

## PREPOSITIONAL PHRASES SPOKEN AND HEARD

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The relation between verbal and nonverbal behavior with common syntactic properties was investigated, using retarded and nonretarded children. Reinforcement was contingent on either verbal or nonverbal responses whereas responses of the other repertoire had no experimental consequences. Changes sometimes occurred in the unreinforced (collateral) repertoire, but they were always changes in the stimulus control of pre-existing topographies. A contingency involving responses of one repertoire never instated new topographies in the collateral repertoire. This suggested that the problem of "cross-modality generalization" should be reformulated to distinguish explicitly between instating new topographies and changing the stimulus control of pre-existing topographies. The result confirmed Skinner's hypothesis about "the same response spoken and heard" and clarified some anomalies in previous studies.

*Key words:* verbal behavior, instructions, children

It is said that Skinner's (1957) theory of verbal behavior has stimulated much controversy but little research (e.g., Boe & Winokur, 1978; Honig & Staddon, 1977), but several experiments have effectively tested aspects of Skinner's theory without acknowledging its relevance. Examples are studies that bear on Skinner's (1957, p. 195) hypothesis about the relation between the repertoires of the individual as speaker and as listener (Guess, 1969; Guess & Baer, 1973; Lee, 1978; Whitehurst, 1977; Harrelson, Note 1).

Traditional theories about this relation assume "a special process of 'understanding the meaning of a word'" (Skinner, 1957, p. 195), common to both the verbal responses of the speaker and the nonverbal responses of the listener. A well-known example is Chomsky's theory of language, which presupposes that these responses manifest an internalized knowledge of language (e.g., Chomsky, 1964). Bloom's (1974) statement that "understanding and speaking . . . involve learning the same words and linguistic structures" (p. 286) illustrates the acceptance of this traditional assumption among developmental psycholinguists (e.g., Deese, 1970; Slobin, 1971).

This paper is based on a thesis submitted to the University of Auckland in partial fulfillment of the requirements for the PhD degree. Send reprint requests to Vicki Lee, Box 6892, Wellesley Street, Auckland 1, New Zealand.

Skinner's theory differs markedly from the traditional view. From a behavioral perspective, the acoustic products of verbal responses serve as discriminative stimuli for nonverbal responses. This does not require the assumption of an underlying knowledge of language common to verbal and nonverbal behavior (MacCorquodale, 1970). Skinner's theory treats the behavior of the individual as speaker and as listener as separate subject matters, not as manifestations of linguistic knowledge. It is an empirical matter whether speakers derive any advantage from their status as listeners or vice versa (Skinner, 1957, p. 195).

Several studies relevant to this issue investigated the relation between verbal and nonverbal behavior that shares syntactic properties (Guess, 1969; Guess & Baer, 1973; Lee, 1978; Whitehurst, 1977; Harrelson, Note 1). An example is the relation between nonverbal responses to instructions to put one object behind another and verbal responses to requests to state the location of one object placed behind another. In this example, reinforcement was contingent on either verbal or nonverbal responses while responses of the collateral repertoire had no experimental consequences. Of interest was whether the contingency would affect verbal and nonverbal responses similarly.

The results varied across subjects. With some subjects, reinforcement affected both rep-

ertoires (Guess & Baer, 1973; Whitehurst, 1977), suggesting that a child can become a listener collateral to becoming a speaker, and vice versa. On its face, this contradicts Skinner's (1957) hypothesis that "the processes through which [a person] becomes a listener differ . . . from those through which he [or she] becomes a speaker" (p. 195). But with other subjects (Guess, 1969; Guess & Baer, 1973; Lee, 1978; Whitehurst, 1977; Harrelson, Note 1), no change occurred in the collateral repertoire, a result consistent with Skinner's hypothesis. The results suggested no explanation for the inconsistencies. As Guess and Baer (1973) put it, the verbal-nonverbal relation seems "open to unexplained individual differences" (p. 326). The following experiments were conducted to provide further information about this relation.

### EXPERIMENT 1

This experiment was initially intended to replicate two previous studies (Guess, 1969; Harrelson, Note 1). After a baseline, one subject was taught standard *nonverbal* "behind" and "front" responses; the other subject, standard *verbal* "behind" and "front" responses. Standard responses in the other repertoire were taught in the next condition, and reversal training was given in the third condition. In reversal training, reversals (i.e., "behind" responses to "front" stimuli, and vice versa) in the repertoire first trained were reinforced, and responses in the other repertoire had no experimental consequences. No collateral change occurred in the unreinforced repertoire for either subject in the first condition, nor for one subject in the third (reversal) condition. But, for the other subject, reversal training affected the unreinforced repertoire, though initial training in the repertoire undergoing reversal training did not. This result suggested that inconsistencies may occur in the verbal-nonverbal relation for each subject. Subsequent conditions of Experiment 1 used alternating standard and reversal training to explore this possibility.

### METHOD

#### *Subjects*

Lawrence and Kenny, aged 9 yr and 10 yr respectively, resided in a children's hospital. Hospital records described them as moderately

retarded. Their speech consisted of short utterances, and was poorly articulated and often unintelligible.

#### *Setting*

The setting was a soundproof, well-lighted cubicle with a table and two chairs. Subject and experimenter sat at adjacent sides of the table. Experimental materials were in a box on the table out of the subject's reach when not in use. They were 80 small stimulus objects (e.g., cup, book, jar); poker chips used as token reinforcers; and toys and food given in exchange for tokens. One-hour experimental sessions were conducted twice daily, Monday to Friday, with each subject.

#### *Stimuli*

Stimuli were arranged in sets, each set consisting of four stimuli for nonverbal responses and four for verbal responses. Table 1 shows one set of stimuli. Each set used a different pair of objects, selected randomly and without replacement from a list of 160 two-way combinations of the 80 objects (cup and book, fork and spoon, toothbrush and box, etc.).

Stimuli for nonverbal responses each consisted of two objects in the behind-front relation and an instruction to put one object left or right of the other. The objects were placed on the table in front of the subject about 8 cm apart, and then the instruction was spoken. The behind-front positions of the objects were changed randomly from trial to trial.

Stimuli for verbal responses each consisted of two objects in the left-right position and a question about the location of one object (Table 1).

#### *Responses*

Two kinds of responses were of interest, standard responses and reversals (e.g., Table 1). Standard responses followed conventional English usage. Reversals departed from conventional usage in that "left" substituted for "right", and so forth. (Standard verbal responses had the form "on the left [or right] of the [noun]" for experimental convenience. In everyday usage, other forms would also be acceptable.) Correct responses were those appropriate to the experimental contingencies. Sometimes they were standard responses and at other times, reversals.

Table 1  
Set of Stimuli, and Responses<sup>a</sup>

Stimuli		Responses	
Objects <sup>b</sup>	Instruction/Question	Standard	Reversals
			<i>Nonverbal</i>
cup behind/in front of book	"Put the cup on the left of the book"	cup left of book	cup right of book
cup behind/in front of book	"Put the book on the left of the cup"	book left of cup	book right of cup
cup behind/in front of book	"Put the cup on the right of the book"	cup right of book	cup left of book
cup behind/in front of book	"Put the book on the right of the cup"	book right of cup	book left of cup
			<i>Verbal</i>
cup left of book	"Where's the cup?"	"on the left of the book"	"on the right of the book"
book left of cup	"Where's the book?"	"on the left of the cup"	"on the right of the cup"
cup right of book	"Where's the cup?"	"on the right of the book"	"on the left of the book"
book right of cup	"Where's the book?"	"on the right of the cup"	"on the left of the cup"

<sup>a</sup>Order of presentation in test phases was determined randomly for each set of stimuli.

<sup>b</sup>Behind-front positions of objects were determined randomly. Objects were placed about 8 cm apart.

### Consequation

Correct responses were reinforced by praising the subject and giving him one token. Incorrect responses were punished by following them with "No" and the removal of one token (if tokens had been accumulated). When the subject had accumulated five tokens, he counted them into the experimenter's hand and chose either a toy to play with for 30 sec or something to eat.

### Baseline Condition

The experiment began with a baseline condition to determine the subject's responses to "left" and "right" stimuli. Five sets of stimuli like those in Table 1 were used in succession. Two procedures, label training and a test phase, were used in succession with the first set, then repeated with the second, and so on, until the five sets of stimuli had been used (Table 2). The stimuli used in the baseline condition were not used again in later conditions.

