DEVELOPMENT OF SYNTAX IN A RETARDED GIRL USING PROCEDURES OF IMITATION, REINFORCEMENT, AND MODELLING[1]

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Three experiments demonstrated the development and generalized use of a singular and plural declarative sentence in a child initially lacking sentence form responses. In each experiment, an adult(s) served as a language model(s), and consequences (sweets) were provided for imitation of the model. During training trials, an item(s) was displayed first to the model(s) then to the subject; these displays were accompanied by requests to label the item(s). Generalization was assessed by a number of probe trials that were periodically interspersed among training trials. During these trials, the subject was requested to label the displayed item(s) without any preceding labelling response from the model. Using these procedures, generalized use of a singular sentence ("That is one _____.") resulted in Experiment I, and generalized use of a plural sentence ("These are two _____.") resulted in Experiment II. In Experiment III, two models (a singular and a plural sentence model) were made available to the subject but imitation of only one model was reinforced during any one condition. Results indicated the subject labelled probe (generalization) items with the same sentence form that was modelled and reinforced during training trials.

A central issue in the experimental analysis of language is explaining the immense productivity of speech, acknowledging the fact that in grammatical development children emit a variety of new word combinations that become increasingly complex and diversified. Critics of learning theory argue that it is impossible to teach every instance in a class of language behavior, and reinforcement of stimulus-response association is an insufficient explanation of speech productivity, especially in grammatical usage (Lenneberg, 1962; Miller, 1962).

Learning theorists have offered the concept of response class (Skinner, 1938; Salzinger, 1957) to account for productivity in speech and language behavior. A response class refers to a set of responses, so organized that an operation applied to a relatively small subset of their members produces similar results in other members as well. Thus, the term refers to the fact that

there often emerges from the organism more behavior exemplifying the dimensions of his experience than that immediate experience has taught directly to him.

Recent experimental examples have been offered in support of the response class concept. Baer, Peterson, and Sherman (1967) demonstrated that teaching a non-imitative retarded child examples of motor imitation resulted in the appearance of more and different imitations than those included in the original training. A series of studies in morphological grammar have produced similar results. In each study, it has been demonstrated that rules of grammar could be taught to severely and moderately retarded children through a sequence of instructions using techniques of imitation and differential reinforcement; most importantly, the effects of training generalized to other examples of the grammatical rule that were not trained directly, as in the case for plural nouns (Guess, Sailor, Rutherford, and Baer, 1968; Guess, 1969; Sailor, 1971), adjectival inflections (Baer and Guess, 1971), and verb inflections (Schumacker and Sherman,

1970). Another recent study (Wheeler and Sulzer, 1970) showed modification of an incomplete ("telegraphic") sentence pattern, to include articles and auxiliary verbs, which generalized to untrained and novel stimuli.

It is this type of research that stresses the eventual goal of any speech training program: training must somehow produce instances of vocal-verbal behavior which have not been directly involved within the training context. This type of goal must be achieved at all levels of our present language system, including labelling, grammatical, and syntactical development. The present investigation demonstrated the development of simple declarative sentences in a girl who, before training, had acquired only single word labels in her speech. Procedures of training included imitation, differential reinforcement, and modelling. Three separate experiments were conducted in the attempt to isolate and functionally analyze the variable controlling acquisition of sentence usage, both in singular and plural form. This analysis can be viewed as a relevant extension of the above reported research dealing with other areas of "generative" speech development.

Subject and Setting

Sue, a 10-yr-old female resident in a state institution for the retarded, had been institutionalized for approximately 4 yr and was classified as severely retarded (AAMD standards). Initially, Sue was non-verbal, but before this study, had completed an intensive imitation training program in which motor and verbal imitations were trained (procedure similar to Baer, *et al.,* 1968; Lovaas, 1968). The training resulted in a small verbal repertoire consisting primarily of single word labels. Spontaneous verbal phrases or sentences were never observed or trained.

The subject was seen five days per week in 10- to 15-min sessions. Sessions were conducted in a small room containing a table, chairs, and a tape recorder. Two individuals, one acting as a model and the other as the experimenter, were

present. (The model and the experimenter were adult males). Sue was seated at the table next to the model, the experimenter sat at the end of the table closest to Sue. Scheduled response consequences included such sweets as Kool-Aid, pieces of cookies, and candy.

EXPERIMENT I

PROCEDURE

Training

An experimental check of phrase and sentence production was accomplished in a pretraining session in which Sue was shown a number of objects used later in the experiment. During this session she was asked, "What do you see?" as each item was displayed. (Sweets were noncontingently dispensed on a variable-interval 30-min schedule during this session.)

Experimental sessions consisted of both imitation training trials and probe trials. During training trials, the experimenter displayed an object (visible to both the model and Sue) and directed the following question to the model, "What do you see?". After a response from the model, the experimenter directed the same question to Sue while displaying the item. Sweets and verbal praise were delivered on a variable ratio 2 (VR 2) schedule for imitation of the model. If the subject failed to imitate the model correctly (or not at all), the experimenter waited 10 sec before going on to the next trial. Each session contained 20 training trials and all trials had the same item.

Experiment I of Table I lists the condition, session number, item used during training trials, and the model's response during these trials. The model's response during training trials varied systematically over two conditions. In Condition I, the model responded with the singular declarative sentence "That is one (*item*)". In Condition II, the model responded with a singular word label appropriate to the item displayed (*e.g.,* "hat"). A reinstatement of Condition I followed Condition II. No interaction between the experimenter and model occurred

Table I

Session-by-Session Training Description for Experiments I and II

Condition	Session	Item(s) Training	Model's Responses
Experiment I			
(I) Item in Sentence	1-2	hat	"That is one hat"
	3-4	net	"That is one net"
	5-6	book	"That is one book"
	7-9	rock	"That is one rock"
	10-11	jack	"That is one jack"
(II) Item Alone	12-13	hat	"hat"
	14-16	net	"net"
(I) Item in Sentence	17-19	book	"That is one book"
Experiment II			
(I) Items in Sentence	1-5	2 hats	"These are two hatsa"*
	6-8	2 nets	"These are two netsa"
	9-11	2 books	"These are two booksa"
(II) Items Alone	12	2 hats	"hatsa"
	13-15	2 nets	"netsa"
(I) Items in Sentence	16	2 books	"These are two booksa"
	17-18	2 rocks	"These are two rocksa"
	19-20	2 jacks	"These are two jacksa"

*Because of Sue's slight articulation problem, "sa" was added in pluralizing model labels.

other than the question-answer interaction; interaction between the model and the subject was minimal in and out of the experimental setting.

Probes

Probe trials were intermixed between imitation training trials. For probe trials, the experimenter displayed an item to Sue and asked, "What do you see?", without a preceding response from the model. No consequences were scheduled for probe responses. Probe trials that made use of trained items were intermixed among training trials each session. They consisted of two probe trials that displayed the item used in training trials during that particular session, and an additional number of probe trials that displayed, singly, those items used in training trials of previous sessions (the number of these probe trials varied between 0 and 4, depending on the number of previously trained items). Consequently, these generalization (probe) trials measured the transfer from imitation of the model to labelling of an object with the same item receiving training and other items

not receiving training. Probe trials that made use of untrained items were intermixed among the probe trials and training trials in the last session of each condition. They consisted of six items (ball, cup, toy truck, toy dog, button, stick), each individually displayed twice. In all cases, probe trials were randomly intermixed among training trials such that a probe trial was always preceded and followed by a training trial.

Scoring and Reliability

The model scored all responses. In the case of training trials, those responses matching the model's responses were scored as imitative; responses that failed to match the model were scored as non-imitative. Scoring of probe trials was based on total content (the model in this case wrote down Sue's total utterance). Correct sentence responses consisted of the use of the singular sentence and label, appropriate to the object shown (*e.g.,* "That is one hat", when a hat was displayed). Correct single word label responses consisted of the use of the appropriate one-word label for the object displayed. Per-

centages of sentence and single word labels for each type of probe were computed for each session.

Reliability measures were taken from recorded tapes of the sessions. An observer listened to a random selection of sessions (at least two sessions in each condition, including all sessions in which probes of never-trained items occurred) and scored Sue's responses according to the following instructions:

"Sue's responses have been divided into two types of responses differentially:

1. Type I responses: you will hear the question "What do you see?" and a response from the model. Immediately following this answer you will hear the same question directed to the subject. Score (+) if the subject's response is identical to the model's. Score (−) if the subject's response is not identical to the model.

2. Type II responses: these responses occur without any prior response from the model. The experimenter will direct the question "What do you see?" to the subject without directing it first to the model. On these responses record S, if you hear the phrase "That is one"; P, if you hear the phrase "These are two"; and record any of the words from the list provided which follow S or P. Record O, if you hear neither S or P, and record any word from the list which you hear.

Along with these instructions, a scoring sheet designating the sequence of Type I and II responses and list of phonetically spelled words was given to the observer. The list of words was necessary because of Sue's moderate articulation problem (*e.g.,* "tic" for *stick* and "woc" for *rock*). Other slight articulation errors were also present but a reliable distinction was possible for items labelled in the study. Reliability for imitation training trials reflects per cent agreement between observer and model for 122 trials sampled from various sessions. Reliability for probe trials reflects per cent agreement on 84 trials with representatives of both types of probe trials.

RESULTS AND DISCUSSION

Reliabilities for imitation training trials and probe trials were 98% and 88% respectively. Sue's imitation of the model during training trials is not presented graphically due to her high and stable level of imitation throughout the three conditions. Thus, in Condition I imitation of the sentence was high, while during the Condition II single-word imitation was high. Throughout the study, imitations ranged from 14 to 20 out of a possible 20 per session; the overall median number of imitations per session was 20, the mean was 19.6.

Probe results are presented in Figure 1; per cent responses of the singular sentence type and the singular one-word type are plotted over successive sessions. During the pretraining session, all items were labelled in the singular word form (100% for both types or probes). During Condition I, when the model labelled the item in sentence form, Sue responded with a high level of correct sentence usage for both types of probes; 78 to 100% on probes of trained items and 90% on probes of never-trained items.

During Condition II (model labelled the item alone), a decrease to 0% in sentence responses occurred for the two types of probes. This decrease in sentence labels corresponded directly to an increase of single word labels during probe trials. Reinstitution of Condition I (item in sentence) resulted in an increase in sentence labels for each probe type. Probe responding increased to 100% usage of sentence label for items trained in the current and previous session; 75% sentence labelling was reached on never-trained probe items. Again, a concurrent decrease to 0% in single word labelling was observed.

In each of the conditions, singular sentence and single word labelling was effected. Consequences for imitating a model's various labelling responses were provided, and imitation of the model remained consistently high. Under
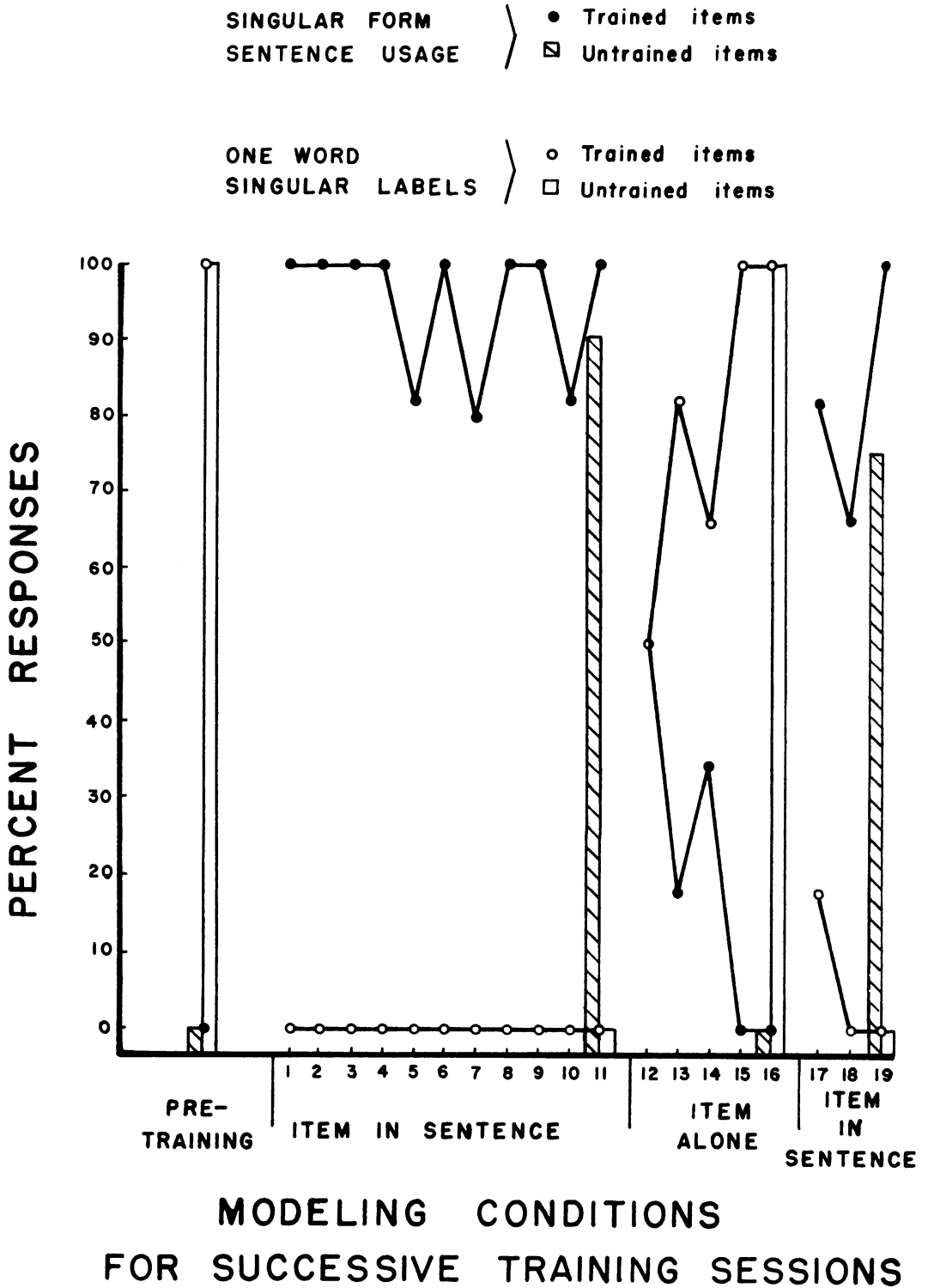
Fig. 1. The per cent of one word singular and singular form sentence labels for trained and untrained probe items are plotted over successive training sessions of Experiment I. (Modelling conditions in effect during respective sessions are labelled.)

these conditions, singular sentence and single word labelling was brought under control. Control was extended to the labelling of items not immediately preceded by a model's response (probes employing currently and previously trained items) and also to items that were never labelled by the model (probes employing never-trained items).

EXPERIMENT II

The results of Experiment I reflect the function of a model and differential reinforcement to control singular sentence labelling. The following experiment systematically replicates Experiment I by investigating the development of a simple declarative sentence in plural form with the same subject.

PROCEDURE

Training

Only two changes were made in the training procedure designed for Experiment I. Pairs of items were now displayed in all trials and the model's response was either of the plural sentence form or the single word plural form. During a pretraining session, pairs of items were individually shown to Sue simultaneously with the experimenter's question "What do you see?". Pairs of each item used in the previous study were shown twice during this session; sweets were delivered on a noncontingent basis. The training items were those used in Experiment I.

Experiment II of Table I describes the items used in imitation training trials in each session, modelling condition, and the model's response. Two modelling conditions that varied the model's response during training trials were again instituted. During Condition I, the model responded with the sentence "These are two (*item*-sa)" when shown a pair of items. (The plural label of each item was made by adding *sa* due to Sue's articulation problem.) In Condition II, the model's response was the appropri-

ate single word, plural label for the pair of objects shown (*e.g.,* "*hat*sa"). Condition I was repeated for the remaining sessions.

Probes

The probe technique and probe items used in Experiment I were again employed in this experiment except for one revision. Probe trials utilizing trained items now consisted of two probe trials displaying the item presently used in training trials and four probe trials displaying the remainder of those items used during training trials in Experiment I. Consequently, six probe trials utilized trained items each session while in Experiment I they varied in number (2 to 6), depending on the number of items used in the training trials of previous sessions.

Measurement and Reliability

Scoring and the measure of reliability was similar to that in Experiment I. Per cent agreement for training and probe response was computed for overall agreement of training and probe trials selected from random sessions of the study, including at least two sessions in each condition. Plural sentence responses were scored correct only if they included the plural sentence, "There are two (*item*-sa)," appropriate to the items displayed. Correct single word plural labels were defined as the use of the plural label appropriate to the items displayed.

RESULTS AND DISCUSSION

Reliabilities for training trials and probe trials were 92% and 84% respectively. As in Experiment I, Sue's imitation scores are not presented graphically. Unlike her performance in the previous experiment, imitation initially was low but increased rapidly from zero per session to the maximum of 20 per session in the first six sessions. After reaching this maximum, imitation never fell below 98% in any single session. Consequently, sentence imitation in Condition I was high, while single word imitation in Condition II was high.

PLURAL FORM ⟩ ● Trained items
SENTENCE USAGE ⟩ ◪ Untrained items

ONE WORD ⟩ ○ Trained items
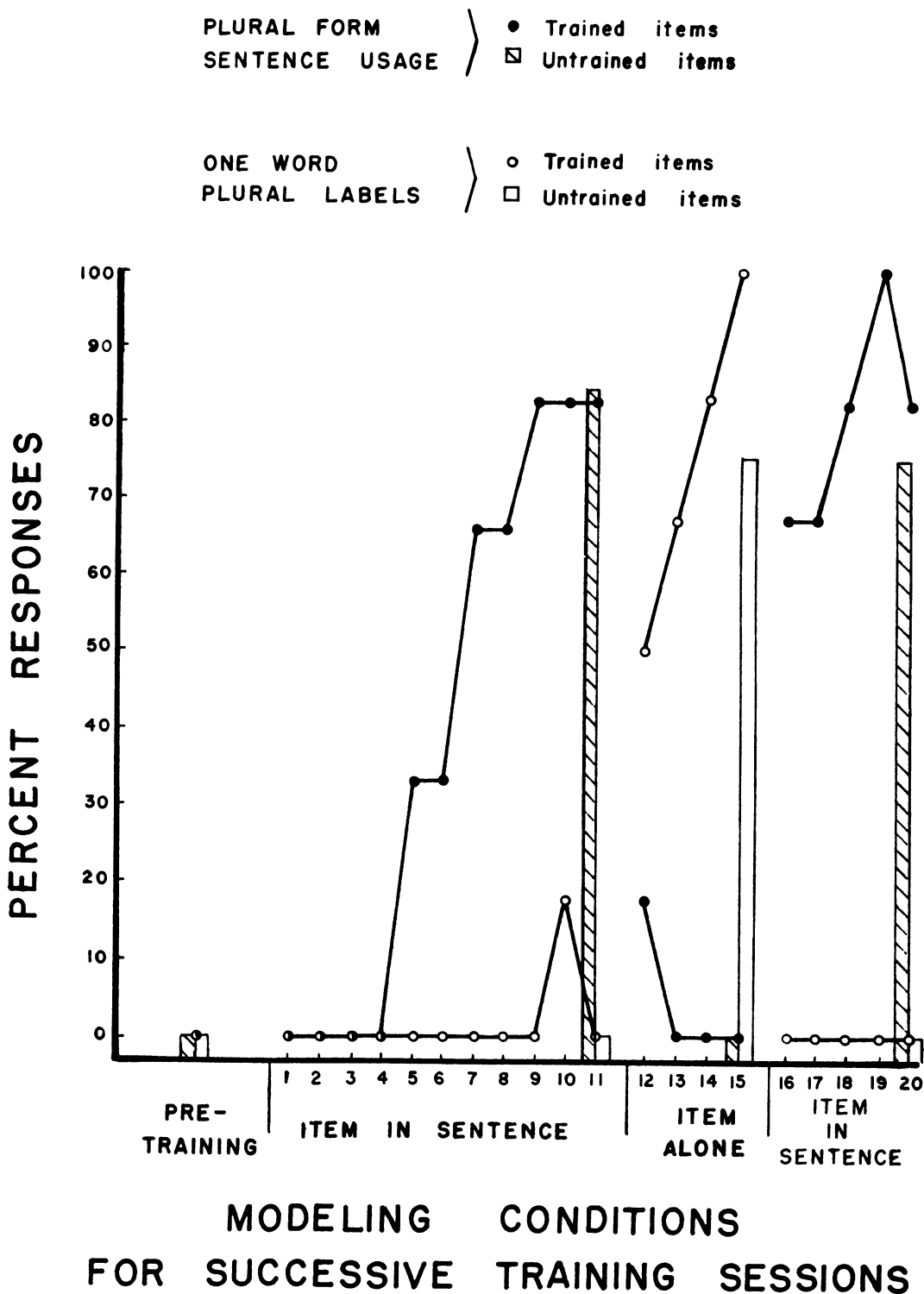PLURAL LABELS ⟩ □ Untrained items

Fig. 2. The per cent of one word plural and plural form sentence labels for trained and untrained probe items are plotted over successive training sessions of Experiment II. (Modelling conditions in effect during respective sessions are labelled.)

Probe results are plotted in Figure 2. Per cent plural one-word labels and per cent plural sentence labels for each of the two probe types are plotted across successive sessions. During the pretraining session, Sue did not respond with one-word plural nor with sentence plural labels. In Condition I, plural sentence responses increased to above 80% for both types of probes (per cent reflects the number out of six possible for trained items and the number of 12 possible for untrained items). Single word plural labels remained at 0%.

Condition II (item alone) modelled results indicate plural sentence responses for both types of probes returned to 0%; concurrently, single word plural labels increased to above 70% for both types of probes. Reinstating Condition I (item in sentence modelled) resulted in an increase in plural sentence responses for each type of probe (above 75%) and a decrease in one-word plural labels (0%).

Results of Experiment II replicate findings of the Experiment I; the use of a specific plural sentence label and single word plural label was brought under experimental control. This was the case under a set of conditions in which consequences were scheduled for specific imitations, and imitation remained consistently high. Sentence and single word labelling generalized to immediately non-modelled items with some history of model labelling (probe items employed during training trials) and to items with no history of model labelling (never-trained probe items).

EXPERIMENT III

The two previous experiments indicated the development of specific and generalized sentence usage. Neither study examined the function of the scheduled consequence for imitation of any specified labelling response. That is, just the modelling of the response might have the same effects as modelling and reinforcement of the model. The third experiment was designed to isolate this variable.

Training

The training items used in the two previous experiments were also used as training items in Experiment III. A second model (an adult male) was now introduced into the experimental situation. Each session consisted of 20 training trials in which the experimenter held up a single object and directed the question, "What do you see?" first to one model, then to the other, then finally to the subject (which model was asked first on each trial was determined randomly). One model (Model I) answered with a specific singular sentence ("That is one ————."); the other model (Model II) answered with a specific plural sentence ("These are two ————sa"). Consequence for Sue's imitation of these models varied over four successive conditions.

(a) Premeasure—During this condition, all items were displayed to Sue twice each without any response from the models and sweets were delivered on a non-contingent VI 30-sec schedule.
(b) Contingent consequences were provided for singular sentence imitation—imitation of Model I.
(c) Contingent consequences were provided for plural sentence imitation—imitation of Model II.
(d) Contingent consequences were provided for singular sentence imitation—imitation of Model I.

In each condition, an imitation was defined as a complete sentence response (all words and in the same sequence) similar to that of Model I or Model II. This measure was recorded by both models and their trial-by-trial agreement was used to compute interobserver reliability. The same objects used for training purposes in the previous experiments were also used as training items in this experiment. Table 2 lists the reinforcement condition, the item employed training, and the models' responses for each session.

Table II

Session-by-Session Training Description for Experiment III

Reinforcement Condition	Session	Item Training	Model I Response	Model II Response
Singular Model Imitation	1-11	hat	"That is one hat"	"These are two hatsa"
	12-14	net	"That is one net"	"These are two netsa"
	15-17	book	"That is one book"	"These are two booksa"
Plural Model Imitation	18-26	hat	"That is one hat"	"These are two hatsa"
	27-30	net	"That is one net"	"These are two netsa"
	31-32	book	"That is one book"	"These are two booksa"
	33-34	jack	"That is one jack"	"These are two jacksa"
	35-36	rock	"That is one rock"	"These are two rocksa"
Singular Model Imitation	37-41	hat	"That is one hat"	"These are two hatsa"
	42-43	net	"That is one net"	"These are two netsa"
	44-45	book	"That is one book"	"These are two booksa"
	46-50	jack	"That is one jack"	"These are two jacksa"
	51-54	rock	"That is one rock"	"These are two rocksa"

Probes

The probe technique was similar to that reported in the previous experiments. During a probe trial the experimenter displayed an object and directed the question, "What do you see?" to Sue without any previous response from the models. The same two types of probe trials reported in Experiment II were interspersed among training trials. During each session, six probe trials occurred consisting of displays of those items used either presently or previously in imitation training trials (two probe trials for the items presently used and one each for previously trained items; a total of six). When Sue had met 70% correct imitation criterion on an item being trained, 12 additional probe trials were interspersed in the succeeding session. These probes utilized items never before used in training trials (the same never-trained items used in Experiments I and II).

For each probe, the content of Sue's response was recorded by both models in the session and per cent of singular and plural sentence responses was computed (a singular or plural response was scored only if it was complete; "That is one ———."; "These are two ———sa."). Reliability was assessed by comparing trial-by-trial scoring agreement by the two models in 20

sessions sampled from each condition of the study.

RESULTS AND DISCUSSION

Per cent scoring agreement per session between the two models ranged between 80 to 100% (mean of 96.4%) on training trials, and 67 to 100% (mean of 86.5%) on probe trials.

Figure 3 presents both training data and probe data for successive sessions of the study. Per cent imitation of singular and plural sentences is presented for a total of 20 possible imitations per training session. Per cent singular and plural sentence responses to probe items with a training history (six trials each session) and probe items without a training history (12 trials in those sessions indicated) are also plotted. Reinforcement conditions are labelled with respect to those sessions in which they were in effect.

Training

During reinforcement for singular sentence labelling, a gradual increase was seen in Sue's singular sentence labels (from an initial 40% to near 100%). Concurrently, a decrease was seen in plural sentence labelling (from 60% to near 0%). Since scoring was based on singular, plural, or neither singular nor plural categories, these data also indicated that Sue was responding
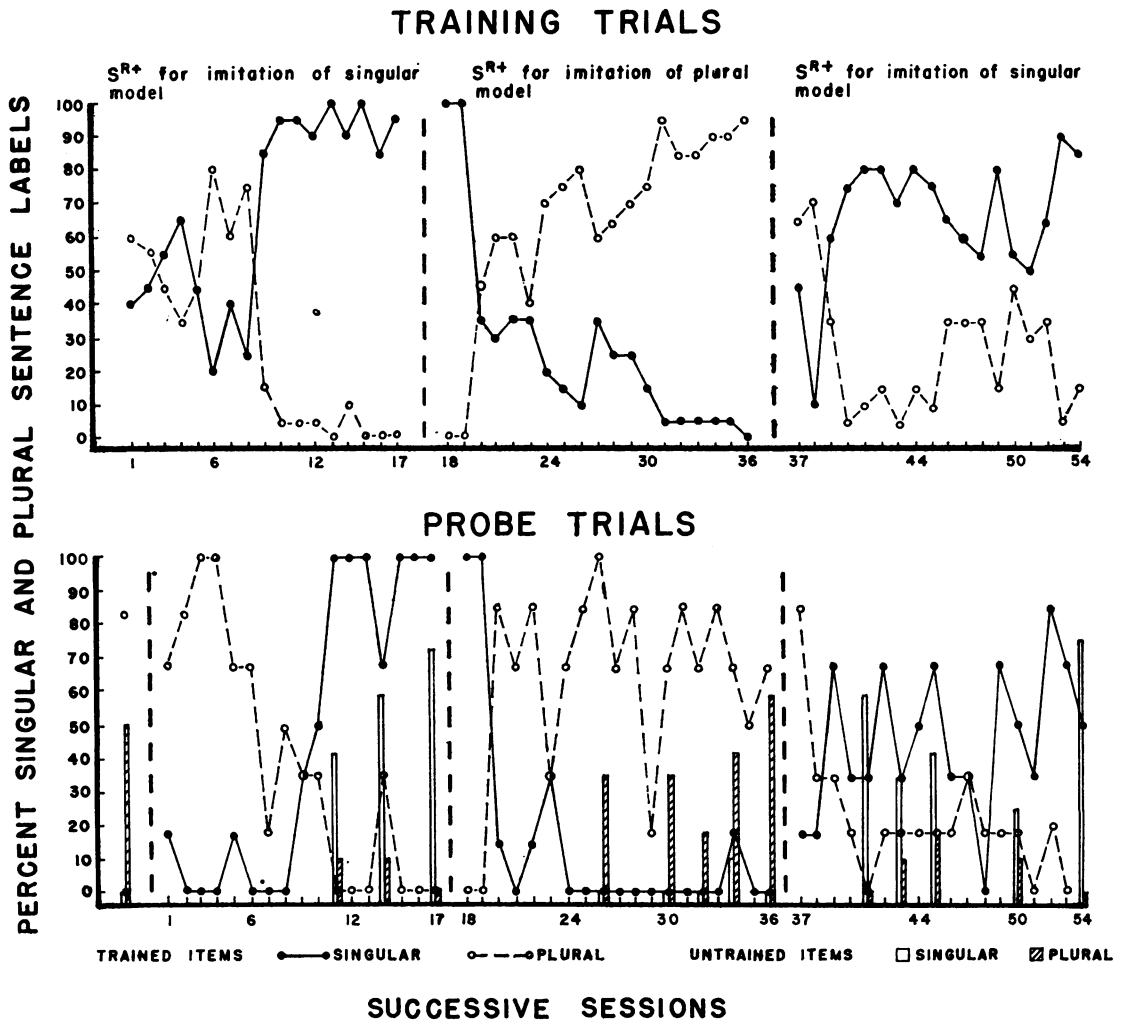
TRAINING TRIALS

Fig. 3. The per cent of singular and plural sentence labels for training and probe trials are plotted over successive sessions of Experiment III. Training trials are plotted in the upper graph with the respective reinforcement conditions labelled. Probe trials for both trained and untrained items are plotted in the lower graph.

either with a singular or plural sentence most of the time; she rarely was scored as responding in the neither category. When reinforcement was delivered contingent upon plural sentence labelling, a gradual increase is seen in plural sentence labels (from 0% to 90%); accompanying this increase is the gradual decline of singular sentence labels (from 100% to 0%). Reinstating the reinforcement contingency for singular sentence labelling resulted in an increase in the singular sentence labels (above 80%), accompanied by a decrease in plural sentence labelling (below 20%). The results in this last condition

were similar to those in the initial reinforcement condition, but, per cent singular sentence labelling did not reach as high a level, nor did plural sentence labelling reach as low a level in this last condition.

Probes

During the premeasure session, Sue responded only with a plural sentence response to both types of probes. (The plural sentence response was trained in the last condition of Experiment II.) As training to imitation of the singular sentence progressed, a shift was seen in probe

responding from plural sentence labelling to singular sentence labelling. Singular sentence labelling increased to 100% for trained probe items and 84% for untrained probe items; concurrently, plural sentence labelling decreased to 0% for both types of probes. When training (reinforcement) was shifted to plural sentence imitation, an accompanying shift to plural sentence responