squares (see legend).

Listener responding to */bidge/* returned to chance frequency in Block 2, Sessions 9 – 16. He produced only five correct listener responses in the */bidge/* — O5 trials, during which there was only one unprompted echoic response. Nevertheless, he produced matched responses in 8/8 tact trials in Tact Test 1 and 8/8 in Tact Test 2, for the bidge target relation. He also produced one unprompted "bidge" "tact" response, in Session 15.

In Block 2, Sessions 9 – 15, for the */lom/* — O6 target relation, RB produced correct listener responses in 7/8 trials, and he produced two unprompted echoic responses. He produced matched responses in 7/8 trials in Tact Test 1 and in 8/8 trials in Tact Test 2. Thus he had demonstrated tacting and listener behaviour to criterion simultaneously for O6 — "lom", in Block 2, but had only demonstrated listener and tacting to criterion in separate blocks for O5 – "bidge".

The Block 3 trials, Sessions 17 – 24, were conducted without further intervention. Figure 6.4.3.1, shows that RB's responses were at criterion for all the target relations in these sessions. He responded correctly in 8/8 listener trials (mrr = 1) of each listener relation, but he produced no unprompted echoic responses. He also produced matched responses in 8/8 tact probes in Tact Test 1 for each tact relation. Thus he had demonstrated the Set 3 target relations to criterion.

There was evidence in both these name relations that unprompted echoic responding was present whilst the tact relation was being established but once the tact relation had been established echoing diminished or disappeared. However, it is not possible to exclude covert echoing here.

Summary

The Set 3 name relations were learned in three blocks of eight trials in which only the listener and tact responses were probed. There was evidence of a high frequency of unprompted echoic responding in the early listener trials. Tacting was seen first in Test 2, that is, following the listener trials, and quickly extended to Test 1. Listener responding to */bidge/* — O5 was disrupted in Block 2. Criterion responding to the listener and tact probes for both name relations was evident in Block 3. RB was 22 months and 29 days old.

Set 4

RB began to learn the Set 4 listener relations at 22 months and 29 days old. The auditory stimuli were */lud/* and */toma/.* The stimulus objects were O7 - a 25 cm long yellow hollow bar, which was 3cm x 3cm x 3cm triangular in section (see Figure 6.1, centre panel), and O8 – a 3.5 cm in diameter x 3.5 cm high green cotton reel (see Figure 6.1, upper panel).

To ensure that RB did not have names for these objects a tact test was conducted in which two familiar objects and the two novel experimental objects were presented in four trials of each tact relation. He named the toy character Noddy correctly in 4/4 trials and Big Ears correctly in 4/4 trials. He did not name the novel objects scoring 0/4 for O7 and 0/4 for O8. RB's responses in the test trials of each target relation are shown, session by session, in Figure 6.4.4.1.

Listener responding was tested over two blocks of eight trials and was demonstrated to criterion in both blocks of trials. It appears that, by chance, he selected the correct object in Trial 1, and thereafter was able to correctly identify the second object by exclusion, (i.e., novel name, novel object). However, given the frequency of unprompted echoing in the early sessions, this result might be described equally well as learning to learn, or higher-order pairwise discrimination (see summary). RB also produced unprompted echoic responses during five consecutive listener trials of */toma/* — O7, and in 4/16 listener trials of */lud/* — O8.

Tact responding to O7 — "toma" began to emerge in Block 1. He produced 6/8 matched responses in Test 2. Matched responses were produced in Tact Test 1 in 4/8 trials, from Session 5 onwards. This was correlated with the production of unprompted but adventitiously reinforced echo-tact responses in the listener trials in Sessions 2 – 6.Tact responding to O8 — "lud" was evident in 7/8 trials in Tact Test 1, and in 7/8 trials in Tact Test 2, thus criterion tacting of this object was seen within one block of trials. In both tests, matched responding first appeared in Session 2.

Learning Serial Pairs of Names

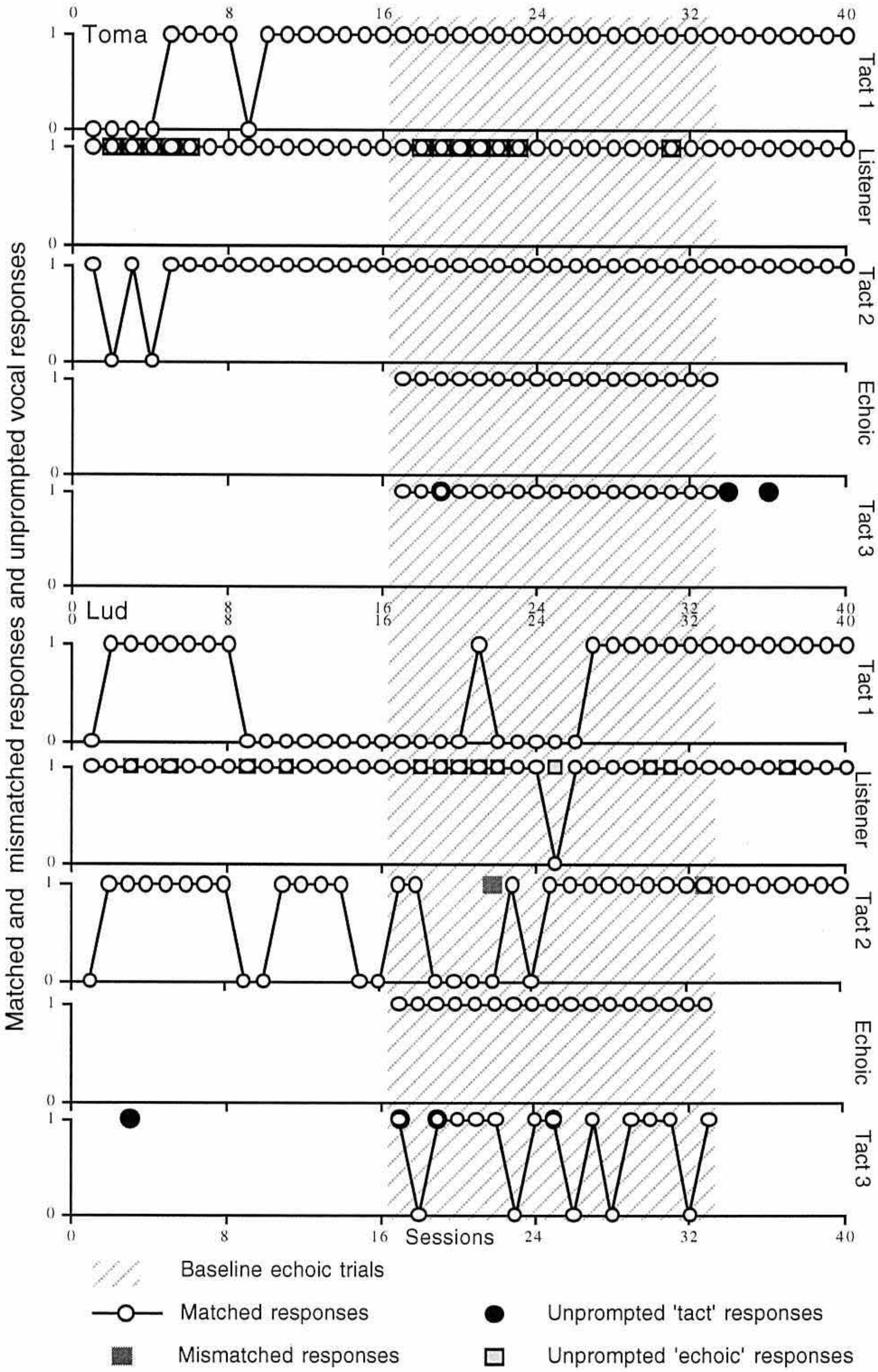

Figure 6.4.4.1 RB's responses in the Tact Tests, the Listener Test, and the Echoic trials for the Set 4 target relations. Mismatched responses and unprompted vocal responses are shown as filled circles and squares (see legend).

While matched responding to the probes for O7 continued, such that criterion tacting was seen in Block 2, responding to O8 virtually disappeared from the Tact Test 1 trials, and matched responses were produced in only 4/8 Tact Test 2 trials, of O8 — "lud" (see Figure 6.4.4.1). Thus, after two blocks of listener training the listener relations */toma/* — O7 and */lud/* — O8 were at criterion, but the corresponding tact relations had not been demonstrated simultaneously.

In Blocks 3 and 4, the echoic relations */lud/* — "lud" and */toma/* — "toma" were probed in the baseline unreinforced condition, and in the absence of the stimulus objects. Both echoic relations were demonstrated to criterion in Block 3, indicating that the listener stimuli were within his pre-existing echoic repertoire.

For the tact relation O7 — "toma", under conditions of unreinforced echoic responding in the echoic trials and adventitious reinforcement of unprompted echoic responses in the listener trials, production of tact responses in respect of O7 — "toma" were demonstrated in all tact test trials from Session 10 onwards. All listener responses to */toma/* were correct throughout the training period, and echoic responses of "toma" were produced in every session in which they were probed. This suggests that this name relation had been established in Block 1 as a consequence of producing unprompted echoic responses in the reinforced listener trials of /toma/ — O7.

The unreinforced echoic probes for */lud/* — "lud" were similarly correlated with an increase in unprompted echoic responding in the listener trials for this target relation. Although responding to the tact probes for O8 remained infrequent in the Tests 1 and 2 trials, there was evidence of increasingly reliable responding in the Test 3 trials, that is, following the echoic probes. Matched responding gradually extended to the Test 2 trials and finally to the Test 1 trials. Matched responding was demonstrated in the criterion Tact Test 1 from session 27 onwards. As RB clearly had echoic responses in respect of each of these auditory stimuli, the unreinforced echoic probes were omitted in Block 5.

Tacting to criterion was demonstrated for both tact relations simultaneously in Block 5, without further training. Listener responding was at criterion for both target relations throughout the training. Thus RB had learned a further set of name relations. He was 23 months 23 days old.

Summary

RB had learned two more name relations to criterion after being reinforced for listener responding and being probed to echo in the unreinforced condition. The O7 — "toma" name relation emerged from listener training alone. It appears that in learning name relations in earlier sets, RB had learned higher-order naming. However, having responded to test trials of O8 — "lud" correctly in Block 1, he developed a less appropriate "mmmm" response during trials for this tact relation in Block 2. This vocal response appeared to under the control of contingencies external to the experimental setting. Prompted echoing coincided with the production of unprompted echoing in the listener trials for both target relations, and this was correlated with improved matched responding to the tact probes in Test 2 and Test 3 in Block 3. Tacting of O8 — "lud" was seen at criterion level, in Test 2 of Block 4. This was followed by criterion responding in Test 1 in Block 5. Thus by the age of 23 months, 23 days RB had learned eight novel name relations.

Set 5

Training of the fifth and final set of name relations began on the same day with a baseline naming test of the novel stimulus objects. The auditory stimuli were */mip/* and */kov/*. The stimulus objects were a 4 cm high orange toy road traffic cone with a base 3cm x 3cm (Figure 6.1, upper panel), and an 8 cm x 6 cm and 1 cm deep green piece of construction toy shown (Figure 6.1, upper panel).

In the baseline naming test RB named a fish correctly in 4/4 trials, a spoon correctly in 4/4 trials but was unable to produce any names in the four trials of each novel tact relation. Once again, the two novel listener relations were demonstrated to criterion within one block of eight trials. Responding was correct in the first trial, and subsequent correct responding in trials of the second target relation were demonstrated either by exclusion, or by having learned to learn pairwise discriminations during listener training in the earlier sets (see discussion). In Block 1, Sessions 1 – 8, RB produced unprompted echoic response in four trials of */mip/* — O9, and in two trials of */kov/* — O10. Tact responses were not produced to criterion. He produced only one matched response to the tact probes for O9 — "mip", in Test 2. He produced four matched responses to tact probes for O10 — "kov", all in Test 2. This response rate was well below the criterion for tacting. RB's responses in the Tact Tests, the Listener Test and the Echoic trials of Set 5 are shown in Figure 6.4.5.1. Unprompted matched vocalisations responses are shown in the corresponding listener or echoic trials as filled circles and squares.

Echoing was probed in the absence of the stimulus objects and without reinforcement for matched responding, in Blocks 2 and 3, Sessions 9 - 24. Echoing was demonstrated to criterion in Block 2 (see Figure 6.4.5.1). Once again, it appears that the auditory stimuli were within the minimal echoic repertoire of this infant.

Tacting of O10 was evident in Tact Test 2, in Block 1, that is after the listener trials. There was evidence of overt echoing in two of these listener trials, and it is not possible to exclude the possibility of covert echoing in other trials, since strong echoic behaviour was demonstrated, without reinforcement, in Block 2. Probing of echoic behaviour, in Block 2, was correlated with a corresponding increase in matched responses in all subsequent tact probes for O10. RB continued to respond accurately in the listener trials of */kov/* and produced three further unprompted "echoic" responses in the listener trials. There was evidence of unprompted tact responding, in respect of O10, in Sessions 23 and 24. Thus this name relation was demonstrated to criterion in Block 2.

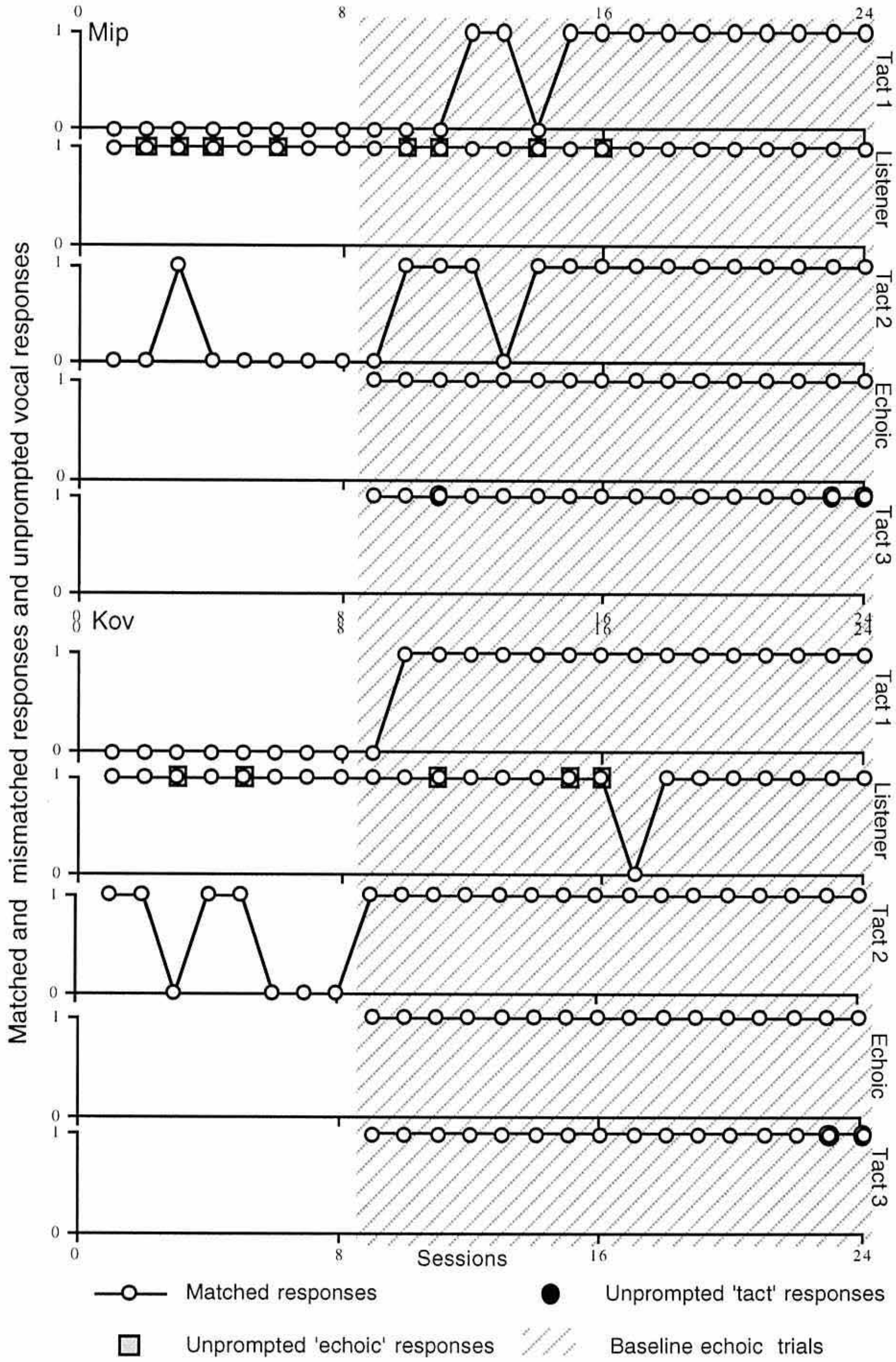

Figure 6.3.5.1, RB's responses in the Tact Test 1, the Listener test, and the Echoic trials for the Set 5 name relations.

Matched responses to the tact probes for O9 were first produced in Test 3, Session 9; this was immediately after the echoic response */kov/*— "kov" had been probed for the first time. Matched responding extended to the Tact test 2 in the next session and to Tact test 1 in Session 12. Criterion tacting for this target relation was demonstrated in Block 3. Listener relations in respect of each target relation had been produced at criterion level throughout the training. Thus, the Set 5 name relations were demonstrated, simultaneously, in Block 3. RB had learned ten novel name relations at the age of 24 months and 3 days.

Summary

RB had learned to name the Set 5 stimuli at the age of two years. He had shown rapid listener responding and generalised echoic responding. The correlated, unprompted echoing of the listener stimuli suggests that higher-order naming was in evidence. In total RB had learned ten novel name relations by the age of two years. The first pair of name relations were learned in 6 months, the second, third, fourth, and fifth pairs were learned in 22, 7, 24, and 10 days, respectively. This sustains the assumption that following learning of the Set 1 pair of names higher-order naming was in evidence.

Maintenance of the Tact Relations

The rapid learning of listener relations in the latter four sets; that is, Sets 4 – 5, suggests that, at least, RB had learned to learn listener relations, and possibly had also learned higher order naming. However, it is possible that he may have been learning to respond to only one of the stimuli by name and could have demonstrated criterion responding to the second listener relation by exclusion, or stimulus negative responding. If, after learning all ten name relations as pairs of names, he was able to tact the ten objects when they were presented together, this would suggest that he had learned separate names for all the ten stimulus objects. This is because tacting by exclusion is much less plausible than responding as a listener by exclusion, especially when the tact probes are presented in random order.

In contrast to the previous participants, while he was learning the target relations in Sets 2 – 5, RB was not given any maintenance tact tests for previously trained sets. In addition, his learning of Set 5 to criterion preceded the Christmas holiday period and, consequently, he was not available for testing for three weeks after he attained criterion tacting for Set 5. On his return, in one trial of each tact relation, RB was unable to tact any of the stimulus objects. A minimal retraining was devised, such that the name relations would be re-established, but without adding significantly to the training which had initially been required to establish them. In one session, he was probed for Tact Test 1, for one pair of counterbalanced and reinforced Listener Test trials, for Tact Test 2, for echoing in the absence of the stimulus object (unreinforced) and for Tact Test 3, for one pair of target relations. These trials were repeated until tact responses were produced on at least two consecutive criterion tact tests for each relation. Each set was presented, in this way, in reverse order (i.e., Set 5 , then Set 4, and so on) until tact responses were produced on at least two consecutive criterion tact tests for each pair of target relations.

Beginning at 24 months 24 days old, he required five trials of O10 and O9, three trials of O8 and O7, three trials of O6 and O5, five trials of O4 and O3, and 17 trials of O2 and O1. While O1 was tacted after five trials he required a total of 17 trials to demonstrate two consecutive correct responses to O2 — "ditta". Following this retraining tacting was tested for all ten objects consecutively. At 25 months and 4 days old, he responded correctly in 8/8 trials in respect of O1, O3, O4, O5, O6, O7, O8, and O9. He produced no matched responses to O2 or O10. He failed to respond to O2 in all eight trials. He produced "zog" responses in four trials of O10 — "kov", failing to respond on the remaining four trials. The phonetic similarity of the auditory stimuli */zog/* and */kov/* may have contributed to his failure to maintain the O10 name relation (see *Discussion).* There was no transparent reason why RB was unable to demonstrate the tact relation O2 — "ditta". He responded correctly in all listener trials and in all echoic trials, but he rarely produced a matching tact response, suggesting that this tact response may have been subject to unscheduled contingencies. Thus, RB was able to demonstrate maintenance of only eight of the ten name relations.

Generalisation

A test of generalisation to novel coloured exemplars of the trained stimulus objects was conducted, when RB was 25 months, 7 days old. Figure 6.4.6 shows RB's responses to the trained and novel stimuli, for each name relation.

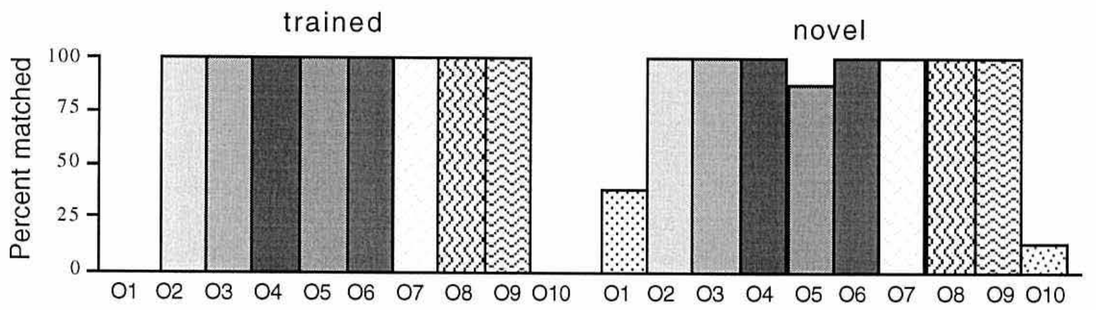

Figure 6.4.6 RB's responses in the test for generalisation of names to novel stimuli.

All eight of the maintained tact relations were produced in response to a similar shaped object of a different colour, in 100 percent of the trials. Not surprisingly, the tact relations that RB failed to maintain in respect of the trained relations did not generalised to shape-based novel coloured exemplars. However, it is interesting to note that he produced at least one matched response in respect of each of these novel exemplars. This, of itself is remarkable, given that he did not produce any matched responses to the trained stimuli. RB's responses are shown in Table 6.4.2.

Learning Serial Pairs of Names

Table 6.3.2

The number of correct responses as a fraction of the number of trials in the tests for generalisation of the trained names to novel exemplars of similar shape but of different colour from the trained stimulus objects.

VARIANT	O1	02	03	O4	O5	O6	O7	O8	O9	O10	TOTAL
colour	8/8	3/8	8/8	8/8	8/8	8/8	8/8	8/8	8/8	1/8	68/80

Conclusion

RB learned five pairs of name relations of which eight were maintained with minimal retraining. For the Set 1 name relations, listener and echoic relations were learned separately. Tacting did not emerge as a consequence of this. When combined listener–echoic trials were introduced tacting emerged for each relation in line with the introduction of the intervention. So for the Set 1 names, RB was reinforced for producing an echo-tact response before naming emerged.

For the Set 2 relations the listener relations and echoic relations emerged as a consequence of listener training and of unreinforced probes for the corresponding echoic relations. The onset of tacting was, however, always correlated with unprompted echoing in the reinforced listener trials. This suggests that RB had already learned generalised echoic behaviour outside of the experimental setting.

The Set 3 tact relations emerged as a consequence of listener training only. Again, there was evidence of unprompted echoing in the listener trials, suggesting generalised echoic responding, and possibly higher-order naming.

In Set 4, there was evidence for higher-order naming of O7 — "toma". RB did not immediately name O8 but produced a typical "mmm" response. This was replaced by appropriate tact responding only after echoic responding was demonstrated to criterion. However, echoing did not require direct reinforcement, suggesting that this participant's minimal echoic repertoire included the Set 4 non-word sounds.

In Set 5, listener relations and echoic relations were demonstrated separately. Again, echoic responding was demonstrated without reinforcement. Tacting was demonstrated without further training. However, the last name relation O10 — "kov" was not maintained in subsequent generalisation tests. Interestingly, he produced only two matched responses in the five retraining trials for O10, and 2/17 matched responses in the retraining trials for O1. This suggests that the minimal retraining was insufficient to re-establish the tact responses for these two relations.

Participant CJ

CJ began Experiment 6 when he was 12 months 7 days old. He experienced four familiarisation sessions during which his phonetic repertoire was re-recorded. (His phonetic inventory was first recorded when he was then between 8 months 20 days and 9 months 5 days old). In both these periods he produced all the target phonemes of the first auditory stimuli (see *Appendix 1*). During the latter sessions of operant conditioning of his speech like vocal production CJ was re-familiarised with the experimental setting and he was encouraged to play with a series of toys for one minute each (cf. Poulson et al., 1991). After one minute he was asked to give the toy to the experimenter. In this way he gradually learned to give and take familiar objects. At 12 months 24 days, following four sessions of intensive giving and taking of familiar objects, see *Procedure*, Step 1, he gave the roller on request in 10/11 consecutive trials. Later in the same session he began pairwise discrimination of familiar objects.

At 13 months 7 days, CJ correctly selected a series of named familiar objects in the first trial of a pairwise discrimination test on eight consecutive occasions.

He began learning the listener relations */doot/* — O1 and */pab/*— O2 at 13 months 7 days. The stimulus objects were O1 - a 14 cm x 5.5 cm yellow adhesive spreader (see Figure 6.1, upper panel), and O2 - a 11cm x 4 cm blue paper clip (see Figure 6.1, centre panel). Pairwise discrimination of novel and familiar objects and of two novel objects began simultaneously. That is, in this period, CJ progressed through Steps 1 – 5 of the listener training in every session, ending with trials of pairwise discrimination of novel objects. This extension of the listener training helped to maintain his giving responding, such that he was able to demonstrate listener behaviour by giving the corresponding stimulus object.

CJ experienced fourteen preliminary listener training sessions, prior to testing pairwise discrimination of the Set 1 novel stimuli. Pairwise discrimination of these experimental stimulus objects was tested in two blocks of eight trials. He learned both these relations to criterion at 14 months 26 days.

Table 6.5.1

The number of correct listener responses (numerator) and listener trials (denominator) for each type of listener trials during the Set 1 listener training and testing stages of CJ. The target relations are shown in bold type.

Listener Relation	***/doot/*** **O 1**	***/pab/*** **O 2**	***/doot/*** **O1** v fam.	***/pab/*** O1 v **O2**	***/doot/*** **O1** v O2
Training	17/22	9/13	7/8	51/68	45/63
Testing				12/16	12/16
Total	17/22	9/13	7/8	63/84	57/79
mrr	0.77	0.69	0.875	0.75	0.72

fam. = familiar object

In total CJ experienced 128 trials when a single familiar object was requested, and 38 pairwise discrimination trials with familiar objects. He had 22 trials when a listener response to the first auditory stimulus */doot/* was requested, and only O1 was present; similarly he had 13 trials when a listener response to */pab/* was requested, and only O2 was present. He then experienced 8 trials when O1 was paired with a familiar object, before beginning the pairwise discrimination trials for the novel stimuli. He required a further 79 listener trials of */doot/* — O1 and 84 listener trials of */pab/* — O2, before demonstrating the listener relations to criterion in the pairwise discrimination procedure. The number of training and test trials in respect of each of the Set 1 experimental stimuli is shown in Table 6.5.1.

CJ's responses in the Tact Tests, the Listener Test, and the Echoic trials are shown in Figure 6.5.1.1. Unprompted matched "echoic" vocalisations are shown as filled squares.

In Blocks 1 and 2, listener responding to both auditory stimuli increased to the criterion level (see Figure 6.5.1.1). CJ produced one vocalisation which matched the auditory stimulus */pab/*, in a listener trial in Block 2. However, his unprompted "echoic" production of "doot" was high in Block 1, and although it diminished in Block 2 there was evidence of three matched responses to the tact probes for O1. As CJ had demonstrated that he could produce the target phonemes of the auditory stimuli, this suggests that the level of CJ's chance production of "doot" was high.

The two listener relations were demonstrated to criterion simultaneously in Block 2. Thereafter they remained at or just below the criterion level throughout the experiment.

In Block 3, echoing of each of the auditory stimuli was probed in the baseline condition, in the absence of the corresponding stimulus objects. There was no evidence of matched responding to probes for either echoic relation. Listener responding and tact responding remained unchanged; he produced no matched responses to the 24 probes to tact O1 or to the 24 probes to tact O2. CJ produced a vocal response which matched the listener stimulus */doot/* in 2/8 listener trials, and a vocal responses which matched the listener stimulus */pab/* in 1/8 listener trials. These unprompted "echoic" responses were well below the criterion for echoing.

In Blocks 4 - 9, the intervention of reinforcement of matched echoic responses was implemented for the echoic relation */doot/* — "doot" only; the echoic relation */pab/* — "pab" was probed in the baseline condition, as in Block 3. There was very little evidence of matched responding to the echoic probes for either target relation. For the

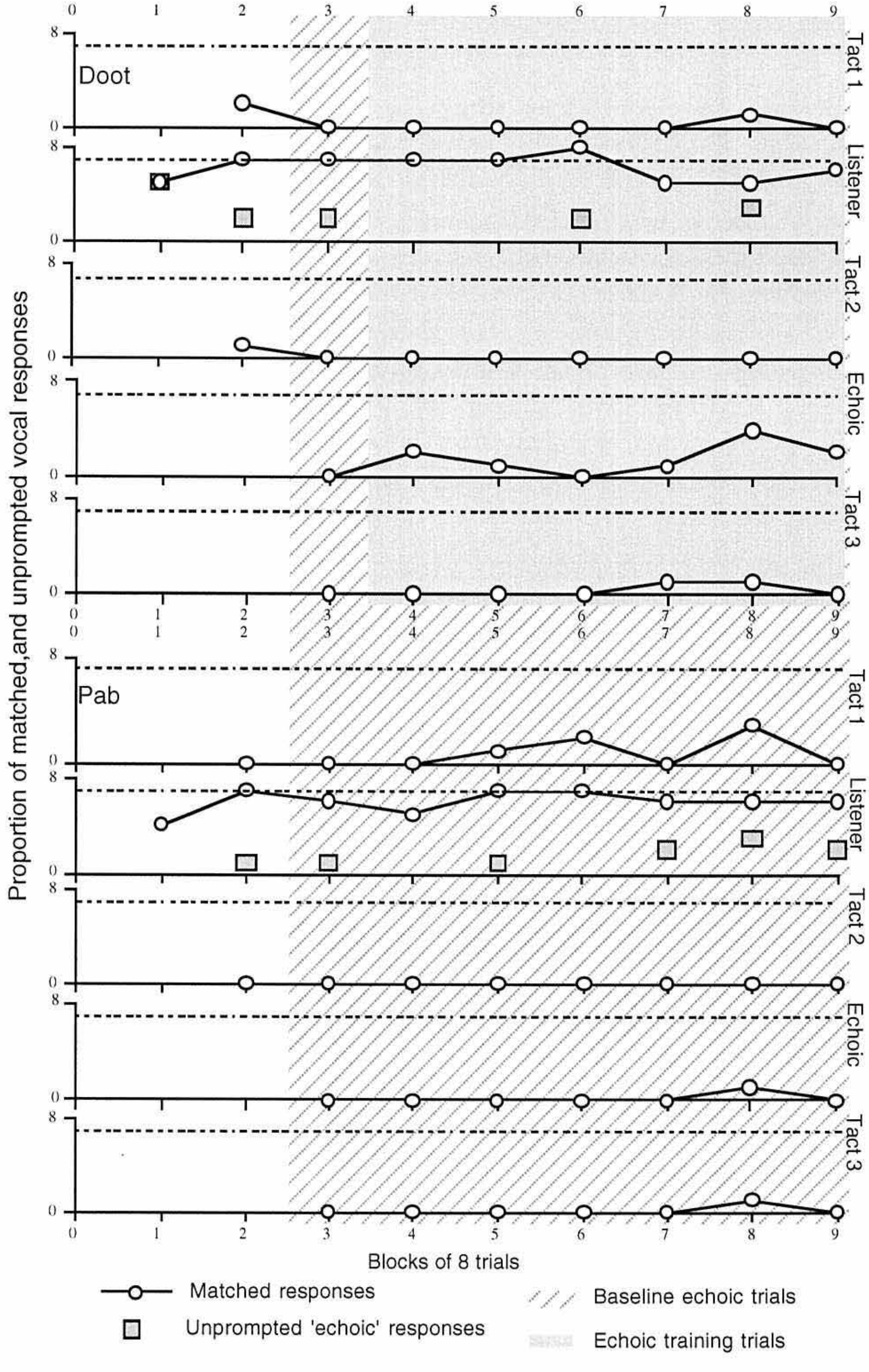

Figure 6.5.1.1 CJ's responses in the Tact Tests, the Listener Test, and the Echoic trials, for the Set 1 relations. Unprompted "echoic" responses are shown as filled squares.

targetted echoic relation */doot/* — "doot", he produced 10 matched responses in the 48 trials when reinforcement was available.

The small number of echoic responses limited the availability of reinforcement, such that the frequency of echoic responding remained well below the criterion for echoing. Similarly, CJ produced unprompted "echoic" responses of "doot" in the listener trials in only 5/48 listener trials in this period. Tact responding was also infrequent; he produced 1/48 matched responses in the criterion Tact Test 1 and 2/96 matched responses in Tact Tests 2 and 3. Thus, for the first target relation CJ learned to respond to the auditory stimulus */doot/* as a listener, but he did not learn to respond to that same stimulus echoically, nor to tact the corresponding stimulus object.

CJ's responses in respect of the second auditory stimulus, */pab/*, followed a similar pattern. In the continued baseline condition, he produced only one matched echoic response to the probes for this echoic relation. He produced unprompted "echoic" responses in 8/48 of the */pab/* listener trials, again well below the criterion frequency. There was some evidence of matched responding in the criterion Tact Test 1; he produced matched responses to 6/48 tact probes. However, once again, this was well below the criterion frequency for tacting. In the Tact Tests 2 and 3 he produced matched responses to only 1/96 tact probes for O2. Thus CJ learned to respond to */pab/* as a listener, but there was no evidence that this behaviour gave rise to echoing of the auditory stimulus or to tacting the corresponding stimulus object.

Summary

CJ began learning the listener relations when he was 13 months 17 days and showed established listener relations at 14 months 26 days. There was no evidence of echoing or tacting at this stage. He experienced 56 further sessions of echoic training, during which reinforcement for echoing */doot/* was available in 48 sessions, but he did not learn to echo either echoic stimulus. During the period of echoic training, listener responding fluctuated at or about the criterion level but fell just below criterion level for each listener relation in the last three blocks of trials. There was no evidence of either echoing or tacting. He was 17 months 21 days when he left the nursery, and was thus unable to continue participating in the experiment.

GROUP RESULTS

Five infants participated in Experiment 6. Four learned to name four, or more, experimental objects. One infant left the nursery having demonstrated listener behaviour for one pair of stimuli, to the criterion level, but before learning to echo the corresponding auditory stimuli. Thus, all the infants who remained at the nursery long enough to complete the procedure successfully learned to name under this procedure. This showed a significant improvement in the attrition rate, when compared with the three referent experiments.

Experiment 6 was designed to examine two propositions: first, whether training listener and echoic relations for only two stimulus objects, at any one time, would allow naming to be demonstrated without needing to directly reinforce the corresponding tact response; and second, if naming in the controlled experimental condition could be demonstrated before the infant had learned a generalised higher-order naming behaviour; this would be demonstrated if name relations could be trained prior to the *naming explosion*. These hypotheses would be sustained if infants showed evidence of "learning to learn" in later presented experimental stimulus pairs, but not in the Set 1 pair. Four infants learned to name four objects, as Set 1 and Set 2; they will be discussed first.

Learning the Set 1 relations

The training histories of each of the five participants is shown, for the Set 1 relations, in Table 6.2. The table is separated into the three training stages; that is, the listener, the echoic, and the echo-tact stages. It shows the age of each infant, in months and days, at four points, namely: (a) at the start of the listener training; (b) when listener relations were demonstrated to criterion; (c) when the echoic relations were demonstrated to criterion; and (d) when the tact relations were demonstrated to criterion. The table also shows the number of training trials experienced by each participant in each of the listener stages, and the training and test trials experienced in each echoic, and echo-tact training stages. In addition the MCDI production vocabulary (CDI) is given at the end of the listener stage and at the end of the echoic stage, where available.

The age at which these participants demonstrated each target behaviour and the number of training trials each required before naming emerged will be compared with the results obtained in the three referent studies. Three infants completed subsequent training, Sets 3 – 5. These will be discussed with regard to generalisation of the name relation and the economies of learning that occurred.

The first pair of listener relations were demonstrated when the infants were from 14 months, 26 days to 20 months, 9 days old ($\underline{M}$ = 17 months, 8 days). The infants required considerable training to demonstrate listener responding to the Set 1 auditory stimuli, to the criterion of ≥7/8 consecutive correct responses, simultaneously ($\underline{M}$ = 245 trials). RB learned the Set 1 listener relations in 32 trials, but the other infants took between 163 trials and 419 trials to learn these target relations. The parents of the participants reported (MCDI) that they could say between 4 and 69 words, at this stage.

These results were comparable with those found in Experiment 2b, except that the infants who participated in 2b appeared to learn two listener relations approximately two months before those in Experiment 6. The participants in Experiment 2b were required to learn pairwise discrimination for three listener relations. All showed pairwise discrimination to mastery criterion for at least two listener relations simultaneously before beginning the one from three discrimination training. Their ages on completion of the two referent listener training, that is, ranged from 12 months, 28 days to 17 months (M = 15 months) and their CDI production vocabularies ranged from 5 - 22

Table 6.2

A summary of the Set 1 training history of the five participants in Experiment 6 (see text for details).

Infant	Listener Behaviour					Echoic Behaviour					Echo-Tact Behaviour			
	Start	Train	Test	End	CDI	Base	RE/1	RE/2	End	CDI	Cont.	RET/1	RET/2	End
TE	16;25	281	80	20;09	69	24	24	16	22;04	106				22;04
TH	14;15	189	64	16;27	17	40	24	8	18;24	66	48	48	24	21;16
HS	14;11	323	96	17;25	21	40	32	8	20;04	N/A	32			20;17
RB	16;07	16	16	16;15	16	16	64	32	21;10	84	24	8	16	21;28
CJ	13;07	131	32	14;26	4	64	48							

Base = the number of unreinforced baseline trials; RE/1 = the number of reinforced echoic trials for the first target relation; RE/2 = the number of reinforced echoic trials for the second target relation; Cont. = the number of trials after criterion echoing was first demonstrated in which no further intervention was implemented; RET/1 = the number of reinforced echo-tact trials for the first target relation; RET/2 = the number of reinforced echo-tact trials for the second target relation.

words. The Experiment 2b group were much younger than the Experiment 6 group at the start of the listener training. The Experiment 2b participants were between 8 months 20 days and 15 months 11 days at the start of pairwise listener training (M = 11 months, 8 days), whereas the Experiment 6 participants were between 13 months, 7 days and 16 months, 25 days at the start of pairwise listener training (M = 15 months 1 day). This suggests that they learned two listener relations earlier because they started listener training at an earlier age.

The number of trials and the duration of training required to teach two listener relations to criterion sustains the results presented in Experiment 2. Even though the experimental paradigm was extensively simplified in Experiment 6, young infants did not learn the Set 1 listener responses with the facility described by Woodward et al. (1994). For pre-verbal infants, the degree of training required to learn conditional discriminations approaches that required by non-verbal animals. McIntire, Cleary, and Thompson (1987), and Meehan (1999), for example, in studies involving macaques and pigeons, respectively, report training extending to thousands of trials. There does not appear to be any evidence, in any of the preceding experiments, that infants can quickly learn to identify new objects by name before they learn higher-order naming. In the absence of a pre-established minimal echoic repertoire, there was no evidence that any of these infants had learned to name the stimulus objects from learning listener responses alone.

Echoic responding to the Set 1 stimuli was demonstrated to criterion between the ages of 18 months, 24 days and 22 months, 4 days (M = 20 months, 20 days). At this age, the infants' MCDI production vocabularies had increased to 66 - 106 words (M = 85 words). It would appear that the production of echoic responses is constrained by the infants' minimal echoic repertoire. In each session, echoic responses were probed in one trial. The trial ended when the infant produced either a matched or mismatched vocal response, or when three probes had been presented without any response within a five second response period. Thus the number of trials cannot be compared with the number of echoic prompts required to learn the echo relations in Experiment 3. However, any difference in the number of training sessions, in the two-referent and three-referent experiments, can be evaluated.

The infants in Experiment 6 required, between 64 and 112 sessions (M = 87 sessions) in which echoing was probed for each echoic relation before learning to echo. The duration of echoic training ranged from 1 month, 19 days to 4 months, 25 days (M = 2 months, 21 days). They were one month younger than the participants in Experiment 3 when they learned the echoic relations, but, of course, they learned one less echoic relation. The echoic training in the 2-stimulus experiments was at least two months less than that of the participants in the 3-stimulus experiments. Thus, under the two referent procedure echoic behaviour was demonstrated earlier than under the three referent procedure.

In Experiment 3, the participants were required to learn three echoic relations. They were between 20 months 21 days and 22 months 21 days (M = 22 months, 5 days) when they reached the criterion for echoing. They required between 37 and 65 sessions (M = 52 sessions) of echoic training over a period of 3 - 5 months (M = 4 months 6 days). Their production vocabulary on learning to echo was from 13 - 114 words (M = 57).

The four learners in Experiment 6 were between 20 months 17 days, and 22 months 4 days when they first demonstrated criterion tacting (M = 21 months, 18 days). Two infants required no listener-echoic training. They learned to tact when listener and echoic relations had been probed separately but echoing had not been probed in the presence of the stimulus objects. However, both these infants produced unprompted echoic responses during the reinforced listener trials, and so were adventitiously reinforced for echo-tacting. Two infants required combined listener-echoic training to demonstrate the tact relations to criterion. One required two blocks of training in which listener-echoic probes were combined in 24 trials; the second required five blocks of training in which listener-echoic probes were combined in 72 trials. Tacting was never directly reinforced for any of the participants, yet all were adventitiously reinforced for the unprompted combined speaker-listener behaviour that occurred during listener training trials. The mean duration of training was 26 days. The MCDI production vocabularies were 84 - 123 words ($\underline{M}$ = 104 words, n = 3). The MCDI for HS was not available.

By contrast, the infants who learned to name in Experiment 4 were between 22 months 12 days and 27 months ($\underline{M}$ = 25 months and 24 days) on attaining the criterion, and their productive vocabulary was between 114 and 329 words ($\underline{M}$ = 170 words). The mean duration of training ranged from 1 month to 4 months 25 days ($\underline{M}$ = 2 months 29 days). All the infants in Experiment 4 required some reinforcement of tact responding.

The difference in the outcome for these two groups of infants, that is, the three referent group and the two referent group, was most marked in the post-echoic training. Those in the three referent studies were 3 months older, and required reinforcement of tact responses before tacting was demonstrated to criterion. Those in the two referent study learned to name earlier, and without direct reinforcement of the tact relation. Thus, the first aim of Experiment 6; that is, to investigate whether tacting would emerge without direct reinforcement, concluded that tacting does emerge without scheduled reinforcement, but only when it is adventitiously reinforced as unprompted echoic responding during the reinforced listener trials.

Experiment 6 demonstrated that learning to name was facilitated when the experimental procedure was modified to reduce the frequency of the tact probes, and thus to reduce possible inhibition of speaker behaviour. It demonstrated that the tact relation was learned when the infant had learned to echo the auditory stimulus to which listener responding had already been trained, so that the echoic response was increasingly produced whilst the infant was orienting to the stimulus object. Crucially, all the tact relations were indirectly reinforced when such speaker responses co-occurred with reinforced listener responses.

Learning the Set 2 relations

It might be argued that, by learning only two name relations, the infants in Experiment 6 had learned less than those in Experiments 2 – 4. This could explain the apparent differences in age and verbal sophistication of the two groups. It is therefore important to consider the outcome for the second pair of name relations.

The Set 2 name relations were learned when the infants were between 22 months, 22 days and 25 months, 5 days (M = 23 months, 17 days). They required between 11 days and 2 months, 3 days (M = 28 days) to learn the listener relations, during which they experienced 32 - 48 listener training trials (M = 36 trials). They needed between 10 days and 29 days (M = 19 days) to learn to echo, (M = 8 trials). Only one infant required combined listener-echoic training and she learned to tact after a further 29 days (20 trials). No MCDI statistics were available at this stage.

The Experiment 6 group had learned four name relations two months before the Experiments 2 - 5 group had learned three name relations. This sustained the hypothesis that teaching serial pairs of names would facilitate learning. However, it is not clear that all these infants learned to name the Set 2 experimental objects before the "so called" naming explosion. Learning the general or higher-order behaviour of naming should enable infants to learn new names more readily. This is because in higher-order naming the infant learns not only to orient to the correct object but also to contiguously echo the listener stimulus as she does so, thereby facilitating learning of the corresponding tact relation.

There were considerable economies in learning the Set 2 name relations. None of the four participants experienced the pre-training described for the Set 1 listener relations. For three of the four infants, listener training began with mixed trials of pairwise discrimination; the fourth (TH) experienced one block of pairwise discrimination testing of a single target listener relation and then proceeded to mixed pairwise trials in Block 2.

One of the four participants in Experiment 6, TE, needed extensive listener training for the Set 2 listener relations. All the other participants were able to demonstrate the new listener relations within one or two blocks of training. There was also evidence of generalisation of echoic responding on the basis of pre-existing echoic repertoires; only RB required three blocks of echoic training to reach criterion. For three of the participants tacting emerged without further training, only TH required listener-echoic training before she learned to tact.

This is critical: three of the four infants showed learning of at least one target behaviour without showing generalisation of all the behaviours that constitute the name relation. This result shows that, even when an infant has a production vocabulary of over 100 words, naming is not necessarily a generalised behaviour; the "pre-verbal behaviours", that is, orienting and echoing, may remain separate functional relations. Only HS showed gradual learning of the full name relation following listener learning and following one block of probes for the corresponding echoic relations. At 21 months 23 days old, having completed only one block of baseline echoic trials in which she did not demonstrate criterion echoing, HS refused to comply with the experimental procedure. She responded only to the Tact Test 1 probes, refusing to participate whenever the experimenter attempted to continue the procedure. The tact responses were demonstrated to criterion without further training.

Learning the second set of names required considerably less time and training than learning the Set 1 names. These infants had vocabularies in excess of 250 words comprehension and 100 words production at the start of this training. Three of the four learned the listener relations within the minimum of 8 sessions; however, TE required 48 sessions to learn the Set 2 listener relations. The second aim of Experiment 6 was to establish experimental name relations before the infants showed evidence of learning to learn. This was achieved, at least in respect of the Set 1 target relations, and possibly for the Set 2 target relations for TE. The effects of generalised higher-order naming, in terms of training requirements and duration of training, were evident in the later pairs of target relations.

However, by psycholinguistic standards these infants may not be considered preverbal. All the infants had vocabularies in excess of 50 words production, when they demonstrated the Set 1 name relations to criterion; their productive vocabularies ranged from 84 - 123 words. (As vocabulary is expanding rapidly at this time only those whose parents returned the MCDI within 10 days of completion of the Set 1 training are reported, n = 3.) Harris reports that from the 30 word stage there is a marked increase in the speed with which infants learn new words. "The most common explanation is that it occurs because the child has learned that things have names (Dore, 1978; McShane, 1979; Nelson, 1973)" (Harris, 1992, p.72). Dale records an exponential increase in vocabulary growth between 18 and 21 months when vocabularies increase from 22 to 118 words (1972/1976, p.174). However, other researchers report no evidence of a universal naming explosion (e.g., Reznick & Goldfield, 1990) or that when it does occur it occurs much later. Mervis and Bertrand (1995) found no evidence of a vocabulary spurt in some children until they could produce around 114 words. Thus, there appears to be no independent measure of higher-order naming, either by vocabulary or by age.

Learning the Sets 3 – 5 relations.

Three infants learned further sets of names. TE learned two further names, the first after one block of listener and one block of echoic training, the second after listener training only. RB learned six more name relations, the first two after listener training only, and the remaining four after listener training and unreinforced echoic probing only. HS learned six further names after listener training only. These results show that once the infants had learned to generalise their pre-existing minimal echoic repertoires to the experimental non-word listener stimuli, learning the listener relation was also sufficient to bring about the corresponding tact response.

Table 6.3

Infant	Set	Age at Criterion	Age on MCDI	MCDI Comprehension	MCDI Production
TE	1	22 months; 04 days			
			22 months; 14 days	282	106
	2	25 months; 05 days			
			25 months; 25 days		280
	3	27 months; 05 days			
			29 months; 13 days		404
TH	1	21 months; 23 days	20 months; 17 days	197	123
			22 months; 29 days	210	182
	2	23 months; 29 days			
HS	1	20 months; 17 days			
			21 months; 7 days	266	183
	2	22 months; 10 days			
	3	22 months; 28 days			
	4	23 months; 11 days	23 months; 10 days		323
	5	23 months; 15 days			
			25 months; 04 days		447
RB	1	21 months; 28 days	21 months; 07 days	306	84
	2	22 months; 21 days			
	3	22 months; 29 days			
	4	23 months; 23 days	23 months; 23 days		458
	5	24 months; 03 days			

Comprehension vocabularies were not recorded for these infants, after 23 months of age. Fenson et al. (1993) suggest that the comprehension vocabulary of normally developing infants grows so rapidly in the second year, that it is unrealistic to expect parents to make judgements about comprehension vocabulary beyond the middle of the second year (p.5). However, to assess the comprehension development as late as possible, the Words and Gestures version of the MCDI was employed, in this experiment, until the end of the 22nd month.

The period of extended name training (i.e., in Sets 3 – 5, when generalised naming was in evidence) was correlated with a marked increase in the MCDI vocabulary of each infant. Three infants learned three or more sets of name relations, CR left the nursery before learning to name the Set 1 stimuli, and TH left the nursery after learning to tact Sets 1 and 2.

Table 6.3 shows all the vocabulary inventories returned during the course of the experiment, related to the ages when each pair of name relations was demonstrated to criterion. The parents did not return the MCDIs to coincide with learning each pair of name relations. However, the increase in vocabulary can be smoothed by joining the data points of the returned MCDIs.

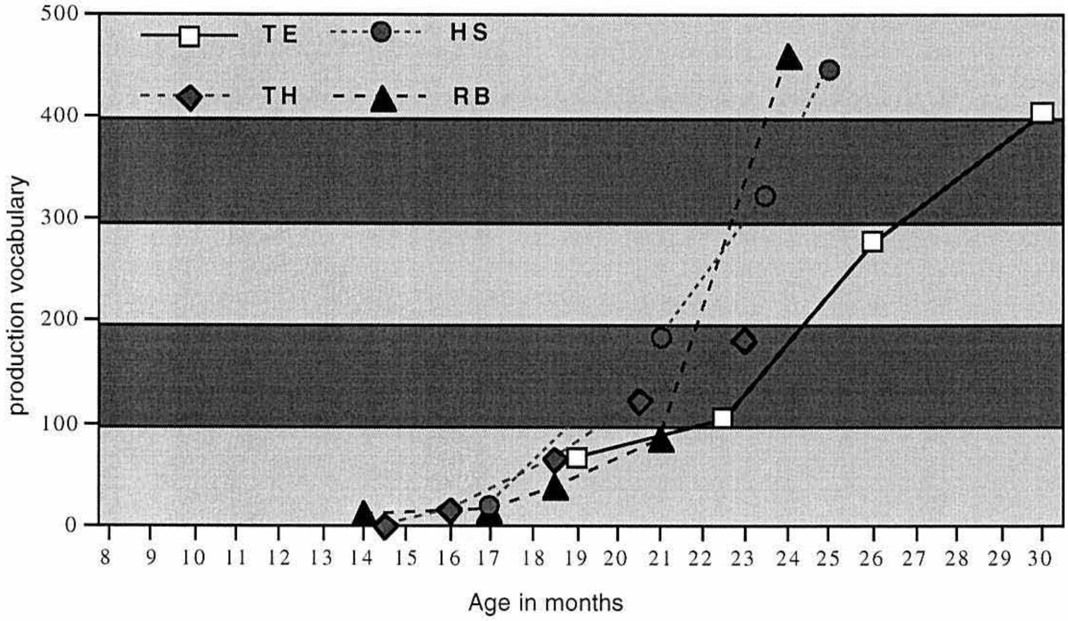

Figure 6.3 The MCDI production scores of the participants who completed Experiment 6. The shading shows vocabulary increments of 100 words.

The rate of increase in productive vocabulary is shown in Figure 6.3. It can be seen that the infants who learned ten novel names, RB and HS, showed a marked increase in rate of vocabulary acquisition between 21 months and 23 months of age, suggesting that this period was correlated with learning higher-order naming. The rate of growth was much more uniform for TE and TH. The productive vocabularies at 23.5 months of age show that whereas TH and TE had vocabularies of less than 200 words, SH and RB had vocabularies in excess of 300 words. TE did not learn to name the Set 2 and Set 3 stimuli until he was 25 months 5 days and 27 months 5 days old, respectively.

CJ did not complete this experiment. He successfully learned two listener relations when he was 14 months 26 days old. He maintained these behaviours at or just below the criterion level through the remainder of the experiment. He did not learn to echo after 64 baseline and 48 reinforced trials. He was 17 months 21 days old when he left the nursery. However, none of the infants tested to date had demonstrated echoing before 19 months of age. Thus there was no evidence to suggest that he was unusual in his inability to learn the echoic relations.

Generalisation

Four infants learned four or more non-word name relations in Experiment 6. Subsequently, all were tested for generalisation of the trained tact relations to objects of similar shape, but of different colour and/or a different texture from that of the trained objects.

For each participant, the strength of the responses on the tests of generalisation was dependent upon the strength of the trained name relation tested. In Chapter 3, I argued that the binomial distribution was inappropriate as an indicator of learning because all the trials were *related* and not *independent*, and that this relationship violates one of the basic assumptions of the binomial distribution. However, in the tests for generalisation this does not apply. None of the objects employed in the generalisation tests had featured in the training procedures and no feedback was provided for infants responses, and there were no scheduled consequences for correct or incorrect responding. The generalisation trials were, thus, *independent*, and the binomial distribution can be used to indicate the rate at which a child might correctly produce a matched vocal response by chance. However, this statistical calculation was unnecessary for a high proportion of the target relations. In many tests the infants showed close to 100 percent accuracy.

DISCUSSION

Experiment 6 has shown that two name relations (consisting of listener, echoic, and tact relations) could be learned, under experimental conditions, by the age of 21 months, at which age the infants had productive vocabularies of approximately 100 words. This vocabulary milestone is taken to be indicative of a transition to parity between comprehension and productive vocabulary size, whereby the "bottleneck" of referential vocabulary is released (Bates, Dale, & Thal, 1995. p107). However, bear in mind that Mervis and Bertrand (1995) suggest that the naming spurt does not occur until nouns constitute 50 percent of the total vocabulary.

Nevertheless, the infants studied in Experiment 6 learned the Set 1 target relations slowly, suggesting that this first pair of name relations was established prior to higher-order naming. Each infant, in learning the first set of target relations required reinforcement of echoing. For at least three of the infants, the reinforcement of echoic responses for the Set 1 target relations appears to have established a generalised echoic behaviour, such that, as they learned to learn to echo, their minimal echoic repertoires increased. This appears to have been instrumental in facilitating rapid learning of subsequent target relations, and a similar increase in their non-experimental vocabularies. Learning to echo enables infants to produce vocal responses in respect of their existing listener relations (and see Horne & Lowe, 1996, p. 202). Learning to echo is a parsimonious explanation of the release of the "bottleneck" described by Bates et al. (1995).

Set 1 Stimuli

Two infants learned to tact after being reinforced for producing the echoic response whilst being directed to orient towards the corresponding stimulus object. They had learned to orient towards the objects first as listeners, and then to echo the auditory stimulus whilst they were looking at the corresponding object. Orienting to the stimulus object was, thus, increasingly followed by speaking the vocal response as an echo-tact. As Horne and Lowe (1996, p.200) predict, this response pattern created the conditions for the object itself to become discriminative for the target vocal response. When the tact response was produced during the subsequent tact test, the infants demonstrated naming.

Up to this point, the infants had demonstrated the behaviours of orienting and echoing only when the experimenter modelled the auditory stimulus. Echoing was established experimentally through reinforcing successive approximations of the modelled auditory stimulus. Vocal responding was, therefore, initially dependent upon a prior auditory stimulus. From the point when vocal responding was no longer solely dependent upon an auditory stimulus but now came under the discriminative control of the object itself, the separate "pre-verbal" behaviours (see Horne & Lowe, 1996, pp. 200 -201) were transformed into the verbal behaviour of naming. Thus the name is seen to be the basic unit of verbal behaviour. In this way, the infants had learned the names of two novel objects.

Two of the infants in Experiment 6 learned to name, having been taught to orient to the auditory stimuli and to echo the auditory stimuli in the absence of the stimulus objects. At first sight, it appears that these two infants learned to name without being reinforced for echoing whilst orienting to the object. If this is the case, it would sustain the claim that stimulus equivalence is a priori to verbal behaviour, and thus would seriously challenge Horne and Lowe, (1996; 1997). However, Horne and Lowe's hypothesis cannot be rejected on the evidence of these two infants. This is because naming did not arise without evidence of echoing in the presence of the stimulus objects. Echoing under the reinforcing conditions of the listener trials was demonstrated by both infants.

This is important. It illustrates why, for Horne and Lowe, listener behaviour is a crucial factor in establishing the tact response. Further it shows that although an infant might respond to a auditory stimulus in one of two ways (i.e., orienting or echoing) it is the generation of both, simultaneously, which brings about echo-tacting, such that eventually, because the object is a frequent antecedent of the vocal response, the tact itself is established.

In Chapter 4, when discussing Lipkens, Hayes and Hayes (1993), the problems of attempting to teach uni-directional verbal relations was stressed. Lipkens, et al. set out to teach a tact relation, *but unwittingly* also taught the corresponding listener and echoic behaviour. The participants in Experiment 6, provide evidence that once an infant has learned a minimal echoic repertoire, echoic responding is an available response to many discriminative stimuli. Even when echoic responding is not heard, one cannot exclude the possibility that on hearing an auditory stimulus a covert echoic listener response is produced. It is the potential for overt or covert echoic responding, which thereafter may qualitatively transform listener behaviour from being solely pointing or orienting behaviour to full blown naming.

The Role of the Minimal Echoic Repertoire

For the participants in Experiment 6, learning the Set 1 target relations parallels the finding from Experiments 2 – 5. It is clear that when *young* infants begin to learn new names, listener responses and echoic responses are not learned simultaneously. Initially the child learns to respond as a listener. The experiments reported in this thesis have shown this to be because the pre-verbal infant does not have the echoic repertoire to produce any corresponding speaker behaviour, even though the target non-word names were assembled from phonemes within their productive capacity. Although there was sporadic evidence of vocalisations which matched the target auditory stimuli, production of the target non-words as echoic responses, did not emerge without prompting; echoic responding was learned under operant conditions over considerable periods of time.

Experiment 6 also shows that listener and speaker behaviour can be functionally separate even when infants apparently have vocabularies of over 100 words. The productive vocabulary of the older infant and young child is speaker behaviour. However, the results of Experiment 6 suggest that this, alone, should not be taken as an indication of the full name relation. When words are learned in the verbal community as reinforced speaker behaviour, they may be identified as words (e.g., on parental report instruments such as the MCDI) when they are purely echoic responses or purely tact responses. Only when listener responding is trained as part of the name relation, so that in addition to producing a vocal response the child also orients towards the corresponding object, can the full name relation be seen to be in place. Thus, the transition from speaking as tacting to speaking as naming may arise from minimal listener responding, but it is an evolutionary development in respect of the potential for continual extension of the repertoire of corresponding listener responses. This observation suggests that vocabulary inventories might be poorly correlated with naming, in the period of "transition to language".

Establishing Higher-Order Naming

Experiment 6 has demonstrated that, in a pairwise discrimination procedure, there is evidence that learning accelerates with each successive pair of name relations learned. Two infants learned five pairs of name relations. They learned the first pair in approximately 6 months, the second pair in 1 –2 months, and subsequent pairs in a matter of days. It was found that learning was facilitated in two respects: first, the infants learned the listener relations more readily (given that they were six months older, this is unsurprising; they had an extensive history of listener responding); second, echoing was readily available as a generalised echoic behaviour (this enabled the infants to produce echoic responses without being probed to do so, or simply after being probed but without being reinforced to do so). Thus, for the target tact relations to become established in the later sets, a child needs only to learn to discriminate the objects as a listener and to contiguously echo the auditory stimulus in the reinforced discrimination trials for the tact to become established, often within a single trial.

However, there was no evidence that tacting emerged as a consequence of learning listener relations in the absence of echoing; in none of the infants studied in this experiment did tacting arise from listener responding alone, that is, without evidence of echoing of the listener stimulus. Moreover, there are clear indications that the rate at which young children learn new name relations is dependent initially upon a minimal echoic repertoire, and subsequently upon a generalised behaviour of responding echoically. As predicted by Horne and Lowe (1996), it appears that not having such a minimal echoic repertoire, is a constraint of the rate of name learning following listener training. Establishing a minimal echoic repertoire appears to be the releasing agent for the vocabulary "bottleneck" described by Bates, et al. (1995).

CHAPTER 7
THE GENERAL DISCUSSION AND CONCLUSION

Thirty-six infants participated in one or more of the experiments described here; 18 infants progressed to the listener training stage, 11 infants continued to the echoic training stage, and 9 infants completed the full name relation training.

The following hypotheses were investigated:

Hypothesis 1.

Infant vocalisation can be operantly conditioned. Experiment 1 reinforced infant speech like vocalisations.

Outcome.

The frequency and duration of speech like vocalisation increased over the period. The increase was correlated with reinforcement of the infants' unprompted speech like vocalisations. Phonetic inventories were obtained by transcribing, for phoneme content only, a sample of preverbal Welsh-English bilingual infants' conditioned vocal responses. Experimental non-words, to be employed as auditory stimuli for all the subsequent experiments, were derived from the most frequently produced infant phonemes.

Hypothesis 2.

Novel listener relations can be learned via associative mechanisms.

Outcome.

Listener relations were trained in Experiments 2a, 2b, and 6. In all three experiments the infants were exposed to name object correspondences prior to operant conditioning of the listener relations. In Experiment 2a these took the form of a minimum of 27 presentations of each name object correspondence. In Experiments 2b and 6, name object correspondences featured in pre-training give and take trials. None of the infants learned any of the first set experimental listener relations, in either 2- or 3-stimulus procedures, from exposure to the name object correspondence alone.

Hypothesis 3.

Novel listener relations can be established in preverbal infants as auditory-visual conditional discriminations, in 3-stimulus and 2-stimulus procedures.

Outcome.

Listener relations were trained as auditory-visual conditional discriminations, in Experiments 2a and 2b and 6. Eleven of eighteen participants learned 50 novel listener relations, to a "mastery" criterion (≥8/9 or ≥7/8 consecutive correct responses in respect of each target relation, for the 3-stimulus and 2-stimulus procedures, respectively). Six of the remaining seven infants learned a further 18 novel listener relations, to a better-than-chance criterion estimated in terms of the binomial distribution. One infant failed to learn three novel listener relations, to either criterion, when they were trained simultaneously. She left the area and was, thus, unable to complete the training

Hypothesis 4.

Learning listener relations, alone, will not give rise to echoing to criterion, of the listener stimuli, or to the corresponding tact relations.

Outcome.

Listener responding to criterion did not give rise to echoing to criterion of the listener stimuli, nor to the corresponding tact relations.

General Discussion

Hypothesis 5.

Echoic responding will not arise, in the preverbal infant, from exposure alone. Echoic responding can be operantly conditioned.

Outcome.

Echoing did not arise from exposure to any of the 23 auditory stimuli trained as Set 1 relations, in any of the nine preverbal infants who participated in these experiments. In Experiment 3, five preverbal infants learned to echo 15 auditory stimuli, to criterion, when echoic responses were reinforced. Similarly, in Experiment 6, four preverbal infants learned to echo the 8 Set 1 auditory stimuli when echoic responses were reinforced. One infant failed to learn to echo. He left the nursery, and was thus unable to complete the training.

Hypothesis 6.

Having learned echoic responses to criterion, in addition to established listener relations to corresponding auditory stimuli, naming will not "emerge" unless echoing is reinforced in the presence of the corresponding object.

Outcome.

Learning to echo the auditory stimuli to criterion, having previously established listener relations for the corresponding stimuli, did not give rise to tacting *unless* echoing was reinforced in the presence of the corresponding object.

Hypothesis 7.

When the listener relation is established, naming will arise from operant conditioning of an echo-tact response; that is from reinforcing an infant's production of an echoic response when her attention is directed towards the corresponding object.

General Discussion

Outcome.

In Experiment 4, the operant conditioning of the echo-tact, and the effects of combining listener and echoic responses to produce echo-tacts and then tacts gave rise to naming of 15 experimental objects by five infants.

Hypothesis 8.

Having learned a name relation, as combined speaker-listener behaviour, the name will be produced in response to similar shaped novel exemplars of the stimulus objects. This was investigated in Experiments 5 and 6.

Outcome.

When listener, echoic, and tact responses were well established, so establishing a name relation, infants were able to name new objects as members of shape-based categories. In Experiment 5, 14 newly trained non-word names were extended to 23/24 similar shaped novel objects presented for naming. In Experiment 6, 28/30 newly trained names were maintained until the end of the training period. These names were extended to 56/60 similar shaped novel objects presented for naming.

Hypothesis 9.

When learning name relations, a point will be reached when higher-order naming is established. When this occurs, the name relation will emerge from minimal exposure; for example, from exposure to a limited number of listener trials.

Outcome.

Experiment 6 found that, following learning of the Set 1 relations, eight name relations "emerged" from listener training alone, and ten other name relations "emerged" after listener training and echoic probing alone. This rate of learning suggests the emergence of higher order naming. No such name relations were learned in the absence of unprompted echoing of the listener stimulus during listener training trials.

The results of each of these investigations are considered here with regard to Horne and Lowe's theory of *naming* and with regard to other behaviourist theories of language.

Phonetic Inventories and the Derivation of Non-Word Experimental Names

In Experiment 1, nineteen infants participated in an investigation of infant phonetic repertoires. The aim of this experiment was to raise the operant level of vocal responding, such that an inventory of infant phonemes could be established. The contingent reinforcement of speech-like vocalisations, in the form of social praise and/or imitation, successfully raised the operant level of vocal responding, in all infants, within ten sessions. Infants, who required more than three sessions to attain the criterion (i.e., three periods of vocalisation in one session), did not vocalise in the experimental situation, at least initially; consequently, there were no vocal responses to reinforce, and vocalisation rate remained at zero. These infants required several sessions before they produced unprompted vocal responses. However, once vocal responding began to occur in the experimental context it was contingently reinforced, and the rate of responding was seen to increase for all infants. This experiment sustained the findings of Poulson and colleagues (1991); contingent reinforcement of speech like vocalisations increased the frequency and duration of vocal utterances, in preverbal infants.

An audio-visual recording of each infant's *unprompted* speech sounds was made, and an inventory of phonemes was established. The most frequently occurring phonemes, so identified, were used to derive non-word names for the subsequent experiments.

General Discussion

During the course of the experiments reported in the thesis, 36 infants experienced operant conditioning of their vocal responses. An inventory of the speech sounds produced by these bi-lingual Welsh-English hearing infants is shown in *Appendix 1*.

The inventory shows that the phones produced by these infants did not differ from those produced by other English hearing infants of similar ages in any significant way.

The earliest consonants were nasals and approximants. The first plosive consonants were observed at 8 months, and these were */b/*, */d/*, and */g/*. However, very few infants produced consonants before 10 months of age, and individual infants produced different types of consonants. The difference between individual production styles in this age group is widely reported (e.g., Kent & Miolo, 1995). A wider range of consonants was evident after 12 months of age, and, in the 12 - 15 month old period, infants were heard to produce vocal sounds that were increasingly like adult consonants.

The earliest vowel sounds were the central *schwas, /ə/ and /ɐ/*, followed by open or open-mid front vowels, */a/* and */ɛ/*. As expected, given the immaturity of the vocal tract, these were a little retracted from the cardinal positions, in that they were not made at the fullest extent of possible mouth movement. The earliest closed front vowel, */i/*, appeared at 10 months. The earliest back vowel was */ʊ/*, a central closed back vowel. The earliest open-mid back vowel, */o/*, was heard at 9 months and the full open back vowel, */ɑ/*, were not in evidence before 13 months.

This brief précis of the inventory suggests that normally developing 12 – 15 month-old infants can produce the constituent phonemes of a large range of words. However, note that the phonemes produced by the infants in this experiment were unprompted; that is, they were non-echoic vocal responses. This study did not set out to measure, nor did it measure, the echoic repertoires of these infants.

Skinner (1989a) notes the distinction between being able to make a response and the likelihood of emitting a response. The operants, in Experiment 1, were unprompted phonemes produced in response to reinforcement of *all* speech like vocalisations. The infants' vocal responses were reinforced by social praise and imitation, but reinforcement was not conditional upon a prior echoic stimulus.

During the course of the experiments described in this thesis, it became clear that some words were difficult for the infants to reproduce echoically, although the phonemes from which they were derived were widely produced in their non-echoic vocal repertoires. The infants' early responses to the echoic probes showed poor definition of the consonants: they contained elements of friction, nasality, and approximation. The production of consonants appeared to be restricted by the immature infant vocal tract; that is, the small jaw, and the disproportion of the tongue to the articulatory surfaces (Vihman, 1996, p.104). In addition, it was observed that infants of this age are disposed to minor nose and throat infections and consequent naso-pharyngeal congestion. The consonants that were echoed most accurately were found to be clearly articulated plosive (stop) consonants; for example, */b/*, */d/*, */g/*. However, even these, at least initially, frequently were not reproduced as modelled. Thus, the infants' typical approximations, related as closely as possible to the target place of articulation; that is, labial (*/p/* and */b/*), apical (*/t/* and */d/*), and coronal (*/k/* and */g/*), were deemed to be a sufficiently accurate criterion for echoic responding (see Menn & Stoel-Gammon, 1993; Veneziano, 1981, p.545). The occasion of fricative, nasal, or approximant qualities within a child's vocal production style, such as might be identified by diacritics in phonetic transcriptions, were considered to be insignificant.

Listener Relations

Experiments 2a, 2b, and 6 successfully taught listener relations to eleven of eighteen infants. A total of 50 listener relations were learned by these infants as 3-stimulus simultaneous discriminations, or as pairwise conditional discriminations. A criterion of ≥7/8 consecutive correct responses was attained (≥8/9 for the 3-stimulus relations), for all 50 relations.

General Discussion

Preverbal listener relations do not emerge without operant conditioning.

The infants were first exposed to the name/object correspondences. In none of the infants was exposure, alone, sufficient to give rise to the first listener relations. There was no evidence of "fast-mapping" of words from exposure alone in either the 2-stimulus or the 3-stimulus condition. This was so, even in Experiment 2b, when the 3-stimulus procedure was modified so that each new object name relation was introduced separately. It was anticipated that, by this means, infants would quickly learn the listener relations, and thus be ready to proceed to echoic training before their productive vocabularies began to increase rapidly. However, this attempt to teach three novel listener relations by fast-mapping was unsuccessful. It was found that although infants selected correctly when trials of one novel relation alone was tested in the context of a second novel object, when trials of two or more novel relations were mixed, responding dropped to chance levels (cf. Augustson & Dougher, 1992).

All participants required extensive training, in the form of operant reinforcement of the arbitrarily matched responses, before they were able to demonstrate three listener relations simultaneously, to a criterion of ≥8/9 consecutive correct responses, in the 3-comparison stimulus experiments (i.e., Experiments 2a and 2b). Six infants learned 18 listener relations to criterion. Their ages at criterion were between 17 months 10 days and 18 months 14 days (M = 17 months 27 days, n = 6). Similarly, in the 2-comparison stimulus experiment (Experiment 6), the five infants required many trials of operant training before they learned the first pair of listener relations, to a criterion of ≥7/8 consecutive correct responses. Two infants also learned two listener relations to mastery criterion in Experiment 2b. Thus, two listener relations were learned to criterion, as conditional discriminations, when the infants were between 12 months 27 days and 20 months 9 days old (M = 16 months 11 days, n = 7).

General Discussion

Preverbal listener relations do not give rise to speaker relations.

Naming did not emerge as a consequence of listener training, in any of the eighteen children who participated in these experiments. Novel listener relations were reliably established with eleven preverbal participants. In none of these infants did the ability to select the object in response to an auditory stimulus give rise to corresponding vocal behaviour in the form of either tacting or echoic imitation. These results pose problems for both stimulus equivalence and relational frame accounts of verbal behaviour. Sidman (1994; 1997) has suggested that speaker behaviour (or expressive behaviour) is derived from receptive (or listener) processes "in order to be a speaker, one must first become a listener" (1994, p.116). Clearly listener relations alone are not sufficient for correspondent speaker behaviour to be emitted. Neither does listener behaviour "mutually entail" speaker behaviour. Listener relations were acquired independently of productive verbal behaviour in the early stages of language learning. For pre-verbal infants, learning to respond as a listener did not invoke any of the necessary conditions of stimulus equivalence.

Naming theory predicts that listener relations will be unidirectional relations, until the infant has *learned* the full name relation (Horne & Lowe, 1996, pp.192-196). However, other behaviourist theories of language disagree. Sidman (1994) suggests that stimulus equivalence is a biological primitive; that is, he suggests that if a child has the necessary history to establish the pre-requisites for an equivalence class, stimulus equivalence will be demonstrated. Equivalence comprises reflexivity, symmetry, and transitivity, and, when all are demonstrated simultaneously, an equivalence class is said to exist.

The relations, trained as listener responses, were not designed to test all of the above criteria of stimulus equivalence; the trained relations did not have a common stimulus. However, if equivalence is a "species characteristic" (Sidman, 1994, p.261) that does not require a learning history for its establishment, one would expect that any part of the equivalence relation would be demonstrable, given the necessary history.

General Discussion

Sidman (1994, p.566) suggests that "whenever we talk about a word-meaning-referent, an equivalence relation will be found to exist". Thus, if a referent can be identified as a "meaning" of a word, even if only a unidirectional relation is trained, the reflexive and symmetrical responses in respect of the trained relation should emerge without training. In Experiments 2a and 2b, there was no evidence of either "reflexive" or "symmetrical" responding; that is, there was no emergent speaker behaviour. Neither the "reflexive" echoic response nor the "symmetrical" tact response was demonstrated by any of the infant participants.

It has been argued that a symmetrical relation to a listener response would not be naming or tacting but covert hearing of an auditory stimulus which had been established as discriminative for the listener response (Barnes, 1996, p.266). However, Horne and Lowe (1997) state, "The child, having learned upon hearing */where's the boy?/* to look at and point to a boy, should then upon seeing a boy look at and point to the auditory stimulus */boy/*; it is clear that within the symmetry relation there is no behavioral basis for the child to emit the vocal response "boy"" (p.275). Naming theory suggests that the name relation is not symmetrical, the object and the name do not "have the same meaning", nor is either "the meaning of the other" (Sidman, 1994, p.343) and thus cannot be accounted for in terms of a pre-existing stimulus equivalence.

Similarly, in Experiment 6, there was no evidence of "reflexive" or "symmetrical" responding for the first set of listener relations. However, following training of Sets 1 and 2, there was evidence of a facilitation of tact learning for two infants (RB and HS). In Sets 3, 4, and 5, for HS, and in Set 3 for RB, 8 listener relations were learned, following which, the corresponding speaker behaviour was demonstrated without further training. In each case, the infants echoed the listener stimulus during the *reinforced* training trials and the corresponding tact relations "emerged". This suggests two things: first, the infants' minimal echoic repertoires were already sufficiently developed for them to readily echo the relevant non-word listener stimuli; and second, that their tendency to echo was strengthened, not only by contiguous reinforcement of correct listener responses, but also by their prior experimental history with Sets 1 and 2, where they were trained or prompted to echo the non-word listener stimuli. There is no evidence, however, of tact "emergence" in the absence of echoing of the listener stimulus and therefore no support for a stimulus equivalence interpretation of these performances.

This hypothesis is further supported by the performance of infants TE, HS, and RB in Set 2 and in Sets 4 and 5 for RB. In these sets, ten listener relations were taught to criterion *without* "emergence" of the corresponding tact relations. However, in all eight relations, tacting was demonstrated after the introduction of echoic prompting without reinforcement of matched responding. Since the infants were already echoing the listener stimuli during the listener trials, it is clear, once again, that their minimal echoic repertoires were sufficient for appropriate echoic responding, whether or not they were prompted to do so. However, the introduction of echoic probes, even when responding was not directly reinforced, raised the frequency of such echoing, as compared with that in the listener trials. This intrusion of previously learned relations demonstrates the difficulties involved in conducting a test of differing accounts of the genesis of naming. This result, however, does allow Hayes' relational frame theory to be re-examined.

A most important research paper in this field, written from the perspective of RFT, is that of Lipkens, Hayes, and Hayes (1993). Recall, that Lipkens et al. observe very similar behaviour to that reported in this thesis in respect of one male infant. Lipkens found that when she trained the tact relation, listener responding was demonstrated. This, she claimed, was a "symmetrical" response; it was the first reported evidence of "symmetrical" responding in an infant as young as 17 months old.

Lipkens' claim, that Charlie demonstrated symmetrical responding at 17 months old, was criticised in Chapter 3. It is difficult to ensure that the relation trained was, in practice, a unidirectional tact relation: one cannot exclude a corresponding reinforced orientation response during tact training. Having trained the tact, however, Lipkens found that her participant could easily respond as a listener at 17 months old.

Further, when Lipkens et al. (1993) trained the listener relation without speaker behaviour; that is, the name → object relation, they found their participant was unable to demonstrate "symmetry". In common with the studies reported here, listener learning did not give rise to the corresponding tact relations, for this 17 months old infant; listener relations appeared to be unidirectional relations. In the light of the studies reported here, the parsimonious interpretation of the Lipkens et al. claim for "symmetry" in the performance of a 17 months old infant is that the test relation was inadvertently trained.

Listener responding, at 17 months old, is comparable with the 11 learners in the studies reported here ($\underline{M}$ = 17 months, n = 13). (Two infants reached mastery in both the 2-comparison, and 3-comparison conditions, thus they were each counted twice.) Five infants learned listener relations to criterion before 17 months old; the youngest, WL, was 12 months 27 days old when she demonstrated mastery of three listener relations in all six pairwise, 2-comparison, trials of three listener relations.

Naming is the basis of verbal behaviour.

The inadvertent listener training involved in the object → name tact training, may have led Lipkens et al. to prematurely assert that mutually entailed responding was a verbal pre-requisite. Consequently, these researchers were led to conclude that, in the absence of an appropriate echoic repertoire, symmetrical responding or mutually entailed responding would have been demonstrated, *if only the appropriate speaker behaviour was available*. However this is only speculation; this is especially so when the uni-directionality of Lipkens training of the picture → name relations *is* questionable. Without clear evidence for unidirectional training of the tact relation, the claim that Charlie showed symmetry at 17 months old must be treated with extreme caution. As Horne and Lowe (1996) predict, and contrary to Lipkens et al. (1993), in the preverbal infants tested in Experiments 2a, 2b and in Set 1 of Experiment 6, training uni-directional listener relations did not give rise to the mutually entailed response of tacting or naming. Thus Lipkens et al.'s hypothesis, that mutual entailment appears prior to naming, cannot be sustained.

Naming theory can provide a more illuminating analysis of Charlie's behaviour. Lipkens' et al. (1993) findings are important because they illustrate how the first name relations are built up of simple responses that have not yet become generalised behaviours. This was evident because the corresponding name relation did not emerge when, at the same age, the procedure was reversed from the tact training (i.e., object → name) to the listener training (i.e., name → object). By Horne and Lowe's (1996) naming account, Lipkens' tact training can be described in terms of an early name relation. Lipkens demonstrated that when speaker behaviour is trained (through learning to echo in the presence of an object, such that seeing the object comes to control the production of the verbal response) the whole name relation, including the listener relation, is learned. This is perhaps the earliest evidence of an experimentally trained name relation, but it need not be "symmetrical" nor does it demonstrate "equivalence" (see Horne & Lowe, 1996; 1997; Lowe & Horne, 1996); it is a circular name relation, as defined by Horne and Lowe (1996). This will be discussed below.

Lipkens et al. (1993) taught Charlie to name at 17 months old. None of the children, reported in Experiments 2 — 6, following the listener training first route, was able to name the experimental stimuli at this age, although the listener stimuli were derived from phonemes within their vocal repertoires. However, the "tact training" described by Lipkens et al. is very similar to the methods parents use to teach their infants naming (Horne & Lowe, 1996, pp.198-200, and see Chapter 2).

Vihman and McCune (1994) report that young infants can and do learn words, under close instruction; these may be learned both expressively and receptively (see

Sidman, 1994, Fig. 4-1). However, very early words differ from later words in two ways: first, there appears to be no evidence that early words are produced in response to other exemplars of the object class; and second, neither is there evidence that they are produced in other contexts from that in which the word was first learned. Horne and Lowe (1996) describe learning a name relation in which listener relations are first well established; in these circumstances each listener operant will be made up of many different listener behaviours. Under these conditions, learning a name should make it increasingly probable that a name would be produced in both these novel conditions; that is, in response to similar objects and to the same object in other contexts. Future research might examine whether training a name relation when the listener relation is minimally specified, as in Lipkens et al.'s study, would allow an infant to produce generalised naming in each of these conditions.

As described below, the infants in Experiments 2 — 6 were able to produce corresponding names to novel shape-based exemplars of the trained objects; but they had been trained to conditionally discriminate the stimulus objects. Thus they had extensive listener histories with the experimental objects before learning the tact relations. This condition (i.e., prior listener experience) more closely resembles the learning sequence seen in object-related play in natural caregiver-infant dyads.

Learning theory and maturational development — (Age-related abilities).

The infants, reported here, reached the *mastery* criterion for listener responding between the ages of 14 months 26 days and 20 months 9 days (M = 17 months, 18 days)(cf. Lipkens et al., 1993). The ages of the learners at the start of listener training ranged from 9 months 15 days to 16 months 25 days (M = 14 months 8 days). The mean duration of training was therefore 3 months 10 days. During this 3-month training period, the infants experienced many training trials. Across all participants in the three experiments the number of training trials required ranged from 120 – 540 (M = 325 trials).

General Discussion

Developmental psycholinguistic theorists, notably Chomsky (1959), have argued that infants learn their first language with little or no formal training. Consequently, they have suggested that there must be a species-specific language acquisition device, within the brain structure, that allows a child rapid and easy access to his or her first language.

The results of these experiments, which were designed to establish only two or three word-object correspondences, as listener relations, suggest that this is not the case. Infants need considerable experience of listening to language before they are able to respond as listeners. However, listener *experience* is not sufficient to establish listener *responding*; in addition to exposure to sound object correspondences, operant reinforcement of correct responding is necessary, before preverbal infants can learn to respond as listeners in a conditional discrimination procedure.

The infants who participated in Experiments 2a and 2b, began the listener training at different ages. Six of eight infants, who began listener training before 14 months of age, were unable to reach the required criterion. BR and WL began listener training at 12 months 18 days, and 9 months, 15 days, respectively. They showed mastery of three listener relations in 2-comparison trials at 15 months 4 days, and 12 months 27 days respectively. This did not appear to facilitate 3-comparison conditional discriminations. BR was 17 months 10 days old, and WL was 18 months 14 days old, when 3-comparison stimulus listener responding was established to criterion.

However, in the pairwise training condition employed in Experiment 6, which was designed to facilitate learning of listener relations, one infant began the training before the age of 14 months (13 months 7 days old) and attained the required criterion at 14 months 26 days. The success of three infants at 12.9 — 15.1 months suggests that maturational age was not a requirement for learning listener relations. Younger infants can succeed on simple discriminations and on conditional discriminations in 2-comparison trials. All of the infants in Experiment 2b showed mastery of at least one pair of 2-comparison stimulus discriminations, and better-than-chance responding for all six pairwise relations. It appears that considerable prior experience of simple relations might be required before infants are able to learn 3-comparison conditional discriminations.

Contrary to Piagetian theories of cognitive development, there was no evidence of a stage-like maturation effect, suggestive of a concept of object permanence (e.g., Gopnik & Meltzoff, 1993). If there was a qualitative difference in the way the infants responded to the stimulus objects after the age of 12 months, it was not apparent; each infant appeared to learn listener relations at an individual pace, without regard to their age at the start of the training. There were considerable differences in the ages of the children, on attainment of the listener relations. They ranged from 14 months 26 days to 20 months 9 days, a period which allegedly covers the one-word and two-word "stages" of language production, and Stages 5 and 6 of Piaget's period of sensori-motor development.

Although the number of learners in these experiments is small (11), nevertheless a considerable number of listener relations were learned (50). It appears, in this small sample, that starting later did not enable them to learn faster. There was no maturational advantage for the older preverbal infants; rather, the results suggest that all preverbal infants require extensive training to learn to respond as listeners in match-to-sample tests of conditional discrimination. The only clear facilitating effect was a prior history of learning experimental listener relations.

Fast-mapping, ostension, and emergent matching.

Learning by exclusion may occur in conditions where there is one novel relation among one or many familiar relations (e.g., Dixon, 1977; McIlvane, Kledaras, Lowry, & Stoddard, 1992; and see Carey & Bartlett, 1978). For example, on hearing a mand containing an unfamiliar word, in the presence of many familiar items and one unfamiliar item a child might choose the unfamiliar item; thereby, the items which were known by name would be excluded. This form of learning has been variously named as *stimulus exclusion*, *emergent matching; fast-mapping*, and *disambiguation* (Wilkinson, Dube, & McIlvane, 1998).

Experiments 2a and 2b, investigated how infants learned 3-stimulus simultaneous discriminations, in one of two conditions: without any prior training (Experiment 2a); and, with prior pairwise training (Experiment 2b). The infants were between 8 months 20 days and 17 months 16 days at the start of training.

In the 3-referent condition, in common with conditional discrimination research in young children, the attrition rate was high (Augustson & Dougher, 1992). Thirteen infants began the training, and seven of these infants did not learn the listener relations to the mastery criterion. However, in Experiment 2b, the infants were able to learn the simpler pairwise discrimination tasks to a better-than-chance criterion; it appears that minimising the complexity of the task is crucial for infants' success in tests of conditional discrimination (cf. Augustson & Dougher, 1992).

The two experimental procedures (i.e., Experiments 2a and 2b) were both successful in teaching listener relations to preverbal infants. However, of those who began listener training before 12 months of age, only WL, who started at 9 months 15 days old, eventually succeeded in learning three listener relations in the 3-stimulus simultaneous condition. Four participants (RA, RC, TS, and FM), that is, two in each experiment, experienced extensive training and yet did not master three novel listener relations. They were all under 12 months of age at the start of the experiment. However, OS, who began learning three listener relations at 17 months 19 days had not learned them when she left the experiment at 19 months 27 days.

These results show that it was possible to train 3-stimulus simultaneous discrimination in preverbal infants. However, the conditional discrimination training was long, and highly repetitious, and it appeared that neither "fast-mapping", nor prior pairwise training enabled infants to reach criterion earlier than those who had no prior training.

General Discussion

As all of the infants in these two experiments had shown mastery of at least one pair of discriminations it appeared that infants might proceed to naming earlier if they were required to learn only two listener relations before continuing to the next stage of the experiment.

Two listener relations were trained, as Set 1, in Experiment 6. All five infants in this experiment learned at least one pair of listener relations to the mastery criterion of ≥7/8 consecutive correct responses. These five learners required a mean of 315 pairwise trials. This procedure overcame the problem of early attrition through failure to learn, but the learners in Experiment 6 required more training trials than did the two learners in Experiment 2a.

Match-to-sample conditional discriminations and comprehension.

The results of this, and other research cited here, suggests that learning to discriminate three objects simultaneously, in a 3-stimulus array, is difficult for human infants. Yet, during this period, infants' vocabularies normally expand rapidly. Learning experimental new words would not be expected to differ from learning any other new words. Two possible reasons for the learning delay experienced in the experimental condition are: (a) the conditional discrimination match-to-sample procedure is more difficult than learning to listen in natural settings, in that it demands reliable and predictable responses to more than one object; or (b) preverbal infants' word comprehension, including that of words learned naturally, is less robust than parental report language inventories would suggest.

Woodward, Markman, and Fitzsimmons (1994) taught a new object label to 13 month old and 18 month old infants. In the training phase the infants were shown two objects. Each object was presented separately, but similar play scenarios were conducted for each. One of the objects was named nine times, that is, in three "triplets" (i.e., three repetitions of a phrase in which the name was produced three times); the unnamed object was referred to as *it* or *this,* also in three "triplets" (see Woodward et al., 1994, p.557).

Comprehension was tested after nine exposures to the experimental object-name relation. In the test trials, a second experimenter asked the infant to perform object related tasks that had previously been trained with familiar items, for example, to put the *toma* in the box. In each test trial two novel objects, a clip and a strainer, were placed on a tray. Test trials included tests when the trained pair of objects were presented and trials when two pairs of similar shaped objects of different colour were presented. In the first study, familiar, control, and test trials were *interspersed.* The 18 month olds performed better-than chance (50%) whereas 13 month olds did not. This was the only study which found a difference between the 13 month old and the 18 month old infants.

Woodward et al. suggest the difference was due to task complexity. In Woodward et al.'s Studies 2 - 4, test trials were presented in *blocks of similar trials*; there was no difference in performance between 13 month old and 18 month old infants. (To further simplify the test condition, control trials were omitted in Studies 2 and 4.) The mean response rate for each group was assessed as a percentage of correct trials. Each group selected the named object at better-than-chance frequencies. In Study 4 the infants were tested after 24 hours and the results were found to be robust. Thus, this study demonstrated that, in some infants, one word/object correspondence can be trained to better-than-chance criterion quickly and easily.

Woodward et al. (1994) presented results for each group of children; individual performances were not reported. Given that performance was assessed only at better than chance level for the group, it is probable that some individuals performed at only chance levels or below. The best overall performances for the 13 month old group were 65 percent for the group, reported in Study 2 (p.560), the 18 month-olds achieved the highest overall score of 76 percent in Study 1 (p.559). Each group result was thus considerable less than the 87.5 percent accuracy required in Experiment 6, or the 89 percent accuracy required in Experiments 2a and 2b.

Further, the Woodward et al. studies trained and tested only one listener relation, or conservatively one word-object relation, and Baldwin and Markman (1989) suggest that naming an object makes it more salient. Therefore, one cannot exclude the possibility that increased salience was instrumental in producing better-than-chance selection of the target object. Real evidence of name-object listener relations might be adduced from pairwise discriminations (e.g., Experiments 2b and 6), but not from a single word-object correspondence.

Woodward, Markman, and Fitzsimmons' (1994) task is clearly less complicated than the simultaneous conditional discrimination task. It appears that the task complexity is increased when both auditory stimulus and object selection response require discrimination. In a 1-stimulus (auditory) and 2-stimulus (objects) there are only two possible responses. In a 2-stimulus condition there are four stimuli, two samples and two comparisons, and thus four possible relations; in a 3-stimulus condition there are six stimuli and thus nine possible relations (see Saunders & Green, 1999, for a discussion of this).

Schafer and Plunkett (1998) designed an experiment to control for several confounding variables in the Woodward et al. study. Schafer and Plunkett chose a preferential looking task to teach two word-object relations. A computer generated program was designed to balance the frequency of presentation of target and distracter images and target and distracter words. Thus the named images were equally salient. Stimulus negative responding was controlled for by including a third non-experimental non-word, thus correct responding to both targets could not be successful on stimulus exclusion alone. In addition, the auditory stimuli were recorded and thus were presented consistently throughout. The experimenter was not visible to the infant, avoiding the possibility of cueing, and the parent was prevented from cueing by wearing headphones. Thus this experiment was designed to investigate if 15 month old infants could learn two new name-object relations from minimal exposure to auditory-visual correspondences, under tightly controlled conditions.

Schafer and Plunkett (1998) conclude only that their 15 month olds had learned one name-object relation. There was a difference on the match vs. anti-match trials but no difference on the match vs. neutral trials. Thus stimulus negative, or exclusion responding, was demonstrated in a high proportion of trials. As described in Chapter 2, this study did not improve on Woodward et al.'s findings for a number of reasons. First, it was only successful at the one-word level, and, in common with the Woodward et al. (1994) study, there was no evidence that this relation was linguistic in any sense. Second, the vocabulary measures appear to confuse production and comprehension vocabularies; 15 month old infants normally have much larger comprehension vocabularies than those reported for the infants in this study. Although *production* vocabularies of 15 month old infants are probably pre-naming "spurt", *comprehension* vocabulary at this age is between 100 - 240 words (25^{th} - 75^{th} percentiles (Fenson et al. 1993, Fig. B-2). However, the measure clearly did not require vocal production and it is very doubtful that it required verbal comprehension. Third, the preferential looking task measured the duration of longest look; this was the most significant difference. Differences on first look and on total duration of looking were less distinct, consequently, the authors appear to have considered them less relevant. In addition, in other studies, longer looks occurring with this technique have been interpreted as evidence that infants look longer at novel or mismatched stimulus pairs, rather than at matched or related pairs, to which they are predicted to "habituate" (see Bremner, 1994, p.16). Finally, Schafer and Plunkett found it necessary to conduct log transformations of the group data. Was this because high levels of variance in individual results were obtained? As the individual results were not reported, this important consideration cannot be ascertained.

The studies reported by Schafer and Plunkett (1998) and by Woodward et al. (1994) suggest that some infants from 13 months onwards can learn a single auditory-visual discrimination from minimum exposure to a name-object relation. This finding is not inconsistent with the findings reported in studies of conditional discriminations in young children, nor from Experiments 2a, 2b, and 6 reported here. Given that infants over 13 months typically have comprehension vocabularies in excess of 100 words, it might be more unusual if this were not the case. However, both studies show that increased task complexity creates difficulties for preverbal infants. Specifically, Woodward et al. (1994) show that preverbal infants perform less well when trial types are mixed, and Schafer and Plunkett (1998) found poorer performance when two conditional responses were required.

The importance of demonstrating clear conditional discrimination is highlighted by other research, which has shown that when trial types are mixed (e.g., A1 — B1 interspersed with A2 — B2) pre-verbal and non-human participants failed to demonstrate relations they have previously learned in unmixed (e.g., A1 —B1 only) trials (Augustson & Dougher, 1992; Schusterman & Kastak, 1993). This effect was evident in Experiment 2b. It occurred in two conditions: (a) when, having learning one set of pairwise discriminations (e.g., */pab/* — O1, and */doot/* — 02, in the context of O1 vs. O2) infants were required to learn the six pairwise discriminations (*/pab/* —O1 vs. O2, */pab/* — O1 vs. O3; */doot/* — O2 vs. O1, */doot/* — O2 vs. O3; */geck/* — O3 vs. O1, */geck/* — O3 vs. O2); and (b) when, having learned the six pairwise relations described above, they progressed to 3-stimulus simultaneous discrimination training (e.g., */pab/* — O1 vs. O2 vs. O3; */doot/* — O1 vs. O2 vs. O3; and */geck/* — O1 vs. O2 vs. O3). Importantly, in Experiment 6, even when only one pair of simultaneous conditional discriminations were tested, the duration of training ranged from 32 trials in one week to 419 trials in 10 weeks. The mean duration of training in this procedure was 2 months.

The auditory-visual conditional discriminations taught in Experiments 2a, 2b, and 6, may be compared with the results of the visual-visual conditional discriminations reported by Augustson and Dougher (1992) and of Devany, Hayes, and Nelson

(1986). Augustson and Dougher, whose youngest participants were over 2 years old, found that learning was complicated when response choice was increased from two to three comparisons, and was further complicated when trial types were mixed. Their findings are sustained by this research. However, although only two infants in Experiment 2b showed mastery of pairwise discrimination, they reached the criterion for all six pairwise listener relations at 13 and 15 months of age, comparable with Devany, Hayes, and Nelson's participant of youngest mental age.

Augustson and Dougher chose a three comparison task, which was similar to the 3-stimulus simultaneous discrimination task described in Experiments 2a and 2b, except that in their experiment the discriminative stimulus was visual and not auditory. Augustson and Dougher reported that their procedure failed to establish conditional discriminations in two year old infants. Although their participants had partial success, in that they could demonstrate either relation in a single trial type, they could not demonstrate them when the trial types were mixed. This result is consistent with the results of those participants who failed to learn in Experiment 2b. However, those who failed to learn in Experiment 2b were much younger (< 12 months) than those who failed to learn in Augustson and Dougher's experiment (> 27 months) at the start of training.

Conditional discriminations in varied settings.

In Experiments 2a and Experiment 2b, six infants successfully learned the 3-stimulus simultaneous discriminations by the age of 18 months. Many trials were required to establish conditional discrimination in young infants, in common with the studies of young children conducted by Augustson and Dougher, and Devany, Hayes and Nelson.

Augustson and Dougher's participants were required to complete a computer generated task. Although this undoubtedly controlled for many extraneous variables, in the absence of a socially structured learning environment it is possible that the contingencies of reinforcement were not sufficient to generalise to the asocial trial conditions. For example, if infants have already learned some conditional discriminations in extra-experimental contexts, it is likely that a particular stimulus context (e.g., caregiver-infant interaction) is central to such acquisition. When a young child is interacting with a computer visual display unit, rather than another human being, important stimulus conditions may not be present. Thus the problem may have been one of learning set.

In Experiments 2b, and 6, the infants participated in a table-top setting where they were in face-to-face contact with the experimenter; and in Experiment 2a, the infants were involved in a play scenario with the experimenter. The "scaffolding dialogue" (Ninio & Bruner, 1978, p3) engendered by the active participation of the experimenter, similar in many respects to parent-infant labelling games, may be more effective in enhancing generalisation or extension of previous learning history to the setting. It should also provide more potent reinforcers than in more contrived settings. Reinforcers and reinforcement will be discussed later in this chapter.

Devany et al. (1986) succeeded in training pairwise discriminations using a table-top setting. Their study was very similar to the pairwise discrimination procedure employed in Experiment 6, except that again the task was visual-visual rather than auditory-visual. Devany did not report how old her participants were when they completed the training stage. The four *normally developing* infants in her study were reported to be 30 months, 35 months, 30 months, and 25 months old, respectively. However, the mental ages of the latter two infants were well below their chronological ages (20 months and 19 months respectively, a 10 month and 6 month developmental delay). The number of trials taken to establish the first two conditional discriminations in the Devany, et al. study was 273, 185, 95, and 107 trials, respectively. The infants in Experiment 6 (age 14.9 - 20.3 months) required from 32 — 419 trials to learn the first pair of listener relations.

General Discussion

The different outcomes, discussed in the previous research reported here, appear to reflect the nature of the tests of listener learning conducted. Of the studies which appear to test for word "learning", all auditory visual tasks, learning that a word, as an auditory stimulus, can direct attention towards one object, and not another, was only unequivocally demonstrated in the conditional discrimination tasks reported in this thesis. The responses of the infants in the studies which showed preference for only one object or image may have been learned through simple association by contiguity; they were not conditional or specific in any sense.

There was no evidence to suggest that auditory-visual conditional discriminations differed fundamentally from visual-visual conditional discriminations. It appears that under optimal conditions, infants can learn conditional discriminations from the beginning of the second year of life. However, tasks which require trial types to be mixed, or which require more than two relations to be learned simultaneously, may demand behavioural repertoires which are not normally demonstrated until the middle of the second year, when the infant begins to produce listener responses in greater numbers. That is, consistent with learning set theory, the participant may first need to have learned to learn listener relations as conditional discriminations. These differences are correlated with the onset of first words at 12 — 13 months and the onset of the "vocabulary spurt" at 17 — 19 months (e.g., Bloom & Beckwith, 1989; Nelson, 1973).

Learning to Echo

In Experiments 2a, 2b, and 6, all the infants had produced the phonemes, of which the non-word stimuli were comprised, during the operant conditioning of their unprompted vocal responses. Clearly, there is a difference between the random sounds which an infant can make and the sounds which the infant produces echoically. The results of Experiments 2a, 2b, and 6 have been compared with the report of Lipkens, Hayes, and Hayes (1993). Lipkens et al. reasoned (post hoc) that failure to demonstrate "symmetry" following name→ object training was because Charlie lacked the echoic repertoire to produce a vocal response. This account of his performance is in accord with the predictions of naming theory. All the infants referred to in this paragraph demonstrated listener relations without the corresponding echoic or tact behaviours, even though they could all produce a wide range of phonemes.

However, as Skinner (1957/1992, pp.58-59) defines, a phonetic repertoire is not necessarily an echoic repertoire: an echoic response produces stimulation that closely matches the echoic stimulus. In addition, learning an echoic repertoire requires an infant to listen to his or her own vocal production and to respond to it in the same way that he or she responds to a corresponding auditory stimulus produced by another member of the verbal community, if it is to facilitate the development of a naming repertoire (Horne and Lowe, 1996, p.199). Unlike RFT, which examines in detail how derived stimulus relations work, but says little if anything about how they are derived (e.g., Hayes & Barnes, 1997), naming theory describes exactly how an echoic repertoire facilitates naming.

Horne and Lowe (1996), suggest that as the child's vocal responses are increasingly shaped by the verbal community the child may also come to respond to the similarity between the sound she hears herself produce and the sound produced by her caregiver (and see Skinner, 1957). At first, infants' speech-like vocal responses are reinforced by the attention and delight of the primary caregivers. In addition, when the child perceives the match between a vocal response and an auditory stimulus it may strengthen the probability of vocal responding and serve to establish an echoic repertoire. Skinner's, and Horne and Lowe's accounts of verbal behaviour emphasise the importance of learning an echoic repertoire for the production of other vocal responses.

General Discussion

Eleven infants learned to respond as listeners to three (Experiments 2a and 2b) or two (Experiment 6) auditory stimuli. Nine of these infants went on to learn echoic relations to the corresponding auditory stimuli, in Experiments 3 and 6. Echoing did not emerge as a consequence of hearing the auditory stimulus on innumerable occasions throughout the listener training phase for any of the infants in Experiment 3 nor for any of the infants learning the Set 1 echoic relations in Experiment 6. Thus exposure to the echoic stimulus alone was not sufficient to give rise to echoic responding. Nor did echoing emerge, for the first echoic relations, from echoic prompting alone. For each of the nine infants in these studies, the baseline frequency of echoing was recorded in a series of unreinforced echoic trials. Echoing did not emerge in response to vocal prompting in the absence of reinforcement, in any of the infants.

Poulson et al. (1991) were able to show, when a number of target echoic responses were reinforced, that the echoic behaviour, thus conditioned, was correlated with a generalised echoic responding, that is, non-reinforced models were also increasingly echoed. At the end of her experiment, all of three infant participants were less than 16 months old, two were less than 13 months old.

In the studies conducted in this thesis, there was no evidence of generalised echoic behaviour, when learning the first set of echoic relations, in any of the infants studied in this research. They were between 16.5 and 20.5 months old at the start of the echoic training. However, in learning further echoic relations, in later sets in Experiment 6, there was evidence in three infants for unprompted echoing in listener trials, and rapid onset of criterion echoing in unreinforced echoic trials. As in the Poulson et al. (1991) study, when several echoic relations have been trained in the experimental context there was increasing evidence of rapid onset of echoing in probes for subsequent echoic relations. It is unclear, however, whether this represents generalisation from a pre-existing minimal echoic repertoire, or some other higher-order form of response generalisation.

General Discussion

Learning to echo by operant conditioning.

Following the introduction of reinforcement, in both Experiment 3 and Set 1 of Experiment 6, echoing emerged in line with the implementation of the intervention. For every infant who participated in these experiments, it was necessary to reinforce echoing of the first set of auditory stimuli, in order for them to be established to the criterion. Thus operant conditioning of echoic vocal responses was both necessary and sufficient to bring about the *first* experimental echoic relations.

There were individual differences in the lag between implementing the intervention and learning to echo; however, the general trend was in line with the implementation of the intervention across the multiple baseline design. At first, the production of a vocal model of the auditory stimulus was sufficient only to bring about occasional vocal responding from the infant. Consequently, the opportunities to reinforce echoic behaviour were few; it took many trials before the strength of the operant increased to the required criterion.

In Experiment 3, following the implementation of the intervention, HC, RR, and BR became increasing likely to produce matched echoic responses so that the frequency of matched responses gradually attained the criterion level. However, it was seen that social reinforcement in the form of verbal praise, alone, was not sufficient to establish echoing for all the infants. WP and WL showed increased responding following reinforcement of the first echoic relation, but when the intervention was extended to the second, and third relations, echoic responding fell to pre-intervention levels. However, for these latter infants there was a marked increase in the number of matched responses following the introduction of a supplementary reinforcer (see below).

In Set 1, Experiment 6, echoing did not emerge without reinforcement; echoing to criterion was demonstrated within 1 – 7 blocks of the implementation of the intervention. For most participants, echoing of the first pair of auditory stimuli was demonstrated within three blocks of the implementation of the intervention. However, for RB this was not the case. Although he produced five matched responses to the first verbal stimulus */paba/*, in the first 8 trials of the intervention (see Figure 6.4.1.1, Block 4), his responding subsequently diminished and did not attain criterion until the seventh blocks of eight reinforced trials (Block 10), following the introduction of the intervention to reinforce echoing of */ditta/,* the second echoic relation.

Many studies have used a generalised reinforcer in the form of social praise to operantly condition infant behaviours (e.g., Augustson & Dougher, 1992; Devany, Hayes, & Nelson, 1986; Lipkens, Hayes, & Hayes, 1993; Poulson, et al., 1991). Some of these studies (e.g., Augustson & Dougher; Devany, Hayes, & Nelson) also report the use of extra reinforcers, for example soap bubbles, fish crackers, fruit snacks, and so on.

In the series of experiments reported here, the children were given the opportunity to play with toys or sticker books at the end of each session; this was scheduled to strengthen the probability of general participation in the experimental procedure. Conditioned generalised social reinforcement (e.g., praise) alone, was not always sufficient to reinforce within experiment responses over long periods of training. Consequently, all the infants were, on occasions, additionally reinforced with short play intervals within the sessions. The secondary reinforcer arose from such an interlude with a *Connect-4* frame and tokens.

Clearly, when echoic responses were not emitted they could not be reinforced. For two infants, the intervention did not come into effect until after the introduction of the secondary reinforcer; but it cannot be assumed that social praise did not reinforce the echoic behaviour of these two infants, because so few responses were produced and could be reinforced in this way. The token used in the secondary reinforcement was visible at the time the echoic prompt was delivered. This may have, even if only initially, served as an *eliciting* stimulus, after which the response was operantly reinforced by social praise. (This will be discussed in greater depth in the section headed *Social Reinforcement.*)

General Discussion

In the eleven pairs of echoic relations trained in Sets 2 - 5, Experiment 6, reinforcement was necessary in order to establish echoic responding in only two pairs of target relations (i.e., TE Set 3, and TH Set 2). Social praise alone was sufficient to establish echoic responding in each of the four echoic relations, and, in each instance, criterion echoing was demonstrated within the first block of reinforced trials. Echoing was established in respect of the remaining 9 pairs of echoic relations without any scheduled intervention. However, recall that these infants produced unprompted echoic responses during listener trials. Following a history of reinforced listener and echoic responding to the same auditory stimulus, established in prior training sets, when an auditory stimulus is modelled in listener trials of subsequent novel verbal relations it appears to occasion not only listener responses, but also the corresponding echoic responses.

The non-emergence of the tact.

Seven of the nine infants in these experiments were unable to tact the corresponding objects after having learned listener relations and echoic relations. Note further, the two infants who learned to tact, having learned to echo, combined listener and echoic responses during the listener trials, thereby occasioning the conditions whereby the echo-tacts were reinforced.

Crucially: none of the seven infants, for whom there was no reinforcement of the tact relation, learned to tact any of the 19 corresponding objects from learning listener and echoic responses separately. On the basis of this evidence the hypothesis that stimulus equivalence is a pre-requisite for language and hence naming must be rejected. Figure 7.1 indicates why this is so. As in previously reported research with non-verbal animals and pre-verbal infants, given the necessary trained relations, in these seven infants equivalence relations were not in evidence.

General Discussion

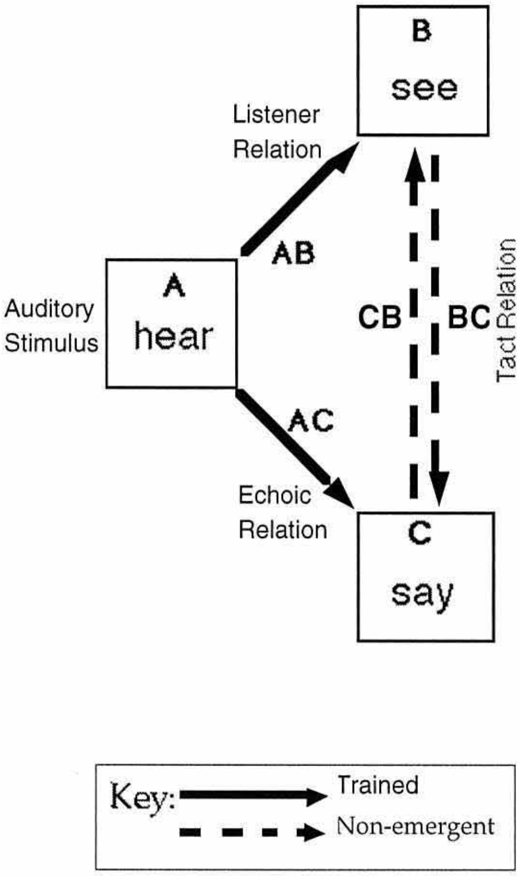

Figure 7. 1 shows the trained listener and echoic relations as unidirectional AB and AC relations. Given this training, if stimulus equivalence is prior to language then the transitive (tact) and equivalence (name) relations should be in evidence (see Saunders & Spradlin, 1996, p.305). This was not the case for the seven infants who learned the listener and echoic elements as separate functional relations.

The listener relation is shown as the first relation A → B (hear → see), and the echoic relation is shown as the second relation A → C (hear → say). It can be seen that in the absence of the tact relation B → C (see → say) equivalence is not demonstrated. This is contrary to the predictions of Stimulus Equivalence (see Saunders & Spradlin, 1996, p.305) and Relational Frame Theory (see Barnes, 1996), which each claim that equivalence is a pre-requisite of language (Hayes, S., in Hayes, L. & Chase, 1991).

General Discussion

Two infants, TE and SH, were able to tact the Set 1 stimulus objects without training of echoing in the presence of the corresponding object, and thus appear to pass the tests for equivalence. However, both these children echoed in the listener trials thus pre-empting the scheduled training and establishing the echo-tact under conditions of generalised reinforcement in the listener trials. They had, therefore, also *learned* to name. Each had a production vocabulary of over 100 words, whereas the other infants in Experiment 6, TH and RB, had production vocabularies well below 100 words at the time they demonstrated echoing of the Set 1 echoic stimuli to criterion (see Figure 6.3). Thus, it might be argued that the former infants were no longer strictly preverbal; that is, in all possibility, in learning their first 100 words, they had learned how to learn a name (Harlow, 1949). Consequently, the possibility that a higher order naming behaviour had become established, cannot be excluded. As the results of these two infants are critical, the detail of their emergent tacting is reproduced below.

The emergence of the "untrained" tact.

In Experiment 6, one of the aforementioned infants (TE) was able to tact two experimental objects as a result of separate listener and echoic training. The second infant (HS) was able to tact two experimental objects after learning listener behaviour and to echo to criterion and having 32 further trials of listener and echoic behaviour without explicit prompts to echo the listener stimulus in the presence of the corresponding object. These children showed the behaviours entailed in stimulus equivalence and derived mutual relations.

Significantly, although listener and echoic relations were trained separately, it should be noted that both these infants had demonstrated generalised echoic responding to the criterion, *in the reinforced listener trials.* It is, therefore, highly probable that these infants were reinforced for echoing when contingently they were looking at the stimulus objects; that is, in similar conditions to those required to establish tacting in all the other infants reported here. For these participants, therefore, it proved impossible to impose the necessary separation of listening and echoing that would permit a test of the competing accounts of the genesis of naming. Thus the possibility of demonstrating *a priori* equivalence is excluded.

Horne and Lowe (1996, 1997) and Lowe and Horne (1996) have variously reported that the name relation is circular, spiral, and bi-directional. However, the conditions in which the change of direction from ongoing circular or spiral relations to bi-directional or "symmetrical" responding are not obvious. Horne and Lowe have described, at length, the unsuitability of the term "symmetry" as a descriptor of bi-directional verbal responding.

The first name relations are unidirectionally circular, and may be endlessly circular (e.g., hear → see → say → hear → say → hear → see or say → hear or see or say). As Horne and Lowe describe, the child first learns to respond as a listener, then echoically, and finally learns to respond to his or her own responses by re-orienting to the object, as in a chained response. However, when the name relation is established as endlessly circular it can be seen that all the verbal responses invoked by a given verbal relation are equally available.

Horne and Lowe (1996, 1997) have stated that there is no need to invoke the concept of stimulus equivalence. It is, like the term "relational frame", a cognitive construct, and although its structure is frequently observed, its construction is not analysed. Further, as Horne and Lowe (1996, 1997) have argued, equivalence is a redundant term in verbal behaviour; this is because a name is not equivalent to its referent, and the conditions under which it is allowed to stand instead of the referent are strictly prescribed.

The results of these experiments sustain the theory that through increasing use of a chained series of responses, the responses become linked into a single but composite intraverbal unit, such as Horne and Lowe (1996) describe as a higher-order naming (and see the circular hear-see-say description above). As such, Horne and Lowe (1996, 1997, in press) and Lowe and Horne (1996) find no need to invoke the unwieldy notion of symmetry. Similarly, neither reflexivity nor transitivity, nor any similar relations derived from RFT, are required to explain emergent behaviour. The child who learns to name, learns a cluster of related behaviours; these, as he or she might also later come to learn metalinguistically, allow speech to function symbolically (cf. Sidman, 1994, p.556-557).

Having raised the operant level of echoing an auditory stimulus such that echoic responding might be demonstrated when the auditory stimulus is presented at any time, these experiments show, that, even in a reinforced listener trial, the conditions emerge for the tact to become established. This is because, when an echoic response is emitted in a listener trial, the vocal operant is increasingly preceded not only by *hearing* the auditory stimulus (echoic relation), but by *seeing* the corresponding stimulus object (listener relation) at the same time or closely contingent upon *saying and hearing* his or her own echoic vocal operant. When the correct listener response is praised, not only the listener response but the entire verbal episode is reinforced (see Catania, 1997).

In this way, all the hereto *proto*-verbal behaviours become reinforced under the single contingency of naming — the vocal operant. However, the vocal operant in this situation is a verbal operant because, in contrast to a simple tact relation, as described by Skinner (1957), hearing the auditory stimulus may evoke orientation to the object; that is, listener behaviour. For Horne and Lowe (e.g., 1996) verbal behaviour is meaningful behaviour, it is not speaker behaviour alone. Unlike a tact, a name cannot be established unless a corresponding listener relations exists in conjunction with a tact and a corresponding echoic relation. The verbal unit can be described thus:

When an infant names an object, event or behaviour, she produces a vocal response, but she also has a corresponding listener operant, and may produce corresponding listener behaviour. When her attention is redirected towards that which she has named, she is a "speaker-listener within the same skin", that is, she responds to her own vocal response as a verbal stimulus, in the same way that she might respond to an auditory stimulus produced by another member of her verbal community. Her verbal behaviour allows the vocal response to exert stimulus control over the entire verbal episode, and it is this higher-order verbal responding, in which the combined speaker-listener behaviour becomes discriminative for all the corresponding operants, which generates understanding of what it is that is named. Understanding, or meaning, in this sense is evolutionary; it is the sum of her experience of a given verbal relation.

Conditioned seeing may occur, even when the object is not present; in these circumstances hearing the auditory stimulus might initiate searching behaviour, when the reinforcing contingencies are available for this behaviour. Similarly, seeing the stimulus object might evoke conditioned hearing of an auditory stimulus and a subsequent echoic vocal response (tact relation). In turn, this second vocal response may serve as an auditory stimulus for further echoic or listener responses, which might be discriminative for a further tact response, and so on, as predicted by *naming theory*.

The infants reported in this thesis progressed from pre-verbal infants to verbally-able young children, over the course of the experimental period. There is an overlap of preverbal and verbal behaviour at the point at which the transition to language occurs (see Vihman, 1996; Vihman & McCune, 1994). It appears that not only do infants understand words that they cannot say, they can also say words that they do not fully understand. Measuring exactly what is understood by infants at this period of transition is problematical, often subjective, and resistant to analysis (Bates, 1993; Dale, 1972; Reznick & Goldfield, 1992).

Behaviour analysis is equipped to describe this period of transition to language objectively. Listener behaviour and echoic behaviour have been shown to be separate behaviours, at least initially, until they are brought together under conditions of combined reinforcement. This has been demonstrated in the experiments reported in this thesis. For the seven infants who did not demonstrate criterion echoing in the listener trials of 19 target relations, there was no evidence of tact responding.

General Discussion

The results show that the listener relation is a uni-directional relation in pre-verbal infants. Similarly when the echoic relation is trained separately from the listener relation, in the pre-verbal infant, it too is a unidirectional relation. However, even in the experimental situation, new relations — previously identified as bi-directional relations — may emerge from uni-directional operants if the infant has well-established higher-order naming. These experiments illustrate the problems inherent in distinguishing proto-verbal and verbal behaviours in the period of the transition to language.

Learning The Tact Relation

All nine infants, who learned to echo in Experiments 3 and 6, learned to tact in Experiments 4 and 6. In both experiments, and for all participants, it was necessary to reinforce echoing in the presence of stimulus objects for the tact relation to become established. By reinforcing echo-tact and tact responses nine infants learned to name 44 experimental stimuli.

In Experiment 4, all the infants required reinforcement of their responses to tact probes, in combined listener-echoic-tact trials, or in the tact test trials, or in both, before they learned to tact to criterion. Five infants learned to name 14 experimental stimuli to criterion in the 3-stimulus simultaneous presentation condition.

In Experiment 6, the infants learned to tact after they were reinforced for combined listener-echoic relations. Two infants produced unprompted echoes in the reinforced listener trials, and two infants received combine listener-echoic training trials as a scheduled intervention. Four infants learned to name 30 experimental stimuli in the 2-stimulus simultaneous presentation condition.

These results suggest that producing an echoic response, and at the same time orienting attention towards an object, is necessary and sufficient for establishing a corresponding tact relation. Once the echo-tact relation had been reinforced in this way, non-echoic tact responses emerged; that is, target vocalisations were produced in response to the corresponding stimulus object, and without the corresponding prior auditory stimulus. Thus, all the infants learned to tact the corresponding stimulus objects by combining listener and echoic responses as echo-tact responses.

Testing the name relation.

Horne and Lowe (1996) have described combined listener-echoic-tact behaviour as the basic *name relation.* Clearly, the name is more than a tact because it requires a listener relation; that is, it demands that the infant can also reliably identify an object on hearing the corresponding auditory stimulus. When the infants had learned to tact the stimulus objects to the criterion level, listener responses were also seen to be at criterion in 42/44 experimentally trained verbal relations. Thus, by Horne and Lowe's definition these infants had learned to name the stimulus objects. Only one infant TH produced tact responses to criterion without demonstrating the corresponding listener relations, simultaneously, to criterion. In the Set 1 relations, she demonstrated criterion tact response in Block 16, and in this block her listener responses were correct in 6/8 trials and in 5/8 trials respectively. Both listener relations were at criterion, simultaneously, in Block 13, however, following extension of the echo-tact intervention to *doot* she produced only 15/24 correct responses to */pab/* —O1 and 14/24 correct responses to */doot/* — O2 (Blocks 14 - 16).

In Experiments 5, and 6, the experimental name relations, so learned, were tested to see if, in addition to Horne and Lowe's definition of a name, they fulfilled the criteria defined in developmental and psycholinguistic research (see Chapter 2).

Principally, these require that a word should have both phonetic correspondence and object correspondence; that is, the word should sound like the word used by other members of the verbal community, and it should be used in relation to the same objects as by other members of the verbal community. Further, the child should use the word in appropriate contexts; that is, as a context-flexible category name (Vihman &

McCune, 1994, p 517). The nature of the training involved in establishing the experimental name relations ensured that the first requirements were not an issue. The verbal community was limited to the infant and the experimenter. The sound correspondence had been trained as the echoic response and the object correspondence had been trained as the listener response.

Regarding category names, each name relation was tested for generalisation on the basis of shape, that is, the infants were asked to name a novel object of similar shape, but of different colour or texture, from the trained object.

In the tests for generalisation of the name to such novel exemplars, tact responses were produced in response to 41/42 corresponding novel objects of similar shape but of different colour or texture. Thus, given both speaker and listener behaviour, as Horne and Lowe (1996) describe, the infants were able to show generalisation of the names to previously unseen objects on the basis of common shape.

Only one infant, TH, showed tact responding without simultaneous corresponding listener responding. She learned to tact O1 and O2, as Set 1, in Experiment 6, but, as described above, she did not show corresponding listener behaviour when the tact responses were demonstrated to criterion. When she learned, later, to tact O3 and O4 (Set 2) to criterion, both tact and listener relations were seen to be at criterion. TH was able to generalise the name to the novel coloured examples of all four objects at better-than-chance criterion, and correctly named O4 in 8/8 trials. She was unable to meet the criterion for naming the novel textured examples of O2, preferring an alternative but appropriate name (*brush*) from her existing vocabulary. She responded at better-than chance criterion for all other texture variants. In addition WP narrowly failed to meet the criterion for tacting O1. She too failed to extend this name to novel exemplars while being able to generalise names to novel examples of O2 and O3. Thus the strength of the tact relations on tests of generalisation to similar shaped novel exemplars was seen to be correlated to the strength of the *combined* listener and tact relations of the trained name relations.

General Discussion

The names learned by these infants fulfilled one of the criteria for context-flexibility, specified by psycho-linguistics. However, the names were not tested in a non-experimental context. Names, derived in accordance with Horne and Lowe's (1996) criteria, fulfil many of the developmental psycho-linguistic criteria for a word.

How Higher-Order Naming was Established

Higher-order classes are classes of behaviour embedded within other classes of behaviour (Catania, 1998, p.155). Horne and Lowe (1996) suggest that higher-order naming incorporates both listener and speaker behaviour in such a way that the presence of one presupposes the other. The following passage extends this theme:

> Thus, when higher order naming skills have been established, even if caregivers ostensibly teach the child only conventional listener behavior (e.g., orienting to and picking up a shoe in response to the utterance "where's shoe?"), she will nevertheless also exhibit the corresponding speaker behavior (saying "shoe" in response to seeing the shoe). Likewise, when only speaker behaviour is ostensibly taught (e.g., when the caregiver points to a dog and says "dog", the child repeats the utterance and learns to say "dog" herself when she sees it), the child also acquires listener behavior (so that when next asked "where's the dog?" she orients and points to it). Second, we have shown that once the higher order name relation has been learned by the child, there may be no need for the verbal community to provide reinforcement to establish appropriate speaker and listener behavior; it may be sufficient, for example, for caregivers merely to point to and utter the name of a novel object for the full name relation, incorporating both speaker and listener behavior, to be established (Horne & Lowe, 1996, p.207).

These claims were tested, in Experiment 6, by training name relations in serial pairs. The Set 1 names required reinforcement of listener and echoic relations and the reinforcement of echo-tact responses before naming was demonstrated. However, in subsequent pairs not only was learning faster, but three infants demonstrated naming when they were only adventitiously reinforced for speaker behaviour, in the listener trials. These results strongly suggest that for two infants a higher order relation had been established, in which listener behaviour training was sufficient to establish the corresponding echoic and tact speaker behaviour: that is, naming.

However, because the listener relations were trained in a pairwise procedure in Experiment 6, and not in the 3-stimulus simultaneous procedure employed in the earlier experiments, the possibility that the infants were learning some of the relations by *exclusion* must also be considered.

Fast-mapping, ostension and emergent matching - revisited.

Emergent matching has been demonstrated by young children, by mentally retarded adults, and by non-human animals (Wilkinson, Dube, & McIlvane, 1998). It is, therefore, neither considered to be an operant, nor a verbally mediated behaviour. However, *naming outcomes* have been reported by Dollaghan (1985) in respect of 45 percent of participants in her study. Dollaghan's participants produced a novel name in response to "what is it?" after a single exposure to a novel verbal stimulus and one unfamiliar stimulus object, in the presence of two familiar objects. However, her participants were between two and five years old, and at this age, and as the research reported in this thesis suggests, naming should already be established as a higher-order behaviour.

In Experiment 6, the infants were all less than two years old when the second pair of stimulus objects were first presented (range 20.5 – 22.5 months). The infants had already learned how to respond as listeners, when learning the Set 1 names; consequently, the Set 2 stimuli were presented simultaneously without preliminary training with familiar objects.

Significantly, for the participants who demonstrated higher-order naming, two novel stimulus objects were presented simultaneously, and each of the two novel auditory stimuli was presented in the first session. The infant, therefore, was required to learn an operant response for both target relations: that is, a response contingent upon the consequence of reinforcement or its absence. The conditions required for establishing learning by fast-mapping were, therefore, not ideal.

However, one cannot exclude the possibility, that having learned to respond operantly to one auditory stimulus, the second relation might be learned as a stimulus negative response (i.e., by exclusion) and not as an operant response. However, if this were the case, one would expect that the listener training for the Set 2 relations would be rapid and this was not the case, universally; whereas RB learned the Set 2 listener relations to criterion in a single block of eight trials, TE required 6 blocks of eight trials to learn them. This would suggest that he did not learn by exclusion, and that he did not have generalised listener behaviour, at this stage.

In addition, the facility for learning to name by exclusion must depend, to an unknown extent, upon each child's comprehension and production vocabulary, particularly with regard to what is a familiar object. In the MCDI norming study (Fenson et al., 1993), the developmental trend for word production at this age shows a rapid increase. At 20 months, Fenson et al. report a mean productive vocabulary of less than 200 words; at 25 months, this has risen to over 350 words; and by 26 months, children have vocabularies in the region of 400 words.

The infants in Dollaghan's (1985) exclusion study were tested using the Peabody Picture Vocabulary Test (Dunn, 1965); however, their individual vocabulary levels were not reported. As the youngest participant was 25 months old at the start of the experiment, without evidence to the contrary, it can be assumed that the infants in Dollaghan's experiments had vocabularies greater than 350 words. Thus learning word names by exclusion, unlike learning via exclusion in non-human animals (e.g., Schusterman & Gisiner, 1997), appears to be a verbal behaviour. There is no evidence that it is a pre-verbal requisite of naming.

Dollaghan (1985) reports no significant correlation between the ages of the children in her experiment and their "fast-mapping" abilities. She reported comprehension, production, recognition and location scores for children in each of four age groups, that is, two year olds, three year olds, four year olds, and five year olds (Dollaghan, 1985, p.453). Whereas between group differences for comprehension can be seen to be minimal, this is not the case for the between group production scores. The trend is not a linear function of the age of the participants, and this might obscure overall differences. However, when the results of the two younger ages groups are combined, Dollaghan's records (Table 3. p. 453) show that only 4/13 (30%) of the children under four years of age were able to reproduce the single novel name to which they were exposed. This response rate rose to 10/18 (56%) for those aged four to six. Further, when the results of the three younger groups are combined, the percentage of children who were able to produce the new name increased only to 37.5 percent, little more than half the 71 percent figure reported for the five year olds. Thus, in contrast to the results reported in Experiment 6, *naming* was not by any means a universal outcome of the Dollaghan (1985) exclusion procedure, even though the children were much more verbally sophisticated.

The infants in Experiment 6 could produce between 84 and 183 words at the start of Set 2 training; thus, they were within the range of the "vocabulary spurt" and appeared to have learned higher-order naming outside the experimental setting. Their ability to learn subsequent pairs of new names was entirely consistent with the predictions of higher-order naming, as described by Horne and Lowe (1996). Tact responses, unlike listener responses, cannot be produced by exclusion. Further, in the generalisation tests, each child was presented with novel exemplars of all the trained target relations, consecutively. Four, six or ten novel object names were tested at once.

The lack of evidence for exclusion in any of the experiments reported in this thesis is consistent with the documented onset and frequency of the phenomenon in the existing published literature. Rather than suggesting that fast-mapping, ostension, learning by exclusion, or emergent matching are the outcome of some cognitive concept that things ought to have names, the ability to learn new names from minimal exposure can be described, predicted and analysed more fully as higher-order naming.

General Discussion

Reinforcers, Reinforcement, and Rewards.

Throughout the series of experiments, some behaviours were scheduled for reinforcement, and other behaviours, most importantly tact responses, were scheduled for zero reinforcement. However, exactly what reinforces a behaviour is difficult to determine. This is particularly so for human participants, for whom conditioned generalised social reinforcers are preferred to primary reinforcers. In the experimental analysis of non-human behaviour, it is customary to deprive the participants of food, such that target behaviours are reinforced when food is given contingently upon production of target responses. However, this technique cannot be employed when working with preverbal human infants.

Secondary reinforcers may be established through association with the primary caregiver or with the satisfaction of primary needs. However, it seems inevitable that these will have less reinforcing strength than primary reinforcers. Social praise is a culturally established generalised social reinforcer. It might constitute what Skinner terms *educational reinforcement* (see Chapter 1)(Skinner, 1957/1992, p.84). However, rewarding a child's behaviour by praising the child is only reinforcing when, as a consequence of the reinforcer — for example, social praise — the strength of the behaviour increases. When social praise fails to strengthen a behaviour it is, by definition, not a reinforcer.

All the infants were willing and often eager participants in the experiment. That is, they were happy to leave the nursery group with the experimenter and to enter the experimental setting. They appeared to welcome the change to their daily routine and to look forward to the one-to-one relationship with the experimenter. However, all the infants experienced some periods when they produced negative responses to the tact probes; that is, they said "no", or they covered their faces, or they threw the stimuli onto the floor.

General Discussion

Failure to reinforce behaviour by CSG_Rs was encountered, from time to time, during the course of Experiments 2 – 5. Five infants participated in all the Experiments 1 - 5. The similar structure of the experimental procedures in each of the latter experiments, and the prolonged periods of training required to establish novel behaviours in respect of three stimuli, simultaneously, contributed to some occasional and intermittent disaffection with the experimental procedure.

The total duration of training, from the beginning of the operant conditioning of vocal production to the completion of the tests for generalisation of naming ranged from 6 months to over 20 months ($\underline{M}$ = 14 months). In view of this, it is unlikely that the same factors were relevant throughout the research. Some contributory factors are suggested here, in historical sequence.

In Experiments 2a and 2b, there was some evidence of reluctance to participate, in the later trials, by the infants who experienced prolonged listener training. The tact probes were difficult for the infants at this stage. They had little or no speaker behaviour and thus no available tact responses. There were also 27 tact probes in each session, and sessions were conducted on every occasion that the infants attended the nursery. In addition, the ongoing failure to learn the listener relations contributed to the general tedium of the listener training.

It is possible that the very young infants had still to learn to learn listener behaviour. Very young infants, and possibly neonates, have the perceptual abilities to reliably discriminate one auditory stimulus from another (see Chapter 2), and even the youngest of these five participants was over eight months at the start of the listener training. However, learning to discriminate a stimulus object, conditional upon a specific auditory stimulus, does not appear to be straightforward.

Harlow (1949) described the effects of learning to learn; many non-correlated factors must be excluded from the situation before a simple discrimination comes to predict the response. The very young infants (i.e., those who were eight or nine months old at the start of the experiment) may not have experienced operant contingencies for listening prior to the experiment. Thus they may not have learned how to learn to listen. Two features of infant caregiver interaction during the second half of the first year of life, and which seem to be designed to promote listening, are *joint attention* and *joint activity* (Baldwin & Markman, 1989; Butterworth & Cochran, 1980; Bruner, 1995; Dunham, Dunham, & Curwin, 1993; and see Halliday & Leslie, 1986).

Such early listening and orienting experience, described by Harris (1992), allows the infant to focus upon particular sound object correspondences, allowing other non-attended objects and events to become less salient. These caregiver-infant routines may help to establish stimulus-stimulus associations such that auditory discriminations become increasingly related to object seeking.

Without such prior learning experience, the infants may have been unprepared to participate in the scheduled procedure. Participating without the necessary prior experience may have created conditions which effectively extinguished responding; for example, when reinforcement was withheld following a series of incorrect responses. Horne and Lowe (1996) suggest that in this context a caregiver would probably shape the target response by selecting the appropriate stimulus and saying "here it is", playing with it, directing the infant's attention towards it, and so on. This consequence was overlooked when designing this series of experiments. However, it must be incorporated into the schedule of future experiments.

In Experiment 3, again, the tact tests were not well tolerated. Again, the infants had few or no available responses, and the number of tact probes remained high. In addition, putative tact responses produced no scheduled consequences. Unlike the conditions which apply in the verbal community, the experimental condition did not reinforce any responses to tact probes that matched the target relation. This flouts the social rules of caregiver-infant interactional routines (Moerk, 1992, pp.10-12). In these conditions it is possible that some of the infants might have learned *helplessness* (Maier, Seligman, & Solomon, 1969).

General Discussion

In Experiment 4, all the infants had echoic vocal responses but these were not, initially, tact responses. By the end of Experiment 4, reinforcement was available in respect of every response. Once reinforcement for correct tact responding was implemented, even if only in the listener-echoic-tact training trials, it was noticeable that the participants became increasingly more compliant with the experimental procedure. Interestingly, when reinforcement of tact responses *was* made available they did not immediately arise — often (see Participants WP, WL, & BR) very long drawn out reinforcement was needed to get to criterion. It is possible, although there were no initial tact responses to extinguish, that under conditions of prolonged zero reinforcement, these infants had learned not to produce vocal responses to the tact probes. This would account for the degree of shaping required to eventually evoke the tact responses.

In Experiment 6, the infants were required to learn only two new relations at a time, and, they were all in their second year at the start of the procedure. These modifications reduced the onset of tedium, and allowed the infants to progress without becoming disaffected.

Token reinforcers.

Tokens have been used as conditioned reinforcers in clinical situations (e.g., Ayllon & Aslin, 1968). In the clinical situation the tokens are readily redeemable for primary reinforcers, such as snacks. In western society, if not world-wide, money has taken on this function of society.

However, for infants, money appears to be of little consequence, and it is unlikely that tokens would have become established as conditioned reinforcers by their similarity to coinage. However, all the infants who participated in this series of experiments appeared to enjoy playing with the Connect-4 toy in the inter-trial and end of session play periods. Thus Connect-4 became an ideal supplementary reinforcer in all trials for two infants and in occasional trials for all the remaining infants.

There were many stages in the use of the Connect-4 toy, all of them appeared to amuse the children. First, when the child was given the token to hold, the act of giving could be endlessly varied (e.g., by spinning the token, by sliding it across the table, by rolling it, by hiding it in the sleeve of the child, or of the experimenter, and so on). Next, the child was helped to fit the token into the frame. This, initially, was preceded by failed attempts, whereupon, the token rolled or bounced onto the table and down to the floor evoking squeals of delight. Later, mastering the skill of getting the token into the frame was itself rewarding; in addition, the child could see the growing column of brightly coloured counters. Finally, when all the trials in one stage of the experiment were completed, the child was allowed to release the tokens so that they crashed on to the table with a loud rattle, sometimes rolling onto the floor and generally effecting great hilarity. A further advantage for this method of reinforcement, perhaps because it is only a plastic chip, is that withholding a token when the child responds incorrectly, or when a child fails to respond, does not appear to punish the child as severely as withholding social praise. Thus, a visual form of social reinforcement, such as described here, together with social praise, appears to be a more effective method of reinforcing infant behaviour than is social praise alone.

Further Research

There is no previous research which has systematically examined proto-verbal behaviour in a number of longitudinal, single-subject experiments. There was, consequently, no tested experimental procedure to follow in these experiments. The experiments successfully trained 44 novel name relations, by training listener, then echoic, and finally tact responses; forty-three of these experimental name relations were seen to be shape generalised.

General Discussion

Listener relations alone did not give rise to tacting or echoing. Neither did listener relations and separately trained echoic relations give rise to tacting. Only when listener and echoic responses were combined, to create echo-tact responses, did tacting emerge. When tact and listener responses had been learned, the names so trained were extended to novel examples of shape-based categories. When repeated measures experiments trained name relations as serial pairs, higher-order naming effects were demonstrated. Thus, Horne and Lowe's theory of naming was rigorously tested, and its hypotheses were sustained.

However, the number of participants who have completed this procedure, to date, is small. There should, therefore, be some attempt to replicate these results, as follows:

Ideally, the participants should begin with preliminary familiarisation, joint attention picture-book "scaffolding" games, together with operant conditioning of vocal responding. This might be initiated at 12 months old, and should ensure that all the participants are able to demonstrate pointing behaviour. Training the first proto-verbal behaviours might begin at, or about, 13 months old, as at this age infants are beginning to produce their first recognisable words, but they have still to learn higher-order naming. Several alternative procedures are identified below.

The studies reported in this thesis found that infants progressed most readily when training was conducted for consecutive pairs of verbal relations. However, tacting was probed in every session, even though Experiment 6 was conducted in blocks of eight trials. The adverse effects of testing for the "emergent" tact relation might be further minimised by testing the tact relations after each block of listener, echoic or echo-tact training trials. Tact responding would be probed, first, as a baseline measure and, subsequently, after each block of 8, training trials. Only four probes need be made in respect of each tact relation, unless responding was 3/4 or better (as criterion of 7/8 could not be achieved).

A series of short studies to examine the effects of changing the order of training the proto-verbal behaviours would allow several possibilities to be examined. Three groups would undergo similar procedures in counterbalanced order. Group 1, as in the experiments reported here would learn listener relations first, then echoic relations, and finally echo-tact relations. This group would be the control group — H^1: they would be expected to replicate the patterns of learning found in Experiment 6. Group 2 would learn echoic relations first, followed by listener relations, and finally echo-tact relations. If an echoic repertoire is sufficient to give rise to naming, once listener relations are learned it would not be necessary to train an echo-tact directly — H^2: naming will "emerge", as in Experiment 6, from unprompted echoic responding in the listener trials. Group 3 would learn a tact relation. Tact responding would be reinforced in the training trials but not in the tact probe trials. When tacting was at criterion level the corresponding listener relations would be tested. This would show if it was possible to establish a uni-directional tact relation, or whether tacting necessarily implies the corresponding listener relation and hence naming — H^3: when a tact relation is at criterion level, corresponding listener behaviour will be demonstrated.

There was some evidence (Experiments 3 & 4) to suggest that, even after it had been trained to criterion, listener responding was not reliably demonstrated until naming emerged. Does learning to name qualitatively alter the listener relation, for example, by making the relation verbal? A further group, Group 4, or a subset of Group 3 would be trained to produce tact responses in the training trials, but would not be probed for tact responding under unreinforced test conditions. Group 4 would be probed for "emergent" listener responses under unreinforced test conditions after each block of tact training trials — H^4: listener responding under unreinforced conditions will be at chance levels, initially, but will become increasingly specified as the corresponding tact relation reaches criterion level.

A second series of experiments might be designed to examine how meaning is derived from the name relation. Horne and Lowe (1996) have stressed the importance of the listener relation, however, listener behaviour is described as a constantly evolving behaviour (pp.204-205). Harris (1992) has suggested that when infants learn comprehension in context-bound ways, their production is context-bound and similarly if comprehension is context-flexible so too is production. Does the way that listener relations are trained restrict the contexts in which the corresponding name can be produced? If meaning exists only in the extent of listener operants, limiting listener training to one situation would imply that name responding will only occur in that situation. If meaning evolves as listener experience extends, then production of a name will evolve in similar conditions — H^5: when listener relations are trained in respect of an image of a novel object, training an echo-tact response in respect of that image will give rise to naming, but the name response will not generalise well to 3-D objects; H^6: when listener relations are trained in respect of a 3-D object in various scenarios, training a corresponding echo-tact relation will give rise to naming which will readily generalise to new contexts, including 2-D images.

Participants might be randomly allocated to a picture-book training condition, or an object-hiding condition. In the picture-book condition, infants would be required to point out a stimulus to show listener responding; in the object hiding condition, infants would be required to hide an object in a number of different hiding places. Tests of generalisation of the listener relation to novel pictures and novel objects should be conducted for both groups. If listener relations are context bound, this will show as failure to generalise across procedures. Following subsequent learning and testing of the tact relation, the tests might be repeated, and differences in outcomes between the two tests observed.

In addition, the modified experimental procedure could be extended to a 3-stimulus procedure. That is, each proto-verbal behaviour would be trained to criterion sequentially, in blocks of 8 trials, in accordance with the order described by Horne and Lowe (1996). Interventions would be implemented for all relations simultaneously. Tact responses would be probed under test conditions at the end of every block of 8 training trials. Infants might progress more easily through this procedure from 15 months-old. Prior to commencement of the training the infants would be required to demonstrate that they had learned to point and other orienting behaviours, in non-experimental situations.

An adapted play scenario method similar to that employed in Experiment 2a, but based upon a table top activity, could be designed to facilitate learning three listener relations as 3-stimulus simultaneous discriminations, but in single type trials. Infants might then be randomly allocated to one of two groups. Group 1 would progress to echoic training after demonstrating listener responding when single type trials in respect of each relation simultaneously were at a criterion of ≥7/8. Group 2 would progress to echoic training only after demonstrating listener responding in respect of each relation simultaneously in mixed type trials, to a criterion of ≥7/8. The effects of learning to echo in each of these conditions could be compared. This would examine the differences between single and mixed conditional discriminations — H^7: simple conditional discriminations at only single trial type criterion will be insufficient for establishing tact relations when corresponding echoic relations are trained. Finally, — H^8: simple discriminations at only single trial type criterion may become more robust over the course of echoic training and give rise to corresponding tact relations.

CONCLUSION

This thesis examined Horne and Lowe's (1996) theory of naming. In particular, it examined Horne and Lowe's description of the name relation and how it is learned. The research was conducted from a behaviourist perspective; behaviour analysis observes the behaviour of organisms objectively, and is resists, as explanatory fictions, hypothetical mental structures. However, it is important for behaviourism that concern for observable phenomena does not prevent adequate examination of the full spectrum of human behaviours.

Skinner (1957) extended the theory of learning to verbal behaviour. This was an important departure; observing how verbal behaviour is learned allows one to consider how other "mental" behaviours are established. Consciousness, itself, is seen to be of a different quality when humans respond to their own speaker behaviour, whether overt, or internalised and thus covert. However, Skinner was roundly criticised for producing an account that inadequately described how the principles of learning by consequences could account for human creativity. This applies not only to language but to all human activity. Subsequently, his influence has been restricted to a circle of behaviour analysts; psychology, in the main, has turned to cognitive explanations of language acquisition.

The principal criticism of Skinner's account of verbal behaviour is that he did not explain how learning principles became generalised. Language is learned with apparently very little direct reinforcement of speaker behaviour. Clearly, many verbal operants arise without any apparent training. Without generalisation, each new behaviour must be directly reinforced. It would be impossible to learn a language in this way. No child hears every possible combination of words before he or she can learn to say them, as sentences.

Conclusion

The Developmental and Psycholinguistic Accounts

Theories of cognitive development and also psycho-linguistic theories of language development propose that the human brain is phylogenetically pre-programmed for language. These theories suggest that a set of biologically determined principles allow children to analyse language by means of a *universal grammar* (Chomsky, 1980, 1981, 1986). The development of language is therefore seen as a maturational process in which the sound systems of the ambient language are assimilated into the universal grammar.

However, the universal grammar is an example of a hypothetical construct. If such a structure or facility exists, in what form does it exist and how is it sustained? There is no micro-biological nor neurological evidence for a universal grammar. As described in Chapter 2, different areas of the brain are dedicated to language, but they are dedicated to hearing language, seeing language, and to speaking and writing language. Each of these areas is proximal to an area which is similarly dedicated to auditory or visual perception or motor behaviour, respectively.

Recent psycho-linguistic research has moved away from the considerations of the origin of language, and now it focuses mainly on looking for the universal rules of language acquisition. These studies are largely conducted in natural settings between mother-infant dyads, or in laboratory constructed dyadic settings. Given the interactive nature of language acquisition studies, dyadic interaction might have suggested that parents teach their children to talk. Nevertheless, for developmental psycholinguistics, the problems of the creativity of language remain too intractable. However, many have embraced Vygotsky's interactive approach to learning.

Vygotsky (1934/1987) identifies the *zone of proximal development* , the period in which a child is ready to learn. Learning, he suggests, occurs when children are helped, by more competent others, to master tasks that they are, as yet, unable to complete alone. Further Vygotsky(1934/1987), and in collaboration with Luria (1930), suggests that language and thinking are initially separate behaviours. The phylogenetic and ontogenetic use of tools by apes and primitive man suggests an evolutionary continuity between humans and their nearest relatives. He observed the same phylogenetic and ontogenetic evolution of language within the child. Thus many developmental psycho-linguists suggest that language is learned as an interaction between genetic maturation and social learning (e.g., Aitchison, 1994; Harris, 1992; Jackendorf, 1993; Markman, 1989; Vihman, 1996).

The social behaviour of the caregiver is normally very finely tuned to the infants' developing abilities (e.g., Harris, 1992; Snow, 1977; Trevarthen, 1977; Trevarthen & Hubley, 1979). Bruner points to the roles of joint attention and joint activity in promoting early object and event related behaviour. Ninio and Bruner (1978) propose that a "scaffolding dialogue" exists between mother and child, which precedes labelling; and Bruner (1975) suggests that the purpose of early naming is to bring objects and events to the attention of another. The social behaviour of the caregiver has been seen as infant determined (Piaget,1954; and see Anisfeld, 1984, p.49; Trevarthen, 1977). However, despite the widely reported individual differences in the rates and styles of vocabulary acquisition (e.g., Bates, Dale, & Thal, 1995), and reports of attempts by parents to promote early language development through language training, the basic sequence of developmental stages remains constant (e.g., Snyder, Bates, & Bretherton, 1981; Vihman & McCune, 1994). Thus, for developmental psycho-linguistics, even if language learning is shaped by interaction with the caregiver, it appears to be constrained by a biological clock.

The results of the research conducted within this thesis found no evidence of an innate mechanism for infant language learning, in any of the participants; all the infants required long periods of listener training, and there was no emergent echoing or emergent tacting. Infants between the ages of 8 - 21 months, who are rapidly learning comprehension skills (e.g., Fenson et al., 1993) did not learn the target experimental relations from exposure alone (cf. Schafer & Plunkett, 1998; Woodward, Markman, &

Fitzsimmons, 1994). Following reinforcement of the appropriate responses a significant number of infants learned the target relations, but only after many training trials.

Listener relations were not learned in the 3-stimulus condition before 17 months, and were not learned in the two stimulus condition before 12 months. This suggests that as the complexity of the task increases, previously learned learning skills may facilitate success. The listener experiments were conducted in three conditions, 2-stimulus simultaneous discriminations only, 3-stimulus simultaneous discriminations only, and 2-stimulus simultaneous prior to 3-stimulus simultaneous discriminations. All infants in the 2-stimulus conditions learned at least one pair of listener relations. Learning three listener relations as pairwise discriminations required many further training trials. As expected, it took much longer to learn in the 3-stimulus condition and five infants (age 17 - 20 months, at the end of training) failed to learn in this condition.

Similarly, the first experimental echoic relations were established to criterion between 18 and 22 months, and the first experimental tact relations were established between 20 and 27 months. There was considerable overlap between learning to echo and learning to tact. However, there was no evidence of learning to tact in the absence of having first learned to produce corresponding echoic responses. Given that some of the infants began the experiment before their first birthdays, it is possible that, in addition to the extensive learning history required, a maturational constraint might delay the production of vocal responses. However, the changes that occur in the vocal tract in the second half of the first year (Kent, 1984, 1992; and see Vihman, 1996, p.35), whilst enabling the child to produce speech like sounds, do not appear to facilitate language; this is the case even when the target words are composed of the speech-sounds an infant produces without prompting. Infants are reported to produce their first words around the age of 12 months, but these are almost entirely constituted from the child's existing "motor production patterns" (i.e., babble units)(Vihman, 1996, p.126). Thus, as was seen in Experiments 3, 4, and 6, the ability to produce utterances which are specified at the phoneme level appears to require considerable operant learning. This in turn suggests that, over and above whatever biological factors may be relevant to language development, the role of socially reinforced learning may have been underestimated.

The Analysis of Behaviour Accounts

The field of behaviour analysis has responded to criticism of Skinner in several ways. Those who have continued to look for ways of describing the higher cognitive abilities of the human animal have largely been concerned with the concept of equivalence. Sidman (1971) proposed that mathematical set theory could describe the way that language allows arbitrary relations to be formed. This research is analogous to that of category formation in developmental psycho-linguistics (e.g., Gopnik and Meltzoff, 1987, 1992, 1993; Markman, 1989).

Stimulus Equivalence.

The theory of equivalence describes how new behaviours emerge; for example, when a minimal number of conditional discriminations allow the relations, of reflexivity, symmetry and transitivity, to be demonstrated. Thus, considerable learning economies can be made when objects or events are discriminated as equivalent stimuli.

Sidman holds that equivalence is a phylogenetic trait; a trait, which he suggests, is a pre-requisite of language. He describes the conditions that may be necessary for its demonstration, but believes it to be a "primitive which cannot be analysed into component parts" (Hayes & Hayes, 1992). Thus Sidman's account, in common with cognitive theories of language acquisition, proposes that the human brain is programmed to classify categorically. However, if equivalence is necessary for language, it must follow that arbitrary classification, that is, of functionally dissimilar stimuli, must also be innate.

Conclusion

Recourse to nativism was a departure from the traditional position of behaviour analysis, which to this point had been careful to explain behaviour in all organisms in terms of learning. However, this *might* be acceptable if, in studying "equivalence", behaviour analysis was able to examine specifically human behaviour. However, the "concept of equivalence" can only inform research into verbal behaviour if it is only found in verbal organisms.

Sidman, Rauzin, Lazar, Cunningham, Tailby, & Carrigan (1982) , and many others (e.g., Dugdale & Lowe, 1990; Hayes & Hayes, 1992; Horne & Lowe, 1996), have claimed that non-human animals appear to be *unable* to demonstrate the *arbitrary* equivalence classes which give rise to emergent behaviour. This is surprising, given that Sidman has claimed that in a conditional discrimination the whole operant, that is, the discriminative stimulus, the response, and the contingency may constitute an equivalence class (e.g., 1994, p.129). However, Sidman terms equivalence of the stimuli within a conditional discrimination as "true matching-to-sample", thus, as the above authors have noted, not all conditional discriminations give rise to stimulus equivalence. However, in recent reports, several researchers have claimed emergent behaviours in match-to-sample experiments with non-human animals (e.g., Kastak & Schusterman, 1994; Meehan, 1999; Schusterman & Kastak, 1993; 1998; Urcuioli, Zentall, & Demarse, 1995; Zentall, Sherburne, Roper & Kramer, 1996; Zentall & Urcuioli, 1993). The *functional* control of these emergent behaviours is variously described as value transfer (Zentall and colleagues), occasion setting (Ross & Lolordo, 1987), and respondent-operant interaction (Meehan, 1999); however, all appear to demonstrate emergent behaviour, in which *arbitrary* phenomena may have become *functionally* related. If "equivalence" can be demonstrated without verbal regulation, then it can no longer be usefully employed to examine verbal behaviour. The "equivalence concept" may be a useful way to examine how well related the members of a class have become, and how organisms learn to generate "new" behaviours, but it does not explain how language is established or how humans behave verbally.

Conclusion

There are currently many problems for the stimulus equivalence account of verbal behaviour. For example: there are problems in match-to-sample experiments, which are demonstrated in the differing outcomes experienced in one-to-many and many-to-one procedures (see Saunders & Green, 1999); there are problems with the differences between behavioural and mathematical equivalence (see Saunders & Green, 1992); and, as described in the experimental chapters of this thesis, there are problems with the terms "equivalence" and "symmetry", neither of which seem adequate to define verbal behaviour (see Hayes & Hayes, 1992; Horne & Lowe, 1996; 1997; Lowe & Horne, 1996).

This thesis shows that verbal behaviours are not symmetrical. There was no evidence that listener responding gave rise to speaker responding, as Sidman (1994, p.116) predicts. There was no evidence that the "concept of equivalence" is innate; infants who have learned corresponding listener and echoic conditional discriminations do not show "emergent" tacting, as Saunders and Spradlin (1996) predict. Neither was equivalence seen to be necessary for the emergence of language. The first name relations were established only when all the constituent behaviours, that is, listener relations, echoic relations, and tact relations were reinforced. Thus at the onset of language, there was no emergent behaviour.

Relational Frame Theory.

Hayes and Hayes (1989) have extended the theory of stimulus equivalence to include stimulus relations other than equivalence. They suggest that equivalence is only one of a number of ways of arbitrarily relating objects and events. They claim that it is the relations that hold between stimuli, which hold the key to higher cognitive functions, and, therefore, should inform the study of verbal behaviour. Equivalence classes can't exist independently of the relation between the organism and the stimuli. They are established through a history in which learning to relate other variables in similar ways has been reinforced. Thus relating behaviour is learned behaviour, and should therefore be analysable.

In principle then, RFT should enable behaviour analysis to deal with more complex methods of classification, for example, more, less, higher, lower, same, different. Hayes (1994, p.10) claims, ". . . reflexivity, symmetry, and transitivity are all relational terms. These properties *result* in classes of stimuli in the case of stimulus equivalence, but if the relational phenomena are more general than equivalence, they may *not* result in classes of stimuli in other cases" (italics original). Thus RFT proposes that stimulus equivalence unnecessarily restricts analysis to equivalence classes, thereby missing the opportunity to observe different ways of arbitrarily relating phenomena.

However, unfortunately, RFT rarely, if ever, *analyses* how relational frames are established; the main thrust of RFT research is to *demonstrate* the many ways in which human behaviour changes as a consequence of the context in which it occurs, that is, to establish frames of relating in the presence of arbitrary contextual cues. Such relations, that is, mutual entailment, combinatorial entailment and transformation of stimulus function, when established, must not only relate phenomena arbitrarily, but the contextual cues also, at least superficially, must be arbitrary. This poses a very real problem, as follows. RFT typically examines the performance of verbally able humans, but to what extent can any symbol be arbitrary for verbally sophisticated humans? As Hayes and Hayes suggest, "The most usual contextual factors, however, are linguistic symbols representing abstracted relations, though more global contexts are also often relevant" (1989, p.171). What could these other global contexts be that might preclude them from being verbally signified?

A further problem for RFT is that some verbally able participants, apparently, are unable to learn to respond "appropriately" (i.e., in accordance with RFT predictions) in the context of the experimental arbitrary contextual cues. This may possibly result from preventing participants from linguistically symbolising the contextual cue (e.g., Dymond & Smeets, 1998; Smeets & Dymond, 1998). It would appear that verbal regulation is a necessary condition for learning relational frames, and that when contextual cues are made too arbitrary, even verbally able humans may have difficulty deciphering what they are supposed to signify (and see Horne & Lowe, 1997). However, RFT maintains that arbitrary applicable relational responding is a pre-requisite for the categorising behaviour that gives rise to stimulus equivalence, and to the stimulus equivalence classifying behaviour that underpins language (Leslie, 1996, p. 305).

> RFT begins with the supposition that organisms can learn to respond relationally to any stimulus event, and that performances such as stimulus equivalence, some forms of exclusion, and verbal behavior itself can be analyzed as generalized instances of such responding (Hayes, 1994, p.11).

Barnes et al. (in press) suggest that under the auspices of RFT, behaviour analysis has studied a wide range of language and cognitive phenomena, showing how complex relations between objects and events are established, in verbally able humans. This research, he claims "aims to increase the level of prediction and influence over these phenomena". However, RFT is increasingly concentrated on human and non-human differences on match-to-sample conditional discrimination procedures. Fascinating as these differences are, to what extent do they allow us to predict and influence verbal behaviour, or other cognitive phenomena? Barnes et al. (in press) have recommended that the continuity hypothesis, that is, that there is evolutionary continuity between non-human species and humans, should be abandoned and that future research should be directed towards examining human behaviour. However, on what principles would such examination of human behaviour be predictable?

Hayes (Lipkens, Hayes, & Hayes, 1993) sought to explain the conditions under which equivalence might be learned. If equivalence can be shown to be learned, a more parsimonious account of problem solving can be presented, than is available from a hypothesis that categorising abilities are innate. Hayes suggests that equivalence is not innate, but that it is established as a consequence of a learning history; particularly, it seems, learning to respond, if not "symmetrically", then at least mutually entailed responding (cf. Schusterman & Kastak, 1993). However, the concept of equivalence is still, Hayes insists, a pre-requisite of language.

Relational Frame Theory might seem to have an advantage over Sidman's theory, and over developmental theories of language acquisition. This is because it describes equivalence as a learned behaviour and not as a biological given. Nevertheless, Hayes does not define precisely how experience establishes a relational frame such as "equivalence", and further, as Horne and Lowe (1996; 1997), and Lowe and Horne (1996), have argued, while the mathematical concept of equivalence is useful in the domain of mathematics, the psychological concept of equivalence is fatally flawed.

This thesis has shown how the proto-verbal behaviours, listener, and echoic responses, are learned as unidirectional responses. Contrary to RFT these early behaviours did not mutually entail a reciprocal behaviour, even though the infants were rapidly learning language in the non-experimental context. Further, when higher order naming was established, so that new naming relations might be learned from minimally learning unidirectional relations, that is, as listener relations, tact relations or echo-tact relations, all the behaviours required for a naming relational frame were demonstrated. Horne and Lowe (1996) have specified the conditions under which infants learn to relate phenomena via naming. This research has demonstrated that their predictions must be sustained.

Naming Theory.

Horne and Lowe (1996) have re-worked Skinner's theory, rejecting very little, but adding much; they have described the importance of the listener relation, and, more importantly, what happens within an organism who learns to listen to himself. This has produced a theory of verbal behaviour (naming behaviour) which explains how children learn to classify their world through naming relations. The experiments reported in this thesis have shown how the constituents of the relation they term naming are learned. In Horne and Lowe's (1996) analysis, the behaviours which constitute naming are not of themselves meaningful; only when the name relation includes bi-directional listener, echoic and tact responses can the related responses be said to constitute meaning. Thus, when a child is able to name an object, any or all the listener responses contingent upon that name may similarly be emitted. This enables a child to classify objects on the basis of their common listener functions (and see Horne & Lowe in press).

Many of the criticisms levelled at naming theory arise from a misunderstanding of the specified use of the term "*naming*" (e.g., Barnes, 1996; McIlvane & Dube, 1996; Saunders & Green, 1996; Schusterman and Kastak, 1998). *Naming* is not just labelling it is an established behaviour which is first learned as a circular name relation. It is thus a higher order *naming behaviour.* As the basic verbal behaviour, naming allows the human organism to categorise the world symbolically. There is no need to invoke a concept of equivalence or of any kind of relational frames. Barnes et al. (in press) suggest that "deriving relations is not genuinely novel, but is a type of *generalized operant behaviour*". This particular generalised operant behaviour is more parsimoniously defined as naming behaviour.

During the course of the six experiments reported here, every effort was made to reject Horne and Lowe's theory of naming. To do this, it was necessary to observe not only responses to the training and test probes, but also to observe the production of unprompted vocal responses. This required meticulous examination and re-examination of many hours of video recorded data. Nevertheless, despite this concentrated effort, there was no evidence that preverbal infants learned to name in conditions other than those described by Horne and Lowe.

Horne and Lowe (1996) have claimed that naming is the basic verbal behaviour, and the research reported here, and in work conducted by Harris, Hughes, and Randle, reported in Horne & Lowe (in press) sustains their prediction. As such, when listener relations, echoic relations, and tact relations become a closed-loop or circular higher order relation what appear to be "bi-directional", or "mutually entailed" responses can be explained in terms of continuous unidirectional responding. The basis for arbitrarily relating phenomena is thus established through naming. Naming, as defined by Horne and Lowe (1996), is the basis for language and the development of consciousness on a specifically human, verbally regulated, level. Vygotsky and Luria have described the evolutionary biology of language and thinking:

> The child's use of tools is comparable to that of the ape's only during the former's pre-speech period. As soon as speech and the use of symbolic signs are included in this operation, it transforms itself along entirely new lines, overcoming the former natural laws and for the first time giving birth to authentically human use of implements.
> From the moment the child begins to master the situation with the help of speech, after mastering his own behaviour, a radically new organization of behaviour appears, as well as new relations with the environment. We are witnessing the birth of those specifically human forms of behaviour that, breaking away from animal forms of behaviour, later create intellect and go on to become the base of labour: the specifically human form of the use of tools (Vygotsky and Luria, in Van der Veer & Valsiner, 1994).

Skinner described the *Origins of Cognitive Thought* (1989b) in terms of arbitrary words for bodily states, which were better left to brain science to examine. However, he also described the relationship of language and thinking as speaker and listener behaviour between the many persons or selves within one skin. Speaker behaviour, he suggests, "takes on a much greater significance when the speaker and listener are within the same skin — Internal dialogues of this sort are most often called *thinking*, but all behaviour is thinking." Skinner thereby described the processes of language and thinking as simply forms of behaviour. However, he did not suggest that language was, therefore, trivial. On the contrary he stated "The practices of the culture we call the verbal environment, or language, are the greatest achievement of the human species, and verbal environments are composed of listeners" (1989, pp.95, 96). Thus, 32 years after *Verbal Behavior* was published, Skinner maintained that the role of the listener is to reinforce verbal behaviour. The listener is behaving verbally only if he is to some extent also speaking.

Horne and Lowe (1996) have argued that listening can become verbal: because whether a word is first heard or spoken it evokes a unique cycle of speaker-listener relations such that the speaker-listener understands what he is saying, and so listens and speaks meaningfully. This thesis has shown that once higher order naming is established, learning an entire verbal relation from what appears to be only listener training not only rapidly accelerates language learning, but allows meaning to become established seemingly without any *overt* speaker training. The name relation is the basic verbal relation, and possibly the basic humanising relation, because when infants speak, and listen to their production of words, they become meaningful. The final words are those of Lowe and Horne

> We maintain, and we have not been the first to do so, that naming is the behavioral atom out of which is generated the vast body of human language, and in this, is responsible for the most profound changes in the structure and function of human behavior (1996, p.340).

and Horne and Lowe

> The result is the creation, within each name, of bi-directional or closed-loop relations between a class of sometimes physically very different objects or events and the speaker-listener behavior it occasions. The name relation is both the focal point of this achievement, where all these events are brought together, and at the same time the means for further dynamic interchange between them, giving rise to the range of emergent and symbolic behavior we have described, including what has been termed *verbal thinking, reference, meaning, rule governance,* and *human consciousness* (1996, p.240).

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APPENDICES

1. The phonetic repertoires of thirty-six infants. Three infants were assessed at three different periods of development.
2. The communicative development inventories, English, and Welsh versions. These are *translations* from the US version and are currently awaiting validation for use in the U.K. They were designed to be used together for all infants in bi-lingual areas of North Wales.
3. The proposal form and approval letter from the University of Wales, Bangor, School of Psychology Research Ethics Committee.
4. The letters requesting parental consent to participate in the experiment.
5. The letters requesting parents to complete the CDI's.

Appendix 1

Age, language, number of sessions, and phonetic repertoires of thirty five pre-verbal infants.

Infant	Age*	Lang.	N°	Vowels		Consonants		
				Front	Mid-Back	Plosive	Fricative	Other
JN	22;08	W/E	1	i ɪ ɛ a ɐ	ə ʊ o ʌ ɔ ɑ	b t d	s ʃ	ɹ l m
EC	22;08	W/E	1	i ɪ e ɛ a ɐ	ə ɯ o	p t d k g	ð s ʃ	ʋ l m n
KC	21;10	E	1	i ɪ ɛ a ɐ	ə ʊ ɯ ɤ o ʌ ɑ	p b t d c k g	v	m j
CH	20;00	E	1	i ɪ e ɛ a ɐ	ʊ ɯ u ʌ o ɔ	b t d g	h	m n
JH	18;25	W/E	1	i e ɛ a ɒ	ə ʊ ɯ u ɤ o ʌ ɔ	t d k g ɟ	v θ ð s z ç h	m n ŋ ɲ j ɭ ʎ
KJ	16;26	E	5	i ɪ e ɛ a ɐ	ə ʌ o ɔ ɒ	p b t d c k g	z	ɹ j l
MC	16;20	E	6	ɪ e ɛ a	ə ɯ u o	p t d c k g	s z ʒ h	m j
HB	16;18	W/E	9	i ɪ a ɐ	ə ɯ u ʌ ɔ ɒ	p b t d c k g	v s	j l
WM	16;18	E	1	i e ɛ a	ə ʊ o	p d g	m s	
FJ	16;17	E	4	ɪ a	ə ʌ	b	h	m n j
TE	16;16	W/E	1	i ɪ ʏ e ɛ æ a ɐ	ə ɵ ʊ ɯ u ɤ o ʌ ɔ	p b t d ɟ k g	β v s z ʒ h	m n ɹ ʋ j l
WJ	16;12	W/E	1	i ɪ e ɛ a ɐ	ə ʊ ɔ	p b t d k g		m j l
SC	16;09	E	1	i ɪ e ɛ a ɐ	ə ʊ o ʌ ɤ o	p b t d c k g	β s ʃ ʒ x h	r ɹ
LD	16;05	W/E	2	ɪ e ɛ æ a ɐ	ə ʊ ɯ u o ʌ	b t d k g ʔ	v s ʃ h	m n j
RW	15;23	W/E	1	ɛ a ɐ	ʊ ɯ	b t d	β ʃ ʒ	
FP	15;09	E	3	i ɪ e ɛ a ɐ	ə u ɤ ʌ ɔ ɑ	b d g	β v h	m n j l
TH	14;12	E	4	i ɪ e ɛ æ a ɐ	ə ʊ ɯ o ʌ ɔ	p b t d ɟ k g		m n ɲ j
PN	14;12	W/E	1	i ɪ ɛ a ɐ	ə ʊ ɯ u ʌ	b t d c k	v s z ʃ ʒ	ɹ ʋ j l n
CE	14;10	E	6	ɪ e ɛ aɐ	ə ʌ	t d c k g	s ʃ h	s ʃ j
OS	14;08	W/E	4	ɪ ɛ a ɐ	ə u ɒ	b t d k g	v s z	m r ɹ

Infant	Age*	Lang.	N°	Vowels		Consonants		
HS	14;04	E		i ɪ e ɛ a ɐ	ə ɵ ʊ ɯ ʌ ɔ ɒ	p b t d c ɟ k g	h	l ɹ j ɫ
HC	14;04	E	7	i ɪ e ɛ a ɐ	ə u ɔ ɑ	b t d k g	β v s ʒ	m n r l j
ND	13;27	W/E	4	i ɛ a ɐ	ə ʊ ɯ o ʌ ɔ	b t d k g	z ʒ	j ʎ
JA	13;25	E	2	ɪ ɛ a ɐ	ə ɒ	b d g		m n j ɹ
WP	13;09	E	1	i e ɛ a ɐ	ə ʊ ɔ ɑ	b t d k g	β v h	j
CJ	12;24	E	5	i ɪ e ɛ a ɐ	ə ɵ ɯ u ʌ ɔ	p b t d c g	v s	m n j l
BR	12;16	E	1	ɪ e ɛ	ə ʌ	b t d g		l
PR	12;10	W/E	3	i ɪ ɛ a ɐ	ə ʊ u o ɔ	p b t d k g	β v h	ɹ l j
CJ	12;07	E	4	i ɪ e ɛ æ a ɐ	ə ʊ o	p b t d c g	h	j l ʎ
TE	12;01	W/E	10	ɪ ɤ e ɛ a ɐ	ə ʊ u ɯ o ʌ ɔ	t d k g	s h j	m n ɲ ɹ ʎ l
TS	11;25	E	10	ɪ e ɛ a ɐ	ə ʊ	p b t d	β f v s ʒ ʔ	ʋ j
TE	11;10	W/E	6	ɪ e ɛ ɐ	ə ʊ u ʌ	g	h	m l
HS	10;16	E	4	i ɪ e ɛ æ a ɐ	ə ɵ ʊ ʌ	p b t g	β f ʒ ɣ h	l j ʎ
RC	10;02	W/E	6	ɪ ɛ a ɐ	ə ʊ u ɔ	p t d	ʃ h	m n ɹ l
WL	09;15	E	3	ɛ a ɐ	ə ʊ ʌ	b t d	β	
HS	09;07	E	1	ɪ ɛ a ɐ	ə ʊ ʌ		h	j l ʎ
RR	09;02	W/E	7	ɛ a ɐ	ə	b k		j
CJ	09;01	E	4	ɪ e ɛ æ a ɐ	ə ʊ	b t d k	β v h	j l w
FM	08;19	E	1	ɛ ɐ	ə ʊ	t		w
RI	08;09	W/E	1	ɛ ɐ	ə u ʊ	b d g	β	
KK	07;26	W/E	1	ɛ	ə			ʋ ɹ
RA	06;25	W/E	3	ɛ ɐ	ə ʊ			m

Age * = infants' age in months and days at the criterion session.

Lang. = Language(s) spoken by parents; E = English; W/E = bilingual Welsh/English.

N° = Number of sessions to criterion vocalisation rate for each infant.

The shaded areas delineate three month age groups.

Enw'r Plentyn______________ Dyddiad Geni__________Dyddiad Presennol_________

Rhestr Datblygiad Cyfathrebu MacArthur: Geiriau ac Ystumiau

Addaswyd ar gyfer ei ddefnyddio yn y Gymraeg
gan M.H.Bell, E.M.Willams ac L.A.Williams.

RHAN 1: GEIRIAU CYNNAR.

A. ARWYDDION CYNTAF O DDEALLTWRIAETH.		
Cyn i blant ddechrau siarad, arddangosant arwyddion o ddeall iaith drwy ymateb i eiriau a chymalau cyfarwydd. Gwelir isod rai engreifftiau cyffredin. A yw eich plentyn yn gwneud unrhyw un o'r canlynol?	ydi	nacydi
1. Ymateb pan y gelwir ei enw (e.e gan droi ac edrych ar yr ffynhonnell)	O	O
2. Ymateb i "na" (gan atal beth bynnag mae ef/hi yn ei wneud o leiaf am eiliad)	O	O
3. Ymateb i "dyna Mam/Dad" gan edrych o'u cwmpas amdanynt.	O	O

B. CYMALAU.			
Yn y rhestr isod, marciwch y cymalau yr ymddengys bod eich plentyn yn eu deall o.g.y.dd.			
	deall		deall
Wyt ti'n teimlo'n gysglyd?	O	Rho gusan i mi	O
Wyt ti wedi blino?	O	Rho sws i mi	O
Bydd yn ofalus.	O	Cer i nôl....	O
Cymer ofal o'r po po	O	Dos i nôl....	O
Bydd yn ddistaw	O	Hogan dda	O
'Ist'	O	Hogyn da	O
'Ssh ssh'	O	Edrych	O
Tyrd yma	O	Edrycha yma	O
Tyrd yn dy flaen	O	Sbia	O
Mae Dad adref	O	Yli	O
Mae Mam adref	O	Paid	O
Wyt ti eisiau mwy?	O	Stopia	O
Paid a gwneud hynna	O	Dweud nôs da	O

B. CYMALAU (Parhad).

Wyt ti eisiau mynd allan?	O	Dweud ta ta	O
Wyt ti eisiau mynd am reid?	O	Dos i 'bei beis'	O
Wyt ti eisiau mynd am dro?	O	Wyt ti'n sal	O
Rho fwytha i mi.	O	Arhosa'n llonydd	O
Caru mawr.	O	Poera fo allan	O
Ŏ bach	O	'Ach '	O
Coda i fyny	O	Newid clwt	O
Sefa	O	Rho fo i Mam	O
Côd	O	Tyrd a fo at Mam	O
Wyt ti eisiau bwyd?	O	'Da i mam	O
Eistedda i lawr	O	Agora dy geg	O
Clapio dwylo	O	Gee ceffyl bach	O
Paid a chyffwrdd	O	Tafla'r bêl	O

C. DECHRAU SIARAD.

1 Mae rhai plant yn hoff o ail-adrodd neu ddynwared yr hyn y maent newydd ei glywed (yn ogystal a geiriau newydd y maent wrthi'n eu dysgu, ac/neu rhan o frawddegau, er enghraifft, ail- adrodd "gwaith rwan" ar ôl i'r fam ddweud "mae Mam yn mynd i'w gwaith rwan")
Pa mor aml mae eich plentyn yn dynwared geiriau?... **Byth** O **Weithiau** O

2 Mae rhai plant yn hoff o fynd o gwmpas yn enwi neu labelu pethau, fel petaent yn teimlo'n falch o wybod yr enwau ac eisio dangos hyn. Pa mor aml mae eich plentyn yn gwneud hyn?...... O O

D. RHESTR ARCHWILIO GEIRFA.

Mae'r canlynol yn restr o eiriau nodweddiaol yng ngeirfa plentyn ifanc. Ar gyfer y geiriau y mae eich plentyn yn eu deall, ond nad ydynt eto yn eu dweud, rhowch farc yn y golofn cyntaf (deall). Ar gyfer y geiriau y mae eich plentyn nid yn unig yn eu deall,ond hefyd yn eu defnyddio, rhowch farc yn yr ail golofn (deall ac yn dweud). Os defnyddia eich plentyn ynganiad gwahanol ar gyfer gair (er enghraifft, "Sgeti" ar gyfer "Spageti") marciwch y gair beth bynnag. Cadwch ar gôf mai "catalog"o eiriau a ddefnyddir gan lawer o wahanol blant yw hwn. Peidiwch a phryderu os nad yw eich plentyn yn gwybod llawer o eiriau ar hyn o bryd.

1. EFFEITHIAU SAIN A SEINIAU ANIFEILIAID.

	deall	deall ac yn dweud		deall	deall ac yn dweud
baa	O	O	cwac cwac	O	O
me me	O	O	"oh oh"	O	O
cockadoodledoo	O	O	'wpadeis'	O	O
grr	O	O	wyff wyff	O	O
miaw	O	O	iym iym	O	O
mw	O	O	mmm	O	O
aaw	O	O	bzzz	O	O
choo choo	O	O	brwm brwm	O	O
clip clop	O	O			

2. ENWAU ANIFEILIAID (GO IAWN NEU FFUG/DEGAN).

	deall	deall ac yn dweud		deall	deall ac yn dweud
anifail	O	O	gwydd	O	O
iâr	O	O	ceffyl	O	O
aderyn	O	O	'gee gee'	O	O
'chwc chwc'	O	O	arth	O	O
'gog gog'	O	O	ci	O	O
cwningen	O	O	ci bach	O	O
bwni	O	O	'wow wow'	O	O
cath	O	O	tylluan	O	O
cath fach	O	O	'gwdi-hŵ'	O	O
pws	O	O	mochyn	O	O
llew	O	O	merlyn	O	O
mwnci	O	O	merlen	O	O
asyn	O	O	dafad	O	O
ebol	O	O	oen	O	O
mul	O	O	'me me'	O	O
'î-o î-o'	O	O	teigr	O	O
eliffant	O	O	twrci	O	O
jiraff	O	O	hwyaden	O	O
pili pala	O	O	chwaden	O	O
glöyn byw	O	O	cwac cwac	O	O
iâr fach yr haf	O	O	broga	O	O
carw	O	O	llyffant	O	O
gwenynen	O	O	llygoden	O	O
pry	O	O	buwch	O	O
bzzz	O	O	'mw'	O	O
tedi ber	O	O	gwiwer	O	O
tedi	O	O	crwban	O	O
morlo	O	O	pysgodyn	O	O
pengwin	O	O			

3. CERBYDAU (GO IAWN NEU FFUG).

	deall	deall ac yn dweud		deall	deall ac yn dweud
jac codi baw	O	O	pram	O	O
awyren	O	O	coets	O	O
beic	O	O	bygi	O	O
bws	O	O	lori	O	O
car	O	O	lori laeth	O	O
modur	O	O	lori ludw	O	O
'bab bab'	O	O	trên	O	O
moto beic	O	O	tractor	O	O
beic modur	O	O	injan dân	O	O

4. TEGANAU.

	deall	deall ac yn dweud		deall	deall ac yn dweud
pêl	O	O	llyfr	O	O
bloc	O	O	pensil	O	O
bricsen	O	O	beiro	O	O
bybl	O	O	creionau (crayons)	O	O
swigod	O	O	lliwiau	O	O
doli	O	O	balŵn	O	O
dol	O	O	tegan	O	O

5. BWYD A DIOD.

	deall	deall ac yn dweud		deall	deall ac yn dweud
afal	O	O	bwyd	O	O
bisgeden	O	O	'nym nyms'	O	O
bisged	O	O	sudd	O	O
bici	O	O	'jiws'	O	O
ymenyn	O	O	llaeth	O	O
cacen	O	O	llefrith	O	O
teisen	O	O	oren	O	O
grawnfwyd	O	O	pys	O	O
caws	O	O	pitsa	O	O
cyw	O	O	jam	O	O
cyw iâr	O	O	spageti	O	O
cracer	O	O	melysion	O	O
diod	O	O	fferins	O	O
ŵy	O	O	da -da	O	O
pysgodyn	O	O	'swîts'	O	O
bara	O	O	reis	O	O
brechdan	O	O	tê	O	O
creision	O	O	tost	O	O
'crips'	O	O	hufen ia	O	O
iogyrt	O	O	dŵr	O	O
cig	O	O	paned	O	O
pwdin	O	O	coffi	O	O
siocled	O	O	'chips'	O	O
tatws	O	O	tomato	O	O
banana	O	O	moron	O	O

6. DILLAD/GWISGOEDD.					
	deall	deall ac yn dweud		deall	deall ac yn dweud
trowsus bach	O	O	bib	O	O
nicer	O	O	trowsus	O	O
clôs	O	O	dillad nôs	O	O
botwm	O	O	pyjamas	O	O
côt	O	O	coban	O	O
ffrog	O	O	trowsus byr	O	O
het	O	O	trowsus cwta	O	O
cap	O	O	siorts	O	O
napi	O	O	cadwen	O	O
clwt	O	O	mwclis	O	O
crys	O	O	siwmper	O	O
esgid	O	O	hosan	O	O
siaced	O	O	sannau	O	O
bŵts	O	O	sbectol	O	O
welingtons	O	O	jîns	O	O
welîs	O	O	cardigan	O	O
sip	O	O			

7. RHANNAU O'R CORFF.					
	deall	deall ac yn dweud		deall	deall ac yn dweud
braich	O	O	pen	O	O
botwm bol	O	O	pen-glin	O	O
boch	O	O	coes	O	O
clust	O	O	ceg	O	O
llygad	O	O	dannedd	O	O
wyneb	O	O	dant	O	O
troed	O	O	bys bawd	O	O
bys	O	O	tafod	O	O
gwallt	O	O	bol	O	O
llaw	O	O	stumog	O	O
trwyn	O	O	'bigi bo'	O	O
'bŵbis'	O	O	pen ôl	O	O

8. DODREFN AC YSTAFELLOEDD.

	deall	deall ac yn dweud		deall	deall ac yn dweud
bath	O	O	ystafell fyw	O	O
ystafell molchi	O	O	popty	O	O
bathrŵm	O	O	toilet	O	O
gwely	O	O	poti	O	O
llofft	O	O	oergell	O	O
ystafell wely	O	O	ffrij	O	O
cadair	O	O	staer	O	O
cot	O	O	grisiau	O	O
soffa	O	O	stôf	O	O
drws	O	O	bwrdd	O	O
garej	O	O	teledu	O	O
modurdy	O	O	ffenestr	O	O
cadair uchel	O	O	cegin	O	O
sinc	O	O	drôr	O	O
cadair siglo	O	O	lle chwarae	O	O

9. EITEMAU BYCHAIN AR GYFER Y TY.

	deall	deall ac yn dweud		deall	deall ac yn dweud
blanced	O	O	arian	O	O
powlen	O	O	pres	O	O
dysgl	O	O	darlun	O	O
bocs	O	O	llun	O	O
cloc	O	O	cobennydd	O	O
crib	O	O	clustog	O	O
llestr	O	O	pwrs	O	O
dysgl	O	O	radio	O	O
fforcen	O	O	ysbwriel	O	O
gwydr	O	O	siswrn	O	O
mwrthwl	O	O	sebon	O	O
morthwyl	O	O	ffôn	O	O
goriadau	O	O	teleffon	O	O
allwedd	O	O	tywel	O	O
moddion	O	O	lliain sychu	O	O
ffisig	O	O	wats	O	O
cwpan	O	O	planhigyn	O	O
bicer	O	O	llwy	O	O
lamp	O	O	brws dannedd	O	O
golau	O	O	sugnwr llwch	O	O
potel	O	O	'hŵfer'	O	O
brws	O	O	plat	O	O
papur	O	O	teledu	O	O
ceiniog	O	O	oriawr	O	O

10. PETHAU ALLANOL A MANNAU YMWELD.

	deall	deall ac yn dweud		deall	deall ac yn dweud
buarth	O	O	craig	O	O
iard gefn	O	O	ysgol	O	O
cowt	O	O	rhaw	O	O
glan y môr	O	O	awyr	O	O
traeth	O	O	sleid	O	O
capel	O	O	eira	O	O
eglwys	O	O	seren	O	O
lleuad	O	O	siop	O	O
tu allan	O	O	haul	O	O
parc	O	O	siglen	O	O
parti	O	O	swing	O	O
pwll	O	O	dŵr	O	O
glaw	O	O	gwaith	O	O
bwrw	O	O	blodyn	O	O
cartref	O	O	gardd	O	O
adref	O	O	coeden	O	O
sŵ	O	O			

11. POBL.

	deall	deall ac yn dweud		deall	deall ac yn dweud
modryb	O	O	babi	O	O
anti	O	O	ba ba	O	O
gwarchodwr	O	O	dyn	O	O
enw'r gwarchodwr	O	O	mam	O	O
bachgen	O	O	mami	O	O
hogyn	O	O	enw'r plentyn ei hun	O	O
dad	O	O	brawd	O	O
dadi	O	O	chwaer	O	O
merch	O	O	athro	O	O
geneth	O	O	athrawes	O	O
hogan	O	O	nain	O	O
dynes	O	O	naini	O	O
ewythr	O	O	taid	O	O
wncwl	O	O	taidi	O	O
pobl	O	O	person	O	O
plentyn	O	O			

12. GEMAU AC ARFERION.

	deall	deall ac yn dweud		deall	deall ac yn dweud
bath	O	O	nôs da	O	O
brecwast	O	O	plîs	O	O
ta ta	O	O	os gwelwch yn dda	O	O
cinio	O	O	shh	O	O
helo	O	O	hist	O	O
'haia'	O	O	aros	O	O
cysgu	O	O	eisiau	O	O
cwsg bach	O	O	isio	O	O
nôs dawch	O	O	sut mae?	O	O
na	O	O	diolch yn fawr	O	O
pi-po	O	O	'da'	O	O
paid	O	O	eto	O	O
ia	O	O			

13. GEIRIAU GWEITHREDOL.

	deall	deall ac yn dweud		deall	deall ac yn dweud
brathu	O	O	agor	O	O
chwythu	O	O	chwarae	O	O
torri	O	O	tynnu	O	O
dod a	O	O	gwthio	O	O
cerdded	O	O	rhoi	O	O
glanhau	O	O	darllen	O	O
llnau	O	O	marchogaeth	O	O
crio	O	O	mynd ar gefn	O	O
dawnsio	O	O	reidio	O	O
tynnu llun	O	O	rhedeg	O	O
dreifio	O	O	dweud	O	O
gyrru	O	O	gweld	O	O
cwympo	O	O	dangos	O	O
syrthio	O	O	camu	O	O
disgyn	O	O	cysgu	O	O
gorffen	O	O	gwenu	O	O
darfod	O	O	sblasio	O	O
digon	O	O	atal	O	O
helpu	O	O	rhwystro	O	O
cynorthwyo	O	O	stopio	O	O
taro	O	O	nofio	O	O
hitio	O	O	siglo	O	O
brysio	O	O	cymryd	O	O
neidio	O	O	taflu	O	O
cicio	O	O	ticlo	O	O
cusanu	O	O	cosi	O	O
sws	O	O	gwylio	O	O
cariad	O	O	'gwatsia'	O	O
caru	O	O	golchi	O	O
ysgrifennu	O	O	ymolchi	O	O
bwydo	O	O	cofleidio	O	O
bwyta	O	O	sychu	O	O
mynd	O	O	cael	O	O
cyffwrdd	O	O	edrych	O	O

13. GEIRIAU GWEITHREDOL.(Parhad)

	deall	deall ac yn dweud		deall	deall ac yn dweud
twtsiad	O	O	sbio	O	O
pi pi	O	O	yfed	O	O
cau	O	O			

14. GEIRIAU DISGRIFIADOL.

	deall	deall ac yn dweud		deall	deall ac yn dweud
wedi mynd	O	O	eisiau bwyd	O	O
gorffen	O	O	cysgu	O	O
gwag	O	O	'bei beis'	O	O
drwg	O	O	llanast	O	O
mawr	O	O	neis	O	O
glas	O	O	hen	O	O
torri	O	O	prydferth	O	O
gofalus	O	O	del	O	O
gwyliadwrus	O	O	tlws	O	O
glan	O	O	coch	O	O
oer	O	O	ofn	O	O
ciwt	O	O	braw	O	O
tywyll	O	O	sal	O	O
budr	O	O	sychedig	O	O
ych a fi	O	O	meddal	O	O
ach	O	O	esmwyth	O	O
cyflym	O	O	cysglyd	O	O
teg	O	O	blinedig	O	O
braf	O	O	blino	O	O
iawn	O	O	sych	O	O
tyner	O	O	gwlyb	O	O
mwyn	O	O	brifo	O	O
da	O	O	niweidio	O	O
hapus	O	O	anafu	O	O
caled	O	O	'po po'	O	O
ychydyg	O	O	poeth	O	O

15. GEIRIAU YN YMWNEUD AG AMSER.

	deall	deall ac yn dweud		deall	deall ac yn dweud
diwrnod	O	O	nôs	O	O
wedyn	O	O	yn awr	O	O
bellach ymlaen	O	O	rwan	O	O
nes ymlaen	O	O	heddiw	O	O
yn hwyrach	O	O	yfory	O	O
bore	O	O	heno	O	O

16. RHAGENWAU.

	deall	deall ac yn dweud		deall	deall ac yn dweud
hi	O	O	fo	O	O
ei	O	O	fi	O	O
mi	O	O	fy	O	O
myfi	O	O	yna	O	O
i	O	O	hwn	O	O
minnau	O	O	ti	O	O
innau	O	O	eich	O	O
'dwi	O	O		O	O

17. GEIRIAU SY'N GOFYN CWESTIWN.

	deall	deall ac yn dweud		deall	deall ac yn dweud
sut	O	O	lle	O	O
beth	O	O	pwy	O	O
pryd	O	O	pam	O	O

18. ARDDODIAD/LLEOLIADAU.

	deall	deall ac yn dweud		deall	deall ac yn dweud
i ffwrdd	O	O	ymlaen	O	O
yn ôl	O	O	allan	O	O
i lawr	O	O	yna	O	O
mewn	O	O	acw	O	O
i mewn	O	O	oddi tanodd	O	O
tu mewn	O	O	o dan	O	O
i ffwrdd	O	O	i fyny	O	O

19. MEINTIOLWYR.

	deall	deall ac yn dweud		deall	deall ac yn dweud
y cwbl	O	O	nid	O	O
arall	O	O	arall	O	O
mwy	O	O	eraill	O	O
rhagor	O	O	yr un fath	O	O
ychwaneg	O	O	rhai	O	O
dim	O	O		O	O

RHAN 2: GWEITHREDOEDD AC YSTUMIAU.

A. YSTUMIAU CYFATHREBOL CYNTAF.

Pan mae babanod yn dysgu cyfathrebu am y tro cyntaf, maent yn aml yn defnyddio ystumiau er mwyn dangos eu dymuniadau. Ar gyfer pob eitem isod, marciwch y frawddeg sy'n disgrifio gweithredoedd eich plentyn ar hyn o bryd.	dim eto	weith-iau	yn aml
1. Ymestyn braich er mwyn dangos i chwi rywbeth y mae ef/hi yn ei ddal.	O	O	O
2. Ymestyn allan ac yn rhoddi i chwi wrthrych neu degan y mae ef/hi yn ei ddal.	O	O	O
3. Pwyntio (gyda braich a mynegfys wedi ei ymestyn) tuag at wrthrych neu ddigwyddiad diddorol.	O	O	O
4. Chwifio ta-ta ar ei ben/phen ei hun pan mae rhywun yn gadael.	O	O	O
5. Ymestyn ei braich/fraich i fyny fel arwydd i ddangos ei fod ef/hi eisiau cael ei godi/chodi	O	O	O
6. Ysgwyd ei ben/phen fel arwydd o "na".	O	O	O
7. Nodio ei ben/phen fel arwydd o "ia".	O	O	O
8. Rhoddi bys ar ei wefys fel arwydd o "hist".	O	O	O
9. Gofyn am rywbeth drwy ymestyn braich ag agor a chau llaw.	O	O	O
10. Chwythu cusan o bellter.	O	O	O
11. Trawo gwefysau mewn ystum "iym iym" fel arwydd fod rywbeth yn blasu'n dda.	O	O	O
12. Codi'r ysgwyddau fel arwydd o "y cwbl wedi mynd" neu" i ble'r aeth o".	O	O	O
13. Chwerthin pan fo rhywun arall yn chwerthin.	O	O	

B. GWEITHREDOEDD GYDA GWRTHRYCHAU.

A yw eich plentyn yn gwneud neu yn ceisio gwneud unrhyw rai o'r canlynol?	ydi	nacydi
1. Bwyta gyda llwy neu fforcen.	O	O
2. Yfed o gwpan/bicer sy'n cynnwys hylif.	O	O
3. Cribo neu brwsio ei wallt/gwallt ei hun.	O	O
4. Brwsio ei ddannedd/dannedd.	O	O
5. Sychu dwylo neu wyneb gyda lliain neu glwtyn.	O	O
6. Gosod het ar ei ben/phen.	O	O
7. Gosod esgid neu hosan ar ei droed/throed.	O	O
8. Rhoi cadwen, breichled, neu oriawr ymlaen.	O	O
9. Gosod ei ben/phen yn ei ddwylo/dwylo a gwasgu ei llygaid ynghau fel petai'n cysgu.	O	O
10. Chwythu i arwyddo fod rhywbeth yn boeth.	O	O
11. Dal awyren a gwneud iddo " hedfan".	O	O
12. Rhoi telefôn wrth ymyl y glust.	O	O
13. Arogli blodau.	O	O
14. Gwthio tegan modur neu lori.	O	O
15. Taflu pêl.	O	O
16. Tywallt hylif "ffug" o un cynhwysydd i un arall.	O	O
17. Troi hylif "ffug" mewn cwpan neu sosban gyda llwy.	O	O

C. GEMAU AC ARFERION.

A yw eich plentyn yn gwneud unrhyw rai o'r canlynol?	ydi	nacydi
1. Chwarae "pi-po".	O	O
2. Chwarae cuddio a chwilio.	O	O
3. Chwarae gemau cuddio gwrthrych a'i ddatgelu.	O	O
4. Chwarae gemau hela ar ôl y plentyn.	O	O
5. Canu.	O	O

C. GEMAU AC ARFERION (Parhad).

A yw eich plentyn yn gwneud unrhyw rai o'r canlynol?	ydi	nacydi
6. Dawnsio.	O	O
7. Clapio dwylo.	O	O
8. "Gwylia, dwi'n dod ar dy ôl di"	O	O
9. Gee ceffyl bach.	O	O
10. Mi welais Jac y Do.	O	O
11. Galop galop a charlam.	O	O
12. Mynd drot drot.	O	O

D. CYMRYD ARNO/ARNI FOD YN RIANT.

Dyma rai o'r pethau y mae eich plentyn weithiau yn ei wneud gyda anifeiliaid wedi cael ei gwneud allan o ddefnydd neu ddoliau. Os gwelwch yn dda, marciwch y gweithredoedd yr ydych wedi gweld eich plentyn yn ei wneud.	do	naddo
1. Rhoi i'w gwlau.	O	O
2. Gorchuddio gyda blanced.	O	O
3. Bwydo gyda photel.	O	O
4. Bwydo gyda llwy.	O	O
5. Brwsio/cribo eu gwallt.	O	O
6. Taro'n ysgafn neu gymryd arno/arni ei fod /bod wedi torri gwynt.	O	O
7. Gwthio mewn pram.	O	O
8. Ei siglo.	O	O
9. Cusanu neu ei gofleidio/anwesu.	O	O
10. Sychu ei dwylo/ddwylo neu wyneb.	O	O
11. Siarad gydag ef/hi.	O	O
12. Ceisio rhoi clwt arno/arni.	O	O
13. Ceisio rhoi esgid, hosan neu het arno/arni.	O	O

E. DYNWARED GWEITHREDOEDD ERAILL GAN OEDOLION (gan ddefnyddio gwrthrychau go iawn neu ffug).

A yw eich plentyn yn gwneud neu yn ceisio gwneud unrhyw rai o'r canlynol?	ydi	nacydi
1. Ysgubo gyda brws neu fop.	O	O
2. Rhoi goriad yn y drws neu yn nhwll y clo.	O	O
3. Curo gyda morthwl/morthwyl neu ordd.	O	O
4. Ymgeisio i ddefnyddio llif.	O	O
5. "Teipio" ar deipiadur neu allweddell gyfrifiadurol.	O	O
6. "Darllen" (agor llyfr, troi'r tudalennau).	O	O
7. Defnyddio'r sugnydd llwch.	O	O
8. Dyfrhau/rhoi dŵr i blanhigion.	O	O
9. Chwarae offerynnau cerddorol (e.e piano,trwmped)	O	O
10. "Dreifio" car gan droi'r olwyn lywio.	O	O
11. Golchi llestri.	O	O
12. Glanhau gyda chlwtyn/dwster.	O	O
13. Ysgrifennu gyda pensil neu farciwr.	O	O
14. Palu gyda rhaw.	O	O
15. Rhoi sbectol ar ei drwyn.	O	O

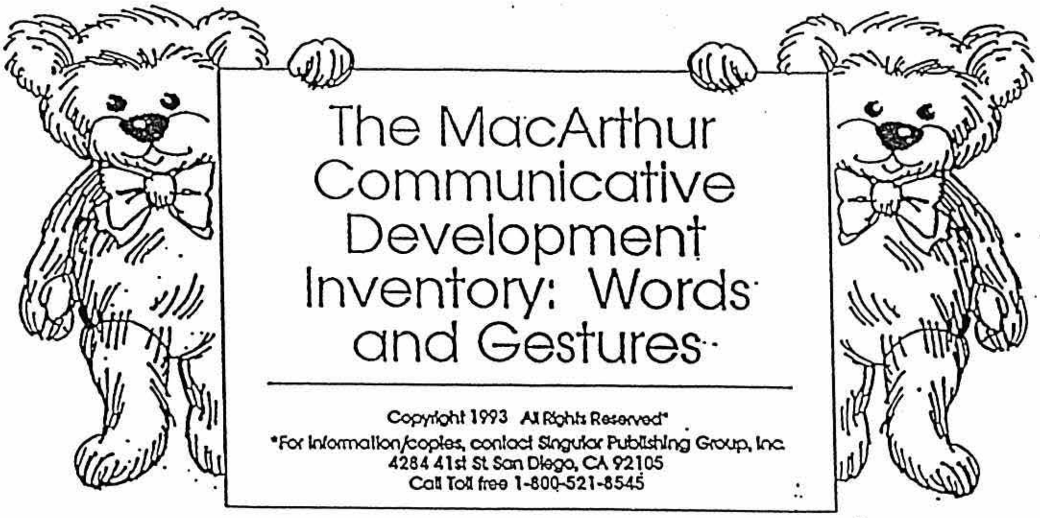
F. GWRTHRYCHAU FFUG.

Yn ystod chwarae, mae plant ar adegau yn defnyddio gwrthrych i gymryd lle un arall. Er enghraifft, os yw plentyn yn dymuno bwydo tedi, fe all gymeryd arno fod bloc yn afal. Fe all plentyn gymryd arno mai het yw bowlen. A ydych wedi gweld eich plentyn yn gweithredu yn y modd yma?......................... do O naddo O

Os 'Do', rhowch nifer o enghreifftiau os gwelwch yn dda:

UNRHYW SYLWADAU ERAILL:

Child's Name____ ____Birthdate____________Today's date________



Adapted for use in the UK by M.H. Bell and A. Svendsen

PART 1: EARLY WORDS

A. FIRST SIGNS OF UNDERSTANDING

Before children begin to speak, they show signs of understanding language by responding to familiar words and phrases. Below are some common examples. Does your child do any of these?

	yes	no
1. Respond when name is called (e.g. by turning and looking at source)	O	O
2. Respond to "no no" (by stopping what he/she is doing, at least for a moment)	O	O
3. React to "there's mummy/daddy" by looking around for them	O	O

B. PHRASES

In the list below, please mark the phrases that your child seems to understand.

	Under stands		Under stands		Under stands
Are you hungry?	O	Don't touch.	O	Open your mouth.	O
Are you tired/sleepy?	O	Get up.	O	Sit down.	O
Be careful.	O	Give it to mummy.	O	Spit it out.	O
Be quiet.	O	Give me a hug.	O	Stop it.	O
Clap your hands.	O	Give me a kiss.	O	Time to go night night.	O
Change nappy.	O	Go get......	O	Throw the ball.	O
Come here/come on.	O	Good girl/boy.	O	This little piggy.	O
Daddy's/Mummy's home.	O	Hold still.	O	Want to go for a ride?	O
Do you want more?	O	Let's go bye bye.	O		
Don't do that.	O	Look/look here.	O		

C. STARTING TO TALK

1. Some children like to "parrot" or imitate things that they've just heard (including new words that they are just learning, and/or parts of sentences, for example, repeating "work now" after mother says "Mummy's going to work now.")
How often does your child imitate words?.. Never O Sometimes O

2. Some children like to go around naming or labeling things, as though proud of knowing the names and wanting to show this. How often does your child do this?... O O

D. VOCABULARY CHECKLIST

The following is a list of typical words in young children's vocabularies. For words your child understands but does not yet say, place a mark in the first column (understands). For words that your child not only understands but also uses, place a mark in the second column (understands and says). If your child uses different pronunciation of a word (for example, "raffe" for "giraffe" or "sketti" for "spaghettii") mark the word anyway. Remember, this is a "catalogue" of words that are used by many different children. Don't worry if your child knows only a few right now

1. SOUND EFFECTS AND ANIMAL SOUNDS

	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
baa baa	O	O	meow	O	O	uh oh	O	O
choo choo	O	O	moo	O	O	vroom	O	O
cockadoodledoo	O	O	ouch	O	O	woof woof	O	O
grrr.	O	O	quack quack	O	O	yum yum	O	O

2. ANIMAL NAMES (Real or Toy)

	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
animal	O	O	duck	O	O	penguin	O	O
bear	O	O	elephant	O	O	pig	O	O
bee	O	O	fish	O	O	pony	O	O
bird	O	O	frog	O	O	puppy	O	O
bug	O	O	giraffe	O	O	sheep	O	O
bunny	O	O	goose	O	O	squirrel	O	O
butterfly	O	O	horse	O	O	teddy bear	O	O
cat	O	O	kitty	O	O	tiger	O	O
chicken	O	O	lamb	O	O	turkey	O	O
cow	O	O	lion	O	O	turtle	O	O
deer	O	O	monkey	O	O			
dog	O	O	mouse	O	O			
donkey	O	O	owl	O	O			

3. VEHICLES (Real or Toy)

	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
aeroplane	O	O	car	O	O	pram/buggy	O	O
bicycle	O	O	fire engine	O	O	train	O	O
bus	O	O	motorbike	O	O	lorry	O	O

4. TOYS

	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
ball	O	O	book	O	O	pen	O	O
balloon	O	O	bubbles	O	O	toy	O	O
brick	O	O	doll	O	O			

5. FOOD AND DRINK

	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
apple	O	O	cornflakes	O	O	noodles	O	O
banana	O	O	cracker	O	O	orange	O	O
biscuit	O	O	drink	O	O	peas	O	O
bread	O	O	egg	O	O	pizza	O	O
butter	O	O	fish	O	O	raisin	O	O
cake	O	O	food	O	O	spaghetti	O	O
carrots	O	O	ice cream	O	O	sweets	O	O
cereal	O	O	juice	O	O	tea	O	O
cheese	O	O	meat	O	O	toast	O	O
chicken	O	O	milk	O	O	water	O	O

6. CLOTHING

	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
beads	O	O	jacket	O	O	shoe	O	O
bib	O	O	jeans	O	O	shorts	O	O
boots	O	O	nappy	O	O	sock	O	O
button	O	O	necklace	O	O	sweater/jumper	O	O
coat	O	O	pants	O	O	zip	O	O
dress	O	O	pyjamas	O	O			
hat	O	O	shirt	O	O			

7. BODY PARTS

	Understands	Understands and says		Understands	Understands and says		Understands	Understands and says
arm	O	O	finger	O	O	nose	O	O
belly button	O	O	hair	O	O	tooth	O	O
cheek	O	O	hand	O	O	toe	O	O
ear	O	O	head	O	O	tongue	O	O
eye	O	O	knee	O	O	tummy	O	O
face	O	O	leg	O	O			
foot	O	O	mouth	O	O			

8. FURNITURE AND ROOMS

	Understands	Understands and says		Understands	Understands and says		Understands	Understands and says
bath	O	O	drawer	O	O	refrigerator	O	O
bathroom	O	O	garage	O	O	rocking chair	O	O
bed	O	O	high chair	O	O	sink	O	O
bedroom	O	O	kitchen	O	O	stairs	O	O
chair	O	O	living room	O	O	stove	O	O
cot	O	O	oven	O	O	table	O	O
couch/settee	O	O	play pen	O	O	TV	O	O
door	O	O	potty	O	O	window	O	O

9. SMALL HOUSEHOLD ITEMS

	Understands	Understands and says		Understands	Understands and says		Understands	Understands and says
blanket	O	O	glasses	O	O	plate	O	O
bottle	O	O	hammer	O	O	purse	O	O
bowl	O	O	keys	O	O	radio	O	O
box	O	O	lamp	O	O	rubbish	O	O
broom	O	O	light	O	O	scissors	O	O
brush	O	O	medicine	O	O	soap	O	O
clock	O	O	money	O	O	spoon	O	O
comb	O	O	paper	O	O	telephone	O	O
cup	O	O	penny	O	O	toothbrush	O	O
dish	O	O	picture	O	O	towel	O	O
fork	O	O	pillow	O	O	vacuum	O	O
glass	O	O	plant	O	O	watch	O	O

10. OUTSIDE THINGS AND PLACES TO GO

	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
backyard	O	O	park	O	O	snow	O	O
beach	O	O	party	O	O	star	O	O
church*	O	O	pool	O	O	store	O	O
flower	O	O	rain	O	O	sun	O	O
garden	O	O	rock	O	O	swing	O	O
home	O	O	school	O	O	tree	O	O
house	O	O	shovel	O	O	water	O	O
moon	O	O	sky	O	O	work	O	O
outside	O	O	slide	O	O	zoo	O	O

* or words used in your family

11. PEOPLE

	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
aunt	O	O	daddy*	O	O	child's own name	O	O
baby	O	O	girl	O	O	people	O	O
babysitter	O	O	grandma*	O	O	person	O	O
babysitter's name	O	O	grandpa*	O	O	sister	O	O
boy	O	O	lady	O	O	teacher	O	O
brother	O	O	man	O	O	uncle	O	O
child	O	O	mummy*	O	O			

* or words used in your family

12. GAMES AND ROUTINES

	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
bath	O	O	lunch	O	O	shh/shush/hush	O	O
breakfast	O	O	nap/sleep	O	O	thank you	O	O
bye or bye bye	O	O	night night	O	O	wait	O	O
dinner	O	O	no	O	O	want to	O	O
don't	O	O	patty cake	O	O	yes	O	O
hello	O	O	peekaboo/peep-po	O	O			
hi	O	O	please	O	O			

13. ACTION WORDS

	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
bite	O	O	help	O	O	show	O	O
blow	O	O	hit	O	O	sing	O	O
break	O	O	hug/cuddle	O	O	sleep	O	O
bring	O	O	hurry	O	O	smile	O	O
bump	O	O	jump	O	O	splash	O	O
clean	O	O	kick	O	O	stop	O	O
close	O	O	kiss	O	O	swim	O	O
cry	O	O	look	O	O	swing	O	O
dance	O	O	love	O	O	take	O	O
draw	O	O	open	O	O	throw	O	O
drink	O	O	play	O	O	tickle	O	O
drive	O	O	pull	O	O	touch	O	O
eat	O	O	push	O	O	watch	O	O
fall	O	O	put	O	O	walk	O	O
feed	O	O	read	O	O	wash	O	O
finish	O	O	ride	O	O	wipe	O	O
get	O	O	run	O	O	write	O	O
give	O	O	say	O	O			
go	O	O	see	O	O			

14. DESCRIPTIVE WORDS

	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
all gone	O	O	empty	O	O	old	O	O
asleep	O	O	fast	O	O	pretty	O	O
bad	O	O	fine	O	O	red	O	O
big	O	O	gentle	O	O	scared	O	O
blue	O	O	good	O	O	sick	O	O
broken	O	O	happy	O	O	sleepy	O	O
careful	O	O	hard	O	O	soft	O	O
clean	O	O	hot	O	O	thirsty	O	O
cold	O	O	hungry	O	O	tired	O	O
cute	O	O	hurt	O	O	wet	O	O
dark	O	O	little	O	O	yucky	O	O
dirty	O	O	naughty	O	O			
dry	O	O	nice	O	O			

15. WORDS ABOUT TIME								
	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
day	O	O	night	O	O	tomorrow	O	O
later	O	O	now	O	O	tonight	O	O
morning	O	O	today	O	O			

16. PRONOUNS								
	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
her	O	O	me	O	O	this	O	O
his	O	O	mine	O	O	you	O	O
I	O	O	my	O	O	your	O	O
it	O	O	that	O	O			

17. QUESTION WORDS								
	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
how	O	O	when	O	O	who	O	O
what	O	O	where	O	O	why	O	O

18. PREPOSITION AND LOCATIONS								
	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
away	O	O	inside	O	O	there	O	O
back	O	O	off	O	O	under	O	O
down	O	O	on	O	O	up	O	O
in	O	O	out	O	O			

19. QUANTIFIERS								
	Under stands	Under-stands and says		Under stands	Under-stands and says		Under stands	Under-stands and says
all	O	O	none	O	O	same	O	O
another	O	O	not	O	O	some	O	O
more	O	O	other	O	O			

PART 2: ACTIONS AND GESTURES

A. FIRST COMMUNICATIVE GESTURES

When infants are first learning to communicate, they often use gestures to make their wishes known. For each item below, mark the line that describes your child's actions right now.

	Not yet	Sometimes	Often
1. Extends arm to show you something he/she is holding.	O	O	O
2. Reaches out and gives you a toy or some object that he/she is holding.	O	O	O
3. Points (with arm and index finger extended) at some interesting object or event.	O	O	O
4. Waves bye-bye on his/her own when someone leaves.	O	O	O
5. Extends his/her arm upward to signal a wish to be picked up.	O	O	O
6. Shakes head "no".	O	O	O
7. Nods head "yes".	O	O	O
8. Gestures "hush" by placing finger to lips.	O	O	O
9. Requests something by extending arm and opening and closing hand.	O	O	O
10. Blows kisses from a distance.	O	O	O
11. Smacks lips in a "yum yum" gesture to indicate that something taste good.	O	O	O
12. Shrugs to indicate "all gone" or "where'd it go".	O	O	O

B. ACTIONS WITH OBJECTS

Does your child do or try to do any of the following?

	Yes	No
1. Eat with a spoon or fork.	O	O
2. Drink from a cup containing liquid.	O	O
3. Comb or brush own hair.	O	O
4. Brush teeth.	O	O
5. Wipe face or hands with a towel or cloth.	O	O
6. Put on hat.	O	O
7. Put on a shoe or sock.	O	O
8. Put on a necklace, bracelet, or watch.	O	O
9. Lay head on hands and squeeze eyes shut as if sleeping.	O	O
10. Blow to indicate something is hot.	O	O
11. Hold plane and make it "fly".	O	O
12. Put telephone to ear.	O	O
13. Sniff flowers.	O	O
14. Push toy car or lorry.	O	O
15. Throw a ball.	O	O
16. Pour pretend liquid from one container to another.	O	O
17. Stir pretend liquid in a cup or pan with spoon.	O	O

C. GAMES AND ROUTINES		
Does your child do any of the following?	Yes	No
1. Play peekaboo.	O	O
2. Play patty cake.	O	O
3. Play "so big".	O	O
4. Play chasing games.	O	O
5. Sing.	O	O
6. Dance.	O	O

D. PRETENDING TO BE A PARENT		
Here are some things that young children sometimes do with stuffed animals or dolls. Please mark the actions that you have seen your child do.	Yes	No
1. Put to bed.	O	O
2. Cover with blanket.	O	O
3. Feed with bottle.	O	O
4. Feed with spoon.	O	O
5. Brush/comb its hair.	O	O
6. Pat or burp it.	O	O
7. Push in pram/buggy.	O	O
8. Rock it.	O	O
9. Kiss or hug it.	O	O
10. Try to put shoe or sock or hat on it.	O	O
11. Wipe its face or hands.	O	O
12. Talk to it.	O	O
13. Try to put nappy on it.	O	O

E. IMITATING OTHER ADULT ACTIONS (Using real or toy implements)		
Does your child do or try to do any of the following?	Yes	No
1. Sweep with a brush or mop.	O	O
2. Put key in door or lock.	O	O
3. Pound with hammer or mallet.	O	O
4. Attempt to use a saw.	O	O
5. "Type" at a typewriter or computer keyboard.	O	O
6. "Read" (opens book, turns pages).	O	O
7. Vacuum.	O	O
8. Water plants.	O	O
9. Play musical instrument (e.g. piano, trumpet).	O	O
10. "Drive" car by turning steering wheel.	O	O
11. Wash dishes.	O	O
12. Clean with cloth or duster.	O	O
13. Write with a pen, pencil, or marker.	O	O
14. Dig with a spade.	O	O
15. Put on glasses.	O	O

F. PRETEND OBJECTS

During play, children sometimes use an object as a replacement for another. For example, a child wishing to feed a teddy bear might pretend that a block is an apple. A child might pretend that a bowl is a hat. Have you seen your child make substitutions of this kind?.................................... yes O no O

If yes, please give several examples:

OTHER COMMENTS:

94/084

University of Wales, Bangor

Department of Psychology

Ethics Committee
Proposal cover sheet

Chief investigator/Supervisor: DR. P.J. HORNE and PROF. C.F. LOWE
Associate investigator/Student: MS. M.H. BELL

Brief project title: LEARNING TO ECHO AS A DETERMINANT OF SYMBOLIC NAMING IN HUMAN INFANTS
Date of submission: 7-11-94

Form used to prepare submission:

__ Departmental ethics committee outline ✓

__ Gwynedd Health Authority

__ Other (please give details) ____________________

____

NB. All relevant paperwork (including consent forms and any translations) <u>must</u> be completed before submission to the departmental Ethics Committee.

Declaration of ethical compliance

This research project will be carried out in accordance with the guidelines laid down by the British Psychological Society and the procedures determined by the Department of Psychology at Bangor. I understand that I am responsible for the ethical conduction of the research.

(Chief ~~investigator/~~supervisor)
Signed:
Date: 7. 11. 94.

(~~Associate investigator~~/student)
Signed: MHBell
Date: 7-11-94

For Departmental Use Only

Reviewer 1 [signature] Approved AW (Initials) 8-11-94 (Date)
Reviewer 2 ______________ Proposal No. 94/084

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8 November 1994

Margaret Bell
School of Psychology
University of Wales
Bangor, Gwynedd
LL57 2DG

Dear Colleague

Learning to echo as a determinant of symbolic naming in human infants

Your research proposal (referred to above and on the attached sheet) has been reviewed by the School of Psychology Research Ethics Committee and the Executive Committee of Tir na n-Og and both are satisfied that the research proposed accords with the relevant ethical guidelines.

If you wish to make any substantial modifications to the research project please inform myself as School of Psychology Research Ethics Committee Coordinator and also Mrs. Sue Kennedy (Nursery Manager) at Tir na n-Og, in writing before proceeding. Please also inform the same parties as soon as possible if research participants experience any unanticipated harm as a result of participating in your research.

Good luck with your research.

Kath Chitty

Kath Chitty
Coordinator - School of Psychology Research Ethics Committee

VR:SLP/311094/Lang Dev study

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Dear Parent/Guardian

At Tir na n-Og we are about to begin another study of language development in children which builds upon previous studies we have conducted there. The research mainly involves teaching the children the names of different objects, within a 'play' context. We are interested in finding ways to teach language effectively and hope to observe how this benefits the child's learning generally. Every effort will be made to ensure that the process will be very enjoyable for the children. The one-to-one interactions, in which our staff will name various objects for the child and assess his/her understanding of these names, should be an enriching experience.

This particular study is to be directed by Margaret Bell, a graduate member of our research team, working under my supervision. Margaret will be happy to discuss the details of the study with you and will keep you fully informed as to how it proceeds.

It is difficult to determine how long it will take to observe the language effects we are investigating, but we anticipate that the study will last from 2-3 months and will involve a daily 'play' session of approximately 20 minutes. When the study has finished, a summary of the findings will be given to parents whose children take part. As a token of our appreciation of childrens' participation in the research we shall also provide, in consultation with parents, a gift for each child at the conclusion of the study.

As you are aware it is Nursery policy to obtain parental approval for any studies in which the children participate, so we would be grateful if you would take the trouble to complete the slip below and return it to Sally Lloyd-Davies (Nursery Development Officer). Sally will also help to keep you informed about all aspects of the study and your child's progress.

Many thanks for your help.

Yours sincerely

C Fergus Lowe
Professor of Psychology
and Head of Department

Name(s) of child or children: ______________________________

I consent for my child to take part in the language development study ☐*

I do not consent for my child to take part in the language development study ☐*

I would like more information about the language development study ☐*

Name of Parent(s) ______________________________

Telephone Number ______________________________

Signed ______________________ Date ______________

*Please tick as appropriate.

Athro a Phennaeth yr Adran
Professor and Head of Department
C Fergus Lowe, PhD, FBPsS

MB. SI. 11/9

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Annwyl Riant/Warcheidwad

Yn Nhir na n-Og 'rydym ar fin dechrau astudiaeth arall o ddatblygiad iaith mewn plant sy'n adeiladu ar astudiaethau blaenorol a gynhaliwyd yno. Prif gynnwys yr ymchwil yw dysgu enwau gwahanol wrthrychau i'r plant, a hynny oddi mewn i gyd-destun 'chwarae'. Mae gennym ddiddordeb mewn darganfod dulliau o ddysgu iaith yn effeithiol a gobeithiwn gael gweld sut mae hyn o fudd i addysg y plentyn yn gyffredinol. Gwneir pob ymdrech i sicrhau fod y broses yn un y mae'r plant yn ei mwynhau yn fawr. Dylai'r sgwrsio rhwng aelodau'r staff a'r plant, fesul un, pan enwir gwrthrychau amrywiol i asesu dealltwriaeth y plentyn o'r enwau hyn, fod yn brofiad gwerth ei gael.

Cyfarwyddir yr astudiaeth arbennig hon gan Margaret Bell, aelod graddedig o'n tim ymchwil a fydd yn gweithio o dan fy ngoruchwyliaeth i. Bydd Margaret yn fodlon trafod manylion yr astudiaeth gyda chwi a bydd yn rhoi gwybodaeth lawn i chwi ynglŷn â sut mae'r astudiaeth yn mynd yn ei blaen.

Mae hi'n anodd pennu hyd yr amser a gymerir i sylwi ar yr effeithiau iaith yr ydym yn eu hastudio, ond rhagwelir fod yr astudiaeth am barhau am 2-3 mis a bydd yn cynnwys sesiwn 'chwarae' dyddiol am oddeutu 20 munud. Pan fydd yr astudiaeth wedi dod i ben, rhoddir crynhoad o'r hyn a ddarganfuwyd i rieni'r plant a gymerodd ran. Fel arwydd o'n gwerthfawrogiad o gyfraniad y plant i'r ymchwil byddwn hefyd ar ôl ymgynghori â'r rhieni, yn rhoi anrheg i bob plentyn ar ddiwedd yr astudiaeth.

Fel yr ydych yn gwybod, polisi'r Feithrinfa yw cael caniatad rhieni plant sy'n cymryd rhan mewn unrhyw astudiaeth, felly byddwn yn ddiolchgar petaech yn llenwi'r bonyn isod a'i ddychwelyd at Sally Lloyd-Davies (Swyddog Datblygu'r Feithrinfa). Bydd Sally hefyd yn cynorthwyo i roi gwybod i chwi am yr holl agweddau ar yr astudiaeth a chynnydd eich plentyn.

Diolch yn fawr am eich cymorth.

Yn gywir

C Fergus Lowe
Athro Seicoleg
a Phennaeth yr Adran

Enw(au)'r plentyn neu'r plant ______________________

Rhoddaf ganiatâd i'm plentyn gymryd rhan yn yr astudiaeth ddatblygu iaith ☐
Nid wyf yn rhoi caniatâd i'm plentyn gymryd rhan yn yr astudiaeth ddatblygu iaith ☐
Hoffwn gael mwy o wybodaeth ynglŷn â'r astudiaeth ddatblygu iaith ☐

Enw'r Rhiant/Rhieni ______________________

Rhif ffôn ______________________

Arwyddwyd ______________________ Dyddiad ______________

* Ticiwch lle bo'n briodol

Athro a Phennaeth yr Adran
Professor and Head of Department
C Fergus Lowe, PhD, FBPsS

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Mrs. Margaret Bell
tel. 01248 383276 (direct)
eMail psp030@Bangor.ac.uk
March 3, 1997

Dear Parent,

I would like your help with the language development study in which your child is participating. It is widely agreed that during the first 24 months of life parental report is an extremely reliable source of information on infant vocabulary. I would therefore be very grateful if you would complete the enclosed questionnaire and return it to me at the nursery as soon as possible. A Welsh adaptation of this inventory has been pioneered here in the University of Wales, Bangor, which we are in the process of validating. If you would like to include any words your child understands or says in Welsh this would help me to gain a comprehensive knowledge of your child's language development.

Yours faithfully

Margaret Bell

Mrs. Margaret Bell

Athro a Phennaeth yr Ysgol
Professor and Head of School
C Fergus Lowe, PhD, FBPsS

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March 3, 1997

Annwyl Riant,

Hoffwn gael eich cymorth gyda'r astudiaeth datblygiad iaith y mae eich plentyn yn cymryd rhan ynddi. Cytunir yn gyffrredinol fod adroddiad y rhieni yn ffynhonnell hynod o ddibynadwy ar gyfer geirfa plant bach yn ystod y 24 mis cyntaf. Felly, byddwn yn ddiolchgar iawn pe baech yn llenwi'r holiadur amgaeëdig a'i ddychwelyd ataf yn y feithrinfa cyn gynted ag y bo modd. Arloeswyd addasiad Cymraeg o'r rhestr hon yma ym Mhrifysgol Cymru, Bangor ac 'rydym wrthi yn ei ddilysu. Os hoffech gynnwys unrhyw eiriau y mae eich plentyn yn eu deall neu yn eu dweud yn Gymraeg byddai hyn yn gymorth imi gael gwybodaeth gynhwysfawr o ddatblygiad iaith eich plentyn.

Yn gywir,

Margaret Bell

Mrs. Margaret Bell

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