*Label training (pointing and tacting).* In label training, the subject was trained to point to and name the objects used in the set of stimuli. Only object labels (e.g., "cup", "book"), not the "left" and "right" phrases, were

taught. This training was given so that any subsequent failure in the test phase to discriminate or produce "left" and "right" phrases incorporating the object names could not be attributed to a failure to discriminate or produce the object labels.

The subject was first taught to point on command. The two objects were placed side by side on the table, about 8 cm apart, and the subject was instructed to "point to the (name of object)." Correct responses were reinforced. Incorrect responses were punished, and then the correct response was modelled. Left-right positions of the objects were changed randomly from trial to trial, as was the object named in the instruction. The objects were removed for about 3 sec before each new trial. Criterion for completing this training was six consecutive correct responses, three for each object.

Next, labelling (tacting) was taught. One object was placed on the table, and the experimenter asked "What's this?" The object presented was changed randomly from trial to trial. Correct responses were reinforced. Incorrect responses were punished and then the correct response was modelled. The same criterion was required (six consecutive correct responses, three for each object), unless each

Table 2

Sequence of Conditions, Stimuli, and Phases		
Condition <sup>a</sup>	Set of Stimuli <sup>b, c</sup>	Phases <sup>d</sup>
Baseline	B 1	Label training, test phase
	B 2	Label training, test phase
	B 3	Label training, test phase
	B 4	Label training, test phase
	B 5	Label training, test phase
I	I 1	Label training, test phase, training phase
	I 2 etc.	Label training, test phase, training phase
II	II 1	Label training, test phase, training phase
	II 2 etc.	Label training, test phase, training phase
III etc.	III 1	Label training, test phase, training phase
	III 2 etc.	Label training, test phase, training phase

<sup>a</sup>Treatment conditions were as follows. Lawrence: (1) standard nonverbal, (2) standard verbal, (3) reversed nonverbal, (4) standard nonverbal, (5) reversed verbal, (6) standard verbal, (7) reversed verbal, (8) standard verbal, (9) reversed nonverbal, (10) standard nonverbal, (11) reversed verbal, (12) standard verbal.

Kenny: (1) standard verbal, (2) standard nonverbal, (3) reversed verbal, (4) standard verbal, (5) reversed verbal, (6) standard verbal, (7) reversed nonverbal, (8) standard nonverbal, (9) reversed verbal, (10) standard verbal, (11) reversed nonverbal, (12) standard nonverbal, (13) reversed verbal, (14) standard verbal.

<sup>b</sup>Each set of stimuli was used only once.

<sup>c</sup>Successive sets of stimuli were presented within each condition until a criterion was met of 20 successive correct responses cumulated over five consecutive test phases (four trials per test phase).

<sup>d</sup>A training phase followed each test phase with fewer than four (100%) correct responses.

object evoked a correct response on its first presentation, in which case training terminated immediately.

*Test phase.* Following label training, responses to the "left" and "right" stimuli (e.g., Table 1) were tested. Each stimulus in the set was presented once, with order of presentation randomized. Reinforcers and punishers were not presented during these four trials.

Following the test phase with the first set of stimuli, label training began with the second set. After testing with the second set of stimuli, label training began with the third set, and so on, until all five sets of stimuli had been used.

### Echoic Training

Following the baseline condition, and before the first treatment condition began, the subject was taught to echo "on the left of the cup" and "on the right of the cup." This en-

sured that he could articulate "left" and "right" phrases and eliminated the need for echoic training during the treatment conditions. The echoic-training procedure of Lee (1978) was used.

### Treatment Conditions

Several treatment conditions followed echoic training (Table 2). Standard verbal and nonverbal responses were taught in the first two conditions. Order of training for Kenny was verbal (Condition 1) then nonverbal (Condition 2); for Lawrence, nonverbal then verbal. In later conditions, the relation between the verbal and nonverbal repertoires established in the first two conditions was investigated. In each condition, responses of one repertoire were reinforced, and the unreinforced repertoire was probed for collateral effects. Standard responses were reinforced in some conditions (standard-verbal and standard-nonverbal conditions) and reversals in others (reversed-verbal and reversed-nonverbal conditions).

Successive sets of stimuli were used in each treatment condition. Two (label training, test phase) or three (label training, test phase, training phase) procedures were used with the first set of stimuli, then repeated with the second, and so on (Table 2). No set of stimuli was used more than once during the several treatment conditions.

*Label training.* The first procedure used with each set was label training. The subject was first trained to point on command to each object in the set (e.g., Table 1) and then to tact each object. The training procedure, which involved only the object labels and not the "left" and "right" phrases, was exactly like label training during the baseline condition.

*Test phase.* After label training for the particular set of stimuli, a test phase was conducted. Each stimulus in the set was presented once, giving a total of four test trials per test phase. Order of presentation was randomized.

Response consequences during test phases were as follows. In all conditions except Condition 2, correct responses (standard verbal, reversed verbal, standard nonverbal, or reversed nonverbal, depending on the condition) were reinforced. Incorrect responses in the same repertoire were punished. Responses in the alternate repertoire had no experimental consequences. For example, in a standard-verbal condition, standard-verbal responses were

reinforced, all other verbal responses were punished, and nonverbal responses had no experimental consequences.

Consequation in test phases of Condition 2 departed from this usual procedure. Condition 2 concerned the training of correct responses rather than the verbal-nonverbal relation. Standard responses in the repertoire established in Condition 1 were reinforced in these test phases to maintain them while the other repertoire was established. Thus, both standard verbal and standard nonverbal responses were reinforced. All other responses were punished.

The number of stimulus sets used in each treatment condition depended on performance during test phases. Criterion for completing each condition was 20 successive correct responses cumulated over five consecutive test phases (four trials per test phase): 20 standard verbal responses in standard-verbal conditions, 20 verbal reversals in reversed-verbal conditions, and so on.

*Training phase.* Each test phase with fewer than four (100%) correct responses was followed by a training phase. Otherwise, the test phase was followed by label training for the next set of stimuli. The four stimuli presented in the immediately preceding test phase were used in the training phase, either the stimuli for verbal responses (in standard-verbal and reversed-verbal conditions) or those for nonverbal responses (in standard-nonverbal and reversed-nonverbal conditions).

Training proceeded in three steps. In Step 1, standard responses to the two "left" stimuli were taught. A random sequence determined which stimulus was presented following a correct (reinforced) response. Following an incorrect (punished) response, the correct response was modelled, and then the same stimulus was presented again, with responses consequated as before, until two consecutive correct responses to the stimulus were given, whereupon the random sequence resumed. Criterion for completing Step 1 was ten consecutive correct responses, five to each stimulus. Responses during the correction procedure did not contribute to this criterion.

In Step 2, the two "left" stimuli and one "right" stimulus were presented, and the criterion was 15 consecutive correct responses, five to each stimulus.

In Step 3, all four stimuli were presented,

and the criterion was 20 consecutive correct responses, again five to each stimulus. Label training for the next set of stimuli followed this criterion performance.

### *Reliability*

One test phase in each condition was audio-tape-recorded. Later an observer listened to the recording and transcribed the verbal responses onto a data sheet showing object positions and questions for each trial. Next the observer used the response definitions implied in Table 1 to assign each response to one category: standard, reversal, or other. The experimenter's records were compared with the observer's trial-by-trial. An agreement was scored when experimenter and observer assigned a response to the same category. Agreements were obtained on every trial so assessed.

Reliability was not assessed for nonverbal responses because an observer was not available during sessions and video recording equipment was not available. However, the behavior of placing one object left or right of another is difficult to mistake, and interobserver reliability has not always been thought necessary for such responses (e.g., Risley, 1968). Further, reliability scores of 100% were obtained under similar conditions in a systematic replication of this experiment (described later).

## RESULTS AND DISCUSSION

The results in test phases are shown in Figures 1 and 2. The main result was in the third and subsequent conditions, after the verbal and nonverbal repertoires had been established. Reinforcing standard verbal responses increased the number of standard responses in both repertoires (Figure 1, Conditions 4, 6, 10, and 14; Figure 2, Conditions 6, 8, and 12), and reinforcing verbal reversals increased the number of reversals in both repertoires (Figure 1, Conditions 3, 5, 9, and 13; Figure 2, Conditions 5, 7, and 11). On the other hand, reinforcing nonverbal responses affected only the nonverbal repertoire (Figure 1, Conditions 7 and 11; Figure 2, Conditions 3 and 9).

## EXPERIMENT 2

To find out whether the results of Experiment 1 were replicable with different phrases, the experiment was repeated, using the phrases

“behind the (noun)” and “in front of the (noun).” The subjects were the same.

**METHOD**

Experiment 2 differed procedurally from Experiment 1 in three ways.

First, the stimuli and responses were different, as illustrated in Table 3.

Second, the training procedure used with some sets of stimuli in Experiment 1 was not used at all in Condition 1 of Experiment 2. Both subjects had been trained earlier to produce and discriminate “behind” and “front” phrases, Lawrence in a previous study (Lee, 1978) and Kenny in preliminary work. They continued to give standard nonverbal re-

sponses to most (Lawrence) or all (Kenny) relevant stimuli in the baseline condition of this experiment, but standard verbal responses did not carry over from the earlier training to the current baseline condition. Therefore, to see if standard verbal responses could be reinstated through reinforcing standard nonverbal responses, standard nonverbal responses were reinforced during test phases of Condition 1. (No training phases were used since standard nonverbal responses were already occurring reliably.) Reinforcing standard nonverbal responses during test phases of Condition 1 produced no collateral effect in the verbal repertoire. Hence, standard verbal responses were reinstated in Condition 2 which, following the usual procedure, included a training phase

**KENNY**

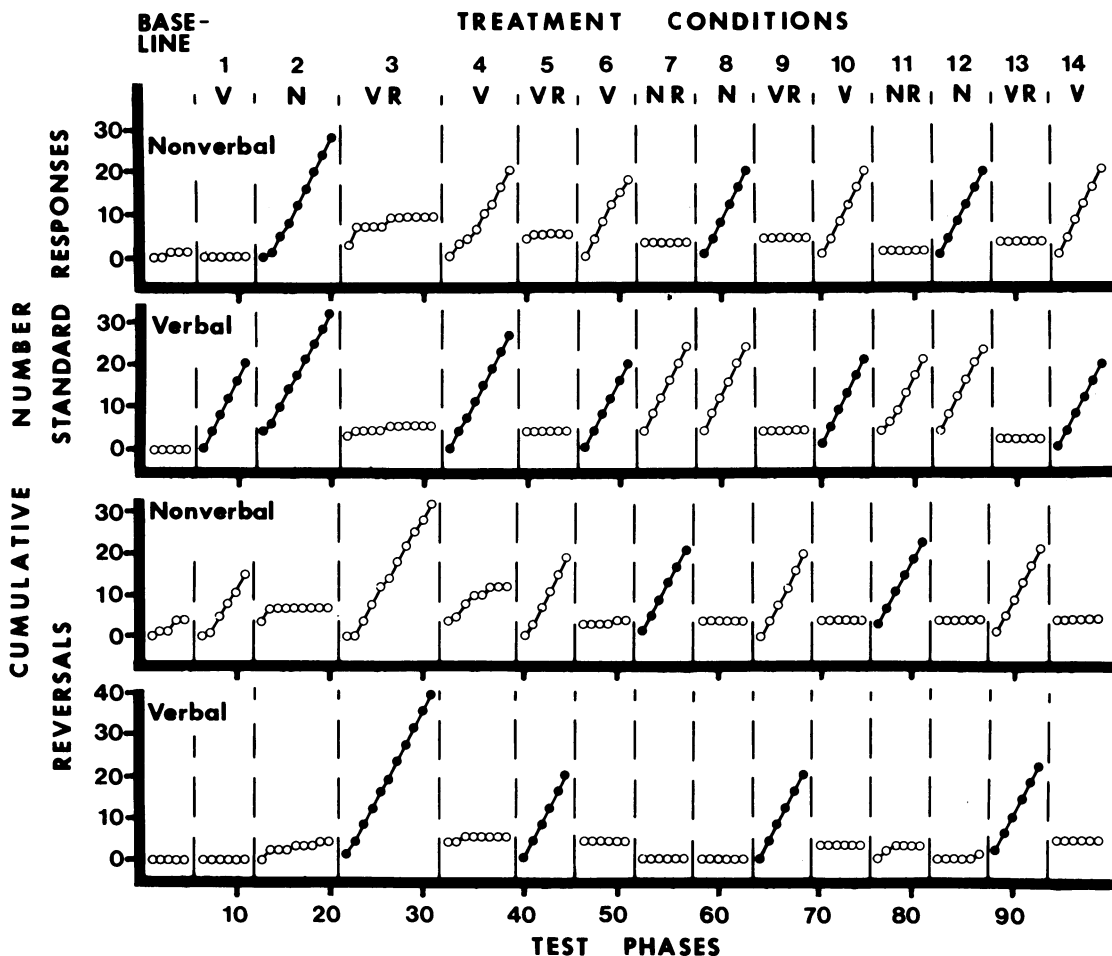


Fig. 1. Responses in test phases (Kenny). Upper-case letters in column headings indicate responses trained in training phases: (N) standard nonverbal responses, (V) standard verbal responses, (NR) nonverbal reversals, (VR) verbal reversals. Filled circles represent responses reinforced in test phases.

after every test phase with fewer than four (100%) correct responses.

Third, interobserver agreement was assessed for nonverbal responses. An observer was present during the first three test phases of each condition and recorded the responses. Agreement between observer and experimenter was assessed as in Experiment 1 and was 100%.

RESULTS AND DISCUSSION

The results of test phases were as in Experiment 1. Reinforcing verbal responses affected both verbal and nonverbal repertoires (Figures 3 and 4, Conditions 6, 8, and 10), but reinforcing nonverbal responses affected only the nonverbal repertoire (Conditions 5, 7, and 9).

results confirmed that the verbal-nonverbal relation observed in Experiment 1 was not unique to "left" and "right" phrases for these subjects, but extended as well to "behind" and "front" phrases.

This finding does not warrant a general conclusion about the organization of the subjects' repertoires. There are four possible relationships between corresponding verbal and nonverbal response classes. First, reinforcing either verbal or nonverbal responses could affect both classes similarly. Second, reinforcing either class could affect only responses of that class. Third, reinforcing nonverbal responses could affect both classes similarly but reinforcing verbal responses, only verbal responses.

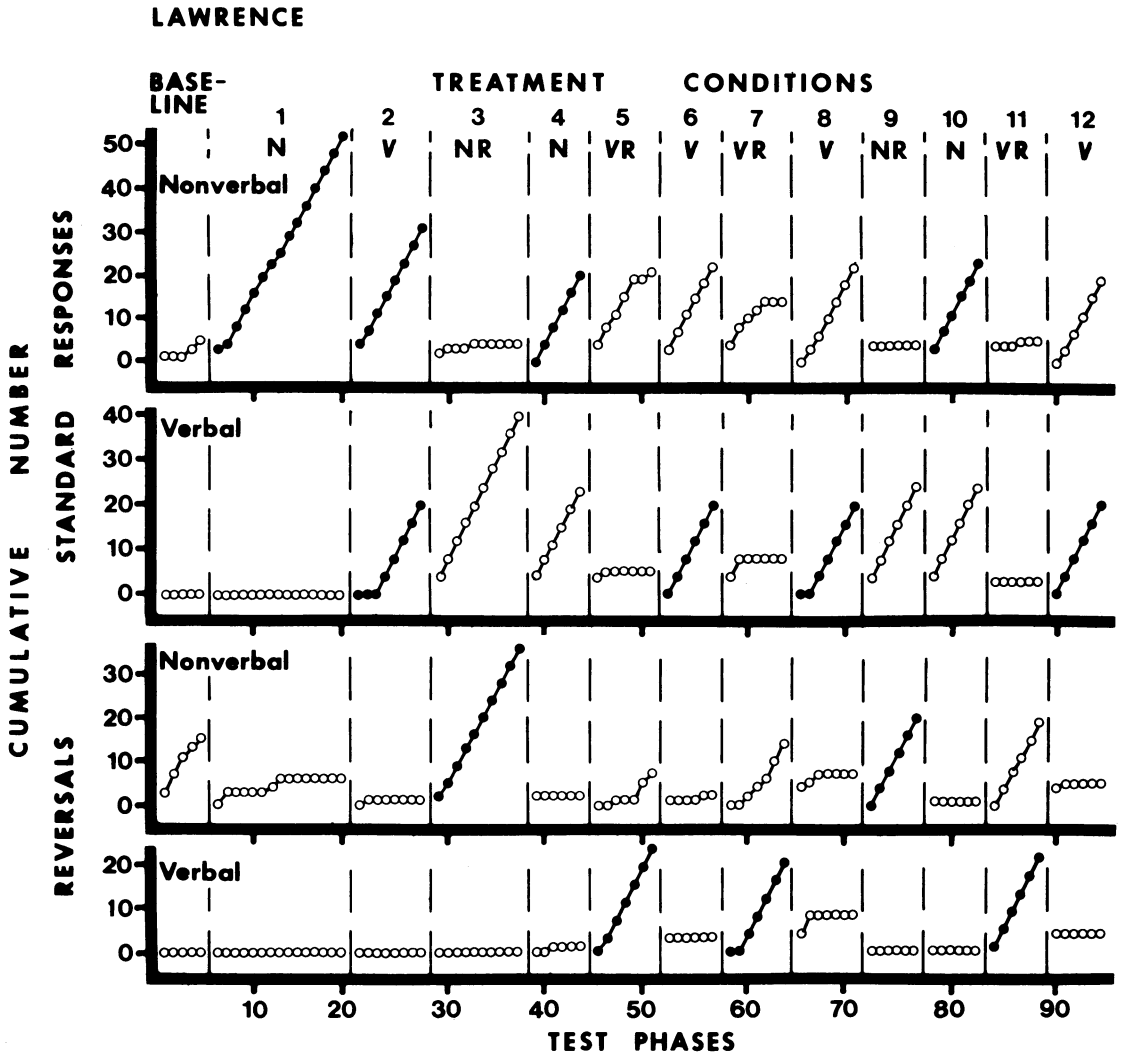


Fig. 2. Responses in test phases (Lawrence).

Table 3  
Set of Stimuli, and Responses<sup>a</sup>

Stimuli		Responses	
Objects <sup>b</sup>	Instruction/Question	Standard	Reversals
			<i>Nonverbal</i>
cup left/right of book	"Put the cup behind the book"	cup behind book	cup front of book
cup left/right of book	"Put the book behind the cup"	book behind cup	book front of cup
cup left/right of book	"Put the cup in front of the book"	cup front of book	cup behind book
cup left/right of book	"Put the book in front of the cup"	book front of cup	book behind cup
			<i>Verbal</i>
cup behind book	"Where's the cup?"	"behind the book"	"in front of the book"
book behind cup	"Where's the book?"	"behind the cup"	"in front of cup"
cup in front of book	"Where's the cup?"	"in front of the book"	"behind the book"
book in front of cup	"Where's the book?"	"in front of the cup"	"behind the cup"

<sup>a</sup>Order of presentation in the test phase was determined randomly for each set of stimuli.

<sup>b</sup>Left-right positions of objects were determined randomly. Objects were placed about 8 cm apart.

Fourth, reinforcing verbal responses could affect both verbal and nonverbal responses similarly but reinforcing nonverbal responses, only nonverbal responses. The results of Experiments 1 and 2 represent the fourth relationship. The first three relationships have not yet been observed. Whether two or more of these four relationships can occur for the same subject across different classes of speech also remains to be determined.

### EXPERIMENT 3

This experiment further explored inconsistencies within subjects' performances. It determined whether reinforcement of verbal responses would affect nonverbal responses and, if so, whether this effect would occur consistently across two or more pairs of phrases for each subject.

#### METHOD

##### Subjects

Four 8-yr-old elementary-school students participated. They conversed readily with the experimenter but, according to school records, read only at the 5-yr level.

##### Setting

The experiment was conducted in a well-lit room (2 by 3 m) in the school's admin-

istration block. The room, which was not soundproof, contained a table, two chairs, and a bench. Subject and experimenter sat at one side of the table. The materials, which consisted of tokens, toys and food, and 40 objects, were on the bench behind the experimenter's chair when not in use. Daily 1-hr sessions were conducted Monday to Friday with each subject.

##### Procedure

The procedure was basically as in Experiment 1. Mention is made here primarily of departures from that previous procedure.

*Stimuli, responses, and consequences.* Table 4 shows one set of stimuli and the standard responses for that set. Each set used a different pair of objects selected randomly from a list of 780 different pair-wise combinations of the 40 objects. No set of stimuli was used more than once during the experiment.

Responses were consequated as before, but now ten tokens were required to obtain a toy or food.

*Conditions.* The experiment began with a baseline condition to determine the subject's responses to the stimuli (e.g., Table 4). Several treatment conditions followed completion of the baseline condition. Standard verbal responses were taught in these conditions, for one pair of phrases in Condition 1 (e.g., "be-



KENNY

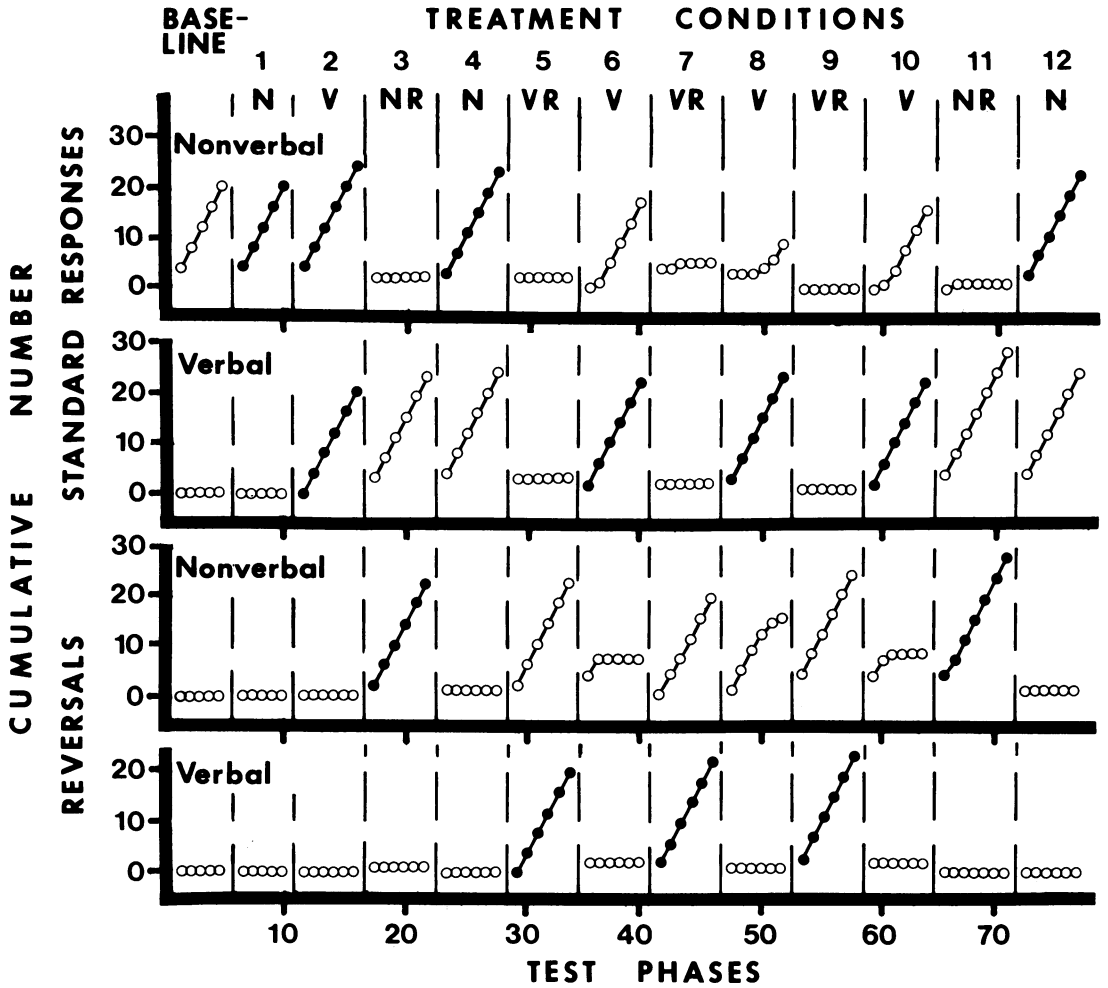


Fig. 3. Responses in test phases (Kenny).

fore" and "after" phrases), for a second pair in Condition 2 (e.g., "behind" and "front" phrases), and so on. Lenny and Shane were taught all four pairs of phrases; Mua, three; and Eddie, two. Sets of stimuli used with Mua and Eddie omitted stimuli for the phrases not taught to these subjects.

*Phases.* Five sets of stimuli were used in succession in the baseline condition. Two phases (label training, test phase) were used in succession with the first set of stimuli, then repeated with the second set, and so on.

In each treatment condition, three phases (label training, test phase, training phase) were used in succession with the first set of stimuli, then repeated with the second set, and so on. The number of sets of stimuli used in each

treatment condition depended on the subject's performance in test phases of that condition. Criterion for completing each condition was correct responses cumulated across five consecutive test phases to 18 or more of the 20 stimuli for the pair of phrases being taught in the condition.

*Label training.* Label training was exactly as in Experiment 1.

*Test phases.* Each stimulus in the set was presented twice in the test phase in randomized order. There were 32 trials per test phase for Lenny and Shane (16 stimuli like those in Table 4, each presented twice), 24 for Mua, and 16 for Eddie.

Responses during baseline test phases had no experimental consequences.

During test phases in treatment conditions, correct responses were reinforced and incorrect responses punished. Correct responses were standard verbal responses for the phrases trained in the condition. For example, when "before" and "after" phrases were trained, standard verbal responses to "before" and "after" stimuli were reinforced, and all other verbal responses to these stimuli were punished.

In addition, during test phases of Conditions 2, 3, and 4, standard verbal responses to stimuli for phrases trained in the previous condition(s) were reinforced, and other responses to these stimuli were punished. For example, in Condition 2, standard verbal responses to

"before" and "after" stimuli (the responses trained in Condition 1) were reinforced, and other responses to these stimuli were punished. These responses were consequated to maintain them while the other phrases were taught.

Nonverbal responses had no experimental consequences during test phases of this experiment. The effect of verbal training on these responses was determined in each treatment condition.

*Training phases.* A training phase followed each test phase in the treatment conditions. Standard verbal responses to stimuli for the pair of phrases trained in the condition were taught; for example, "before" and "after" phrases in Condition 1. The stimuli were pre-

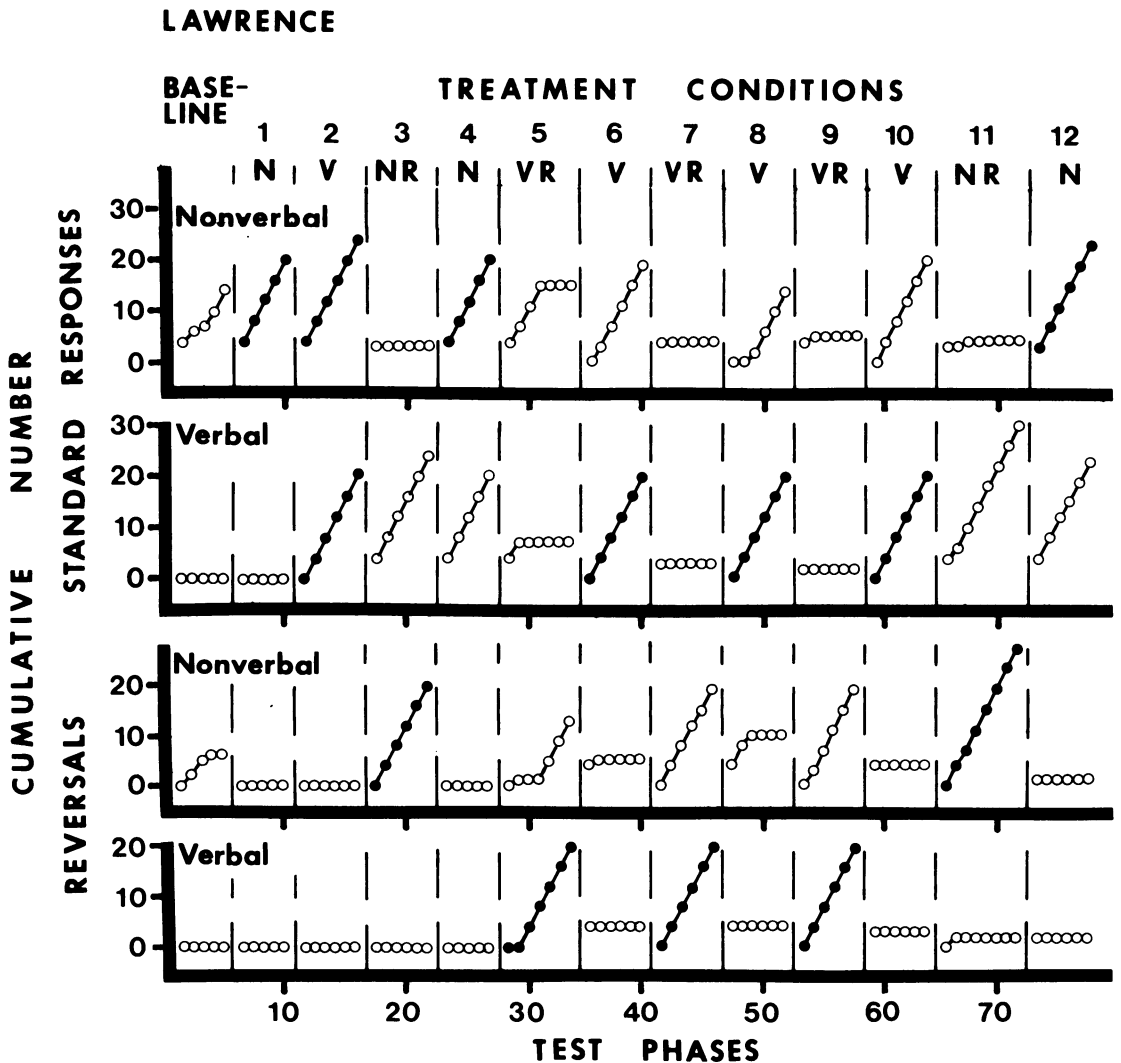


Fig. 4. Responses in test phases (Lawrence).

Table 4  
One Set of Stimuli, and Responses<sup>a</sup>

Stimuli		
Objects <sup>b, c</sup>	Instruction/Question	Standard Responses
		<i>Nonverbal</i>
cup left/right of book	"Pick up the cup <i>before</i> the book"	pick up cup, then book
cup left/right of book	"Pick up the cup <i>after</i> the book"	pick up book, then cup
cup left/right of book	"Put the cup <i>behind</i> the book"	put cup behind book
cup left/right of book	"Put the cup <i>in front</i> of the book"	put cup in front of book
cup behind/front of book	"Put the cup <i>on the left</i> of the book"	put cup left of book
cup behind/front of book	"Put the cup <i>on the right</i> of the book"	put cup right of book
cup left/right of book	"Put the cup <i>above</i> the book"	hold cup above book
cup left/right of book	"Put the cup <i>below</i> the book"	hold cup below book
		<i>Verbal</i>
cup picked up first, then book	"When did I pick up the cup?"	"before the book"
book picked up first, then cup	"When did I pick up the cup?"	"after the book"
cup behind book	"Where's the cup?"	"behind the book"
cup front of book	"Where's the cup?"	"in front of the book"
cup left of book	"Where's the cup?"	"on the left of the book"
cup right of book	"Where's the cup?"	"on the right of the book"
cup held above book	"Where's the cup?"	"above the book"
cup held below book	"Where's the cup?"	"below the book"

<sup>a</sup>Order of presentation in the test phase was determined randomly for each set of stimuli. Each stimulus was presented twice.

<sup>b</sup>Left-right and behind-front positions were determined randomly from trial to trial. Objects were placed about 8 cm apart.

<sup>c</sup>Left-right and behind-front positions, and left-hand/right-hand positions of objects held by the experimenter for "before," "after," "above," and "below" stimuli were determined randomly from trial to trial. Objects in behind-front and left-right positions were placed about 8 cm apart; objects in the above-below position were held about 8 cm apart. When arranging objects for "before" and "after" responses, the experimenter paused for about 3 sec before picking up the second object.

sented in random sequence, and responses were consequated as in earlier training phases. Criterion for completing this training was 10 consecutive correct responses, five to each stimulus.

*Interobserver reliability.* Reliability for verbal responses was assessed as before and was

100%. Reliability for nonverbal responses was not assessed.

## RESULTS AND DISCUSSION

In general, during test phases standard nonverbal responses did not increase in number collateral to verbal training (Figures 5 to 8). Most often, the subjects continued to respond nonverbally as they had before verbal responses were trained.

However, there was one clear exception, in Shane's standard nonverbal "behind" and "front" responses. They averaged 11% immediately before verbal "behind" and "front" training (Condition 1) and 84% during this training (Condition 2). In two other cases, there was some collateral increment in standard nonverbal responses. First, Shane's standard nonverbal "left" and "right" responses averaged 78% immediately before verbal "left"- "right" training (Condition 2) and 90% during this training (Condition 3). Second, Lenny's standard nonverbal "behind" and "front" responses averaged 38% immediately before (Condition 1) and 79% during (Condition 2) verbal "behind"- "front" training.

In these three cases, the subject displayed both required nonverbal topographies (e.g., nonverbal "behind" and "front" topographies in response to "behind" and "front" instructions) before verbal training, though neither reliably nor always correctly. During the baseline condition, Shane gave 18 "behind" or "front" responses (including 12 reversals) to the 20 "behind" and "front" instructions, and 18 "left" or "right" responses (including 12 reversals) to the 20 "left" and "right" instructions. Lenny gave no "behind" or "front" responses to "behind" or "front" instructions during the baseline condition, but he gave 12 of these responses (including two reversals) to the 24 "behind" and "front" instructions presented during Condition 1, before verbal "behind"- "front" training.

In all other cases, except for Lenny's nonverbal "left" and "right" responses (Figure 6), the subject displayed neither, or only one, of the required nonverbal topographies prior to verbal training. (Lenny gave 10 nonverbal "left" or "right" responses, including four reversals, during the baseline condition.)

To sum up, there was no collateral change in nonverbal responding unless the instructions evoked both required nonverbal topogra-

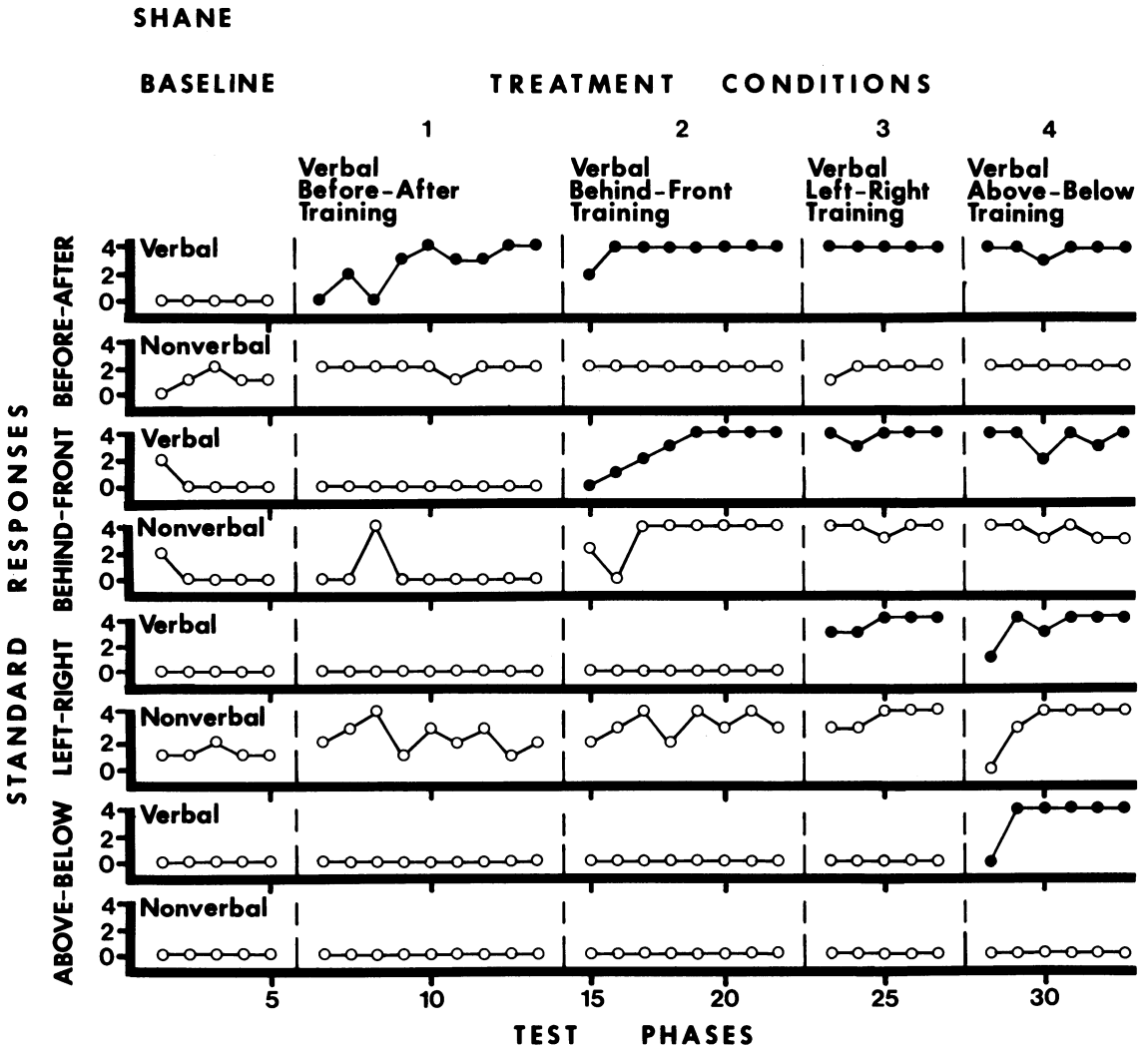


Fig. 5. Responses in test phases (Shane). Column headings indicate responses trained in training phases. Filled circles represent responses reinforced in test phases.

phies prior to verbal training. Collateral changes in nonverbal behavior always reflected a change in the stimulus control of pre-existing nonverbal topographies. (The collateral effects in Experiments 1 and 2 also reflected such a change.) This finding suggested that the prior appearance of the required nonverbal topographies in response to the instructions could be a *necessary* condition for a change in nonverbal responding collateral to verbal training. However, that it was not a *sufficient* condition is suggested by the absence of a collateral change in Lenny's nonverbal "left" and "right" responses (Figure 6, Condition 3), and the weak effects both in Lenny's nonverbal "behind" and "front" responses (Figure 6, Condition 2) and in Shane's nonverbal "left" and "right" responses (Figure 5, Condition 3).

### GENERAL DISCUSSION

These results indicated that the research problem should be reformulated. Previous formulations, for example as "generalization across language modalities" (Guess & Baer, 1973) and as "cross-modality generalization" (Guess, Sailor, & Baer, 1974), implied only the one issue of generalization between the repertoires. Yet the present results suggest two distinct issues, neither of which can accurately be described as generalization. "Generalization", meaning collateral changes mediated by common response elements (but cf. Stokes & Baer, 1974), is not a term appropriate to collateral changes where there are no common elements. So the term is irrelevant to the present problem. The verbal and nonverbal behavior ob-

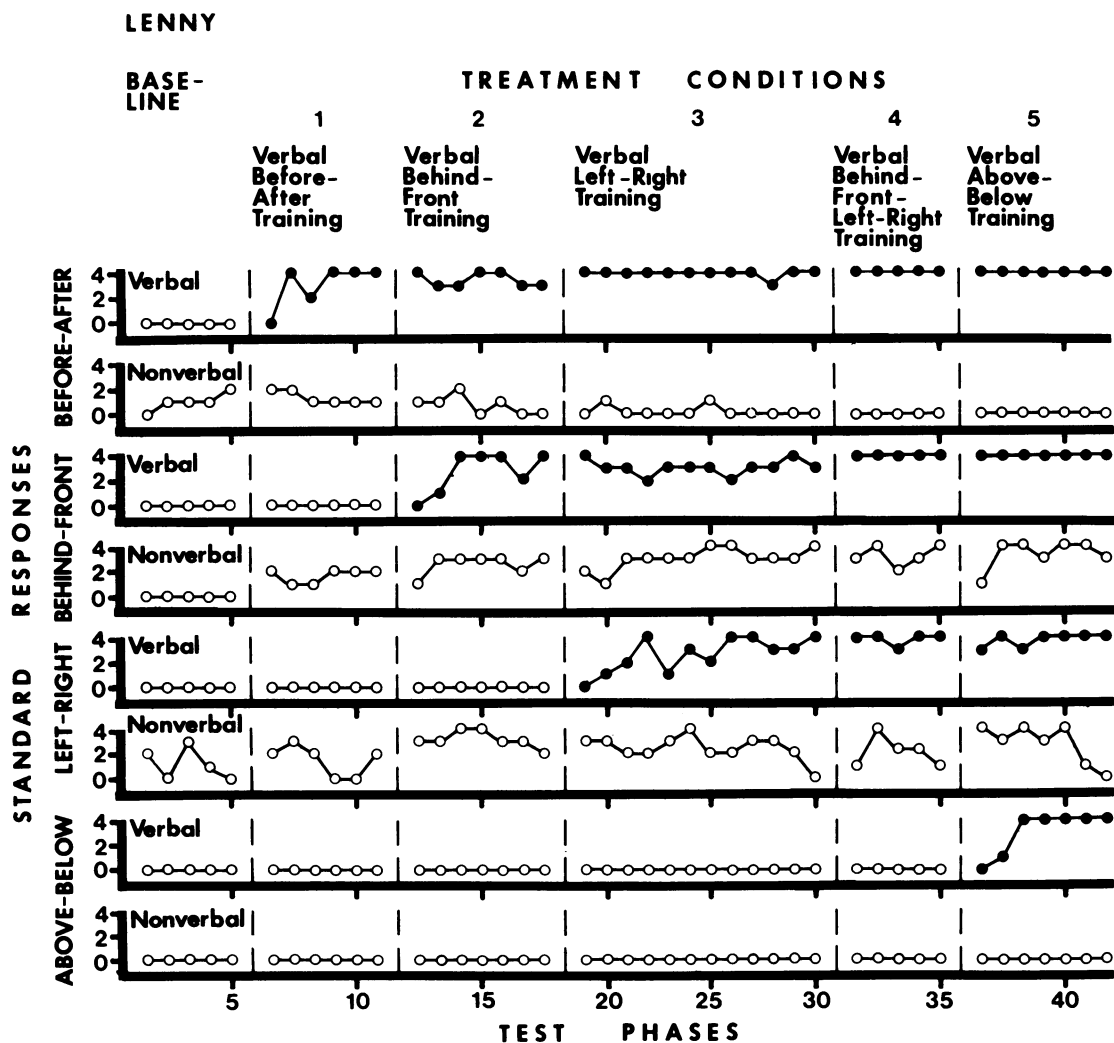


Fig. 6. Responses in test phases (Lenny).

served in these and previous experiments belonged to two topographically-distinct classes. They involved different parts of the body and shared no response elements that could mediate generalization.

As well, the term "generalization" has obscured the distinction implied by the present results between instating new topographies and modifying the stimulus control of pre-existing topographies. To understand this distinction, consider an experiment in which training standard verbal "behind" and "front" responses increases the number of standard nonverbal "behind" and "front" responses. Suppose the subject does not respond to "be-

hind" and "front" instructions with both "behind" and "front" responses before verbal training. Then an increment in standard nonverbal responses would reflect the instatement of one, or two, new topographies, at least as far as could be determined in the experimental setting. But say the subject does respond with both these topographies, though neither reliably nor always correctly. In this case, an increment in standard nonverbal responses would necessarily reflect a change in the stimulus control of pre-existing topographies.

This distinction makes the research easier to relate to Skinner's hypothesis about "the same response spoken and heard." Skinner (1957)

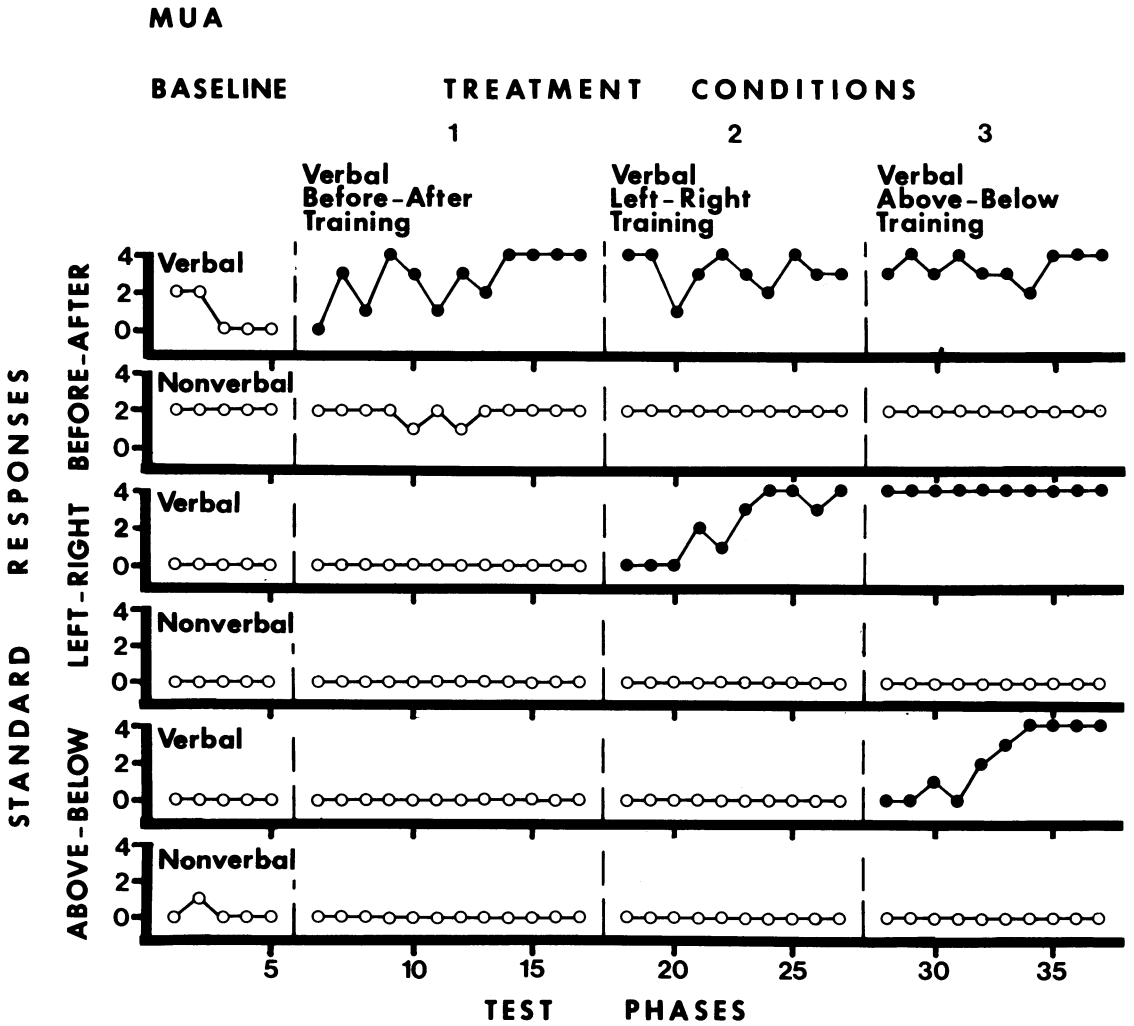


Fig. 7. Responses in test phases (Mua).

hypothesized that “the processes through which a [person] . . . becomes a listener differ . . . from those through which he [or she] becomes a speaker” (p. 195). This hypothesis implies the prediction that “in acquiring a verbal repertoire the speaker does not necessarily become a listener, and in acquiring the behavior characteristic of a listener he [or she] does not spontaneously become a speaker” (Skinner, 1957, p. 195). The present results confirmed this prediction, though they provided evidence only in the speaker-to-listener direction. Yet some earlier results seemed to contradict Skinner’s hypothesis, in suggesting that a child can become a speaker collateral to becoming a listener, and vice versa. But they seemed contradictory only because the distinction between instatement and modification was not made.

First, Guess and Baer (1973) found that correct nonverbal responses increased in number collateral to verbal training. But they reported that prior to verbal training their subjects responded at about chance level to the “singular” and “plural” instructions. This statement implies that the subjects already emitted the required instruction-following topographies of pointing to a single object or to a pair of objects in response to the instructions. If so, the increment in correct nonverbal responses reflected a change in the stimulus control of pre-existing topographies, as in the present study. Second, Whitehurst (1977) reported changes in verbal behavior collateral to nonverbal training. But his subjects had acquired the verbal topographies through a modelling procedure prior to nonverbal training, so the change in

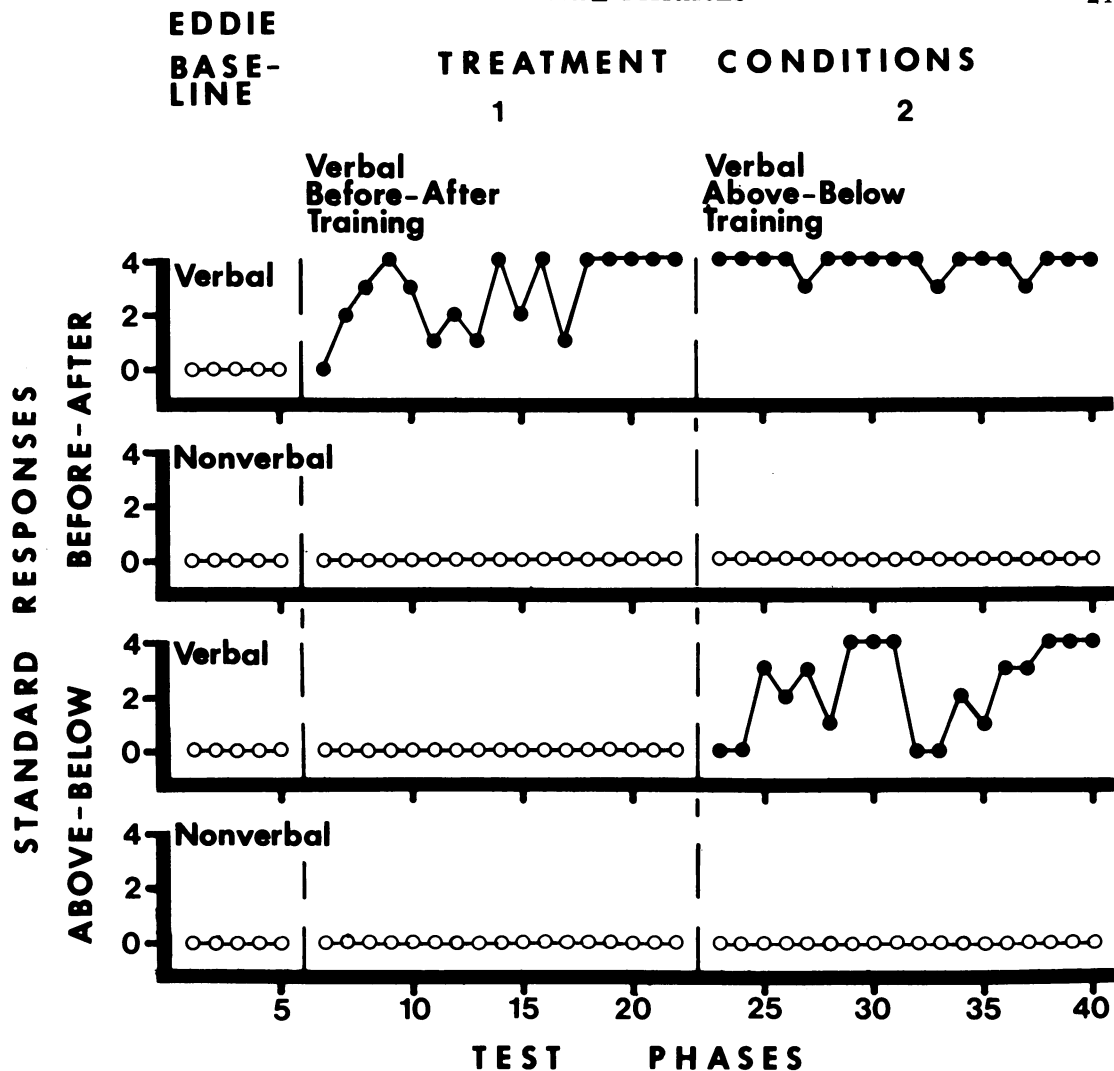


Fig. 8. Responses in test phases (Eddie).

verbal behavior reflected a change in the stimulus control of pre-existing topographies, a result not inconsistent with Skinner's hypothesis.

The only remaining inconsistency among previous studies is the increment in correct verbal responses collateral to nonverbal training for one subject (Gary) in Guess and Baer's study. In this case, the verbal topographies were not emitted in the experimental setting prior to nonverbal training. Gary was trained to produce *-es* plurals (e.g., "peaches", "bridges") and to discriminate *-s* plurals (e.g., "cups", "books"). Probes determined if, as a result of this training, he would discriminate *-es* plurals and produce *-s* plurals. Correct responses to probes for *-s* plurals increased in

number. So, it seemed that Gary produced *-s* plurals collaterally to nonverbal training. Yet Guess and Baer's scoring criteria (p. 318) meant that responses to *-s* probes were not necessarily *-s* plurals. They could have been *-s* plurals, *-es* plurals, or plurals with both an *-es* and a *-s* ending (e.g., "hat-s-es"). Also, Sailor's (1971) results suggested an alternative interpretation of Gary's performance. Sailor reported that his subjects extended *-z* plurals (e.g., "pens", "cards") to stimuli for *-s* plurals when *-z* (but not *-s*) plurals were reinforced, and vice versa. Essentially the same result would be expected with *-s* and *-es* plurals. This suggests that Gary's plural responses to *-s* probes could have been *-es* plurals, a result of training him to label *-es* stimuli with *-es* plu-

rals rather than of training him to discriminate -s plurals. In this case, Gary's performance does not unequivocally contradict Skinner's hypothesis.

To sum up, studies of the relation between verbal and nonverbal behavior with syntactic properties in common support Skinner's hypothesis about the relation between the repertoire of the individual as speaker and as listener. The reported collateral effects reflected either changes in the stimulus control of pre-existing topographies (Guess & Baer, 1973; Whitehurst, 1977; this study) or transfer within one repertoire (Guess & Baer, 1973). In the sense of acquiring new topographies, the subjects of these studies derived no advantage as speakers from their status as listeners, and vice versa. This finding implies that the syntactic behavior of the individual as speaker and as listener constitute distinct repertoires that require separate training even if they may become interrelated following acquisition of the requisite topographies. The topographical distinctiveness of the verbal and nonverbal responses implies just this conclusion and was probably the basis of Skinner's prediction that the repertoires of the individual as speaker and as listener require separate training.

Future research would be facilitated by relating the hypothesis about the same response spoken and heard to Skinner's broader hypothesis that one *formal* unit (e.g., a class of phrases) may participate in more than one *functional* unit and that acquisition of one such functional unit need not necessarily be accompanied by acquisition of the others (Skinner, 1957, pp. 187-195). This broader hypothesis fits existing findings concerning the verbal-nonverbal relation at the syntactic level. As well, it implies new experiments investigating the relation between other pairs of behavior classes with syntactic properties in common. Examples include the relation between mands (e.g., "Put the cup behind the book") and tacts (e.g., "The cup is behind the book") and between self-descriptive verbal behavior (e.g., "I put the cup behind the book") and verbal behavior descriptive of others (e.g., "You put the cup behind the book"). Further research in this direction, exploring both the collateral instatement of new topographies and the collateral modification of the stimulus control of pre-existing topographies, would

give one aspect of Skinner's (1957) theory the experimental scrutiny it deserves.

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Received October 18, 1979

Final acceptance September 15, 1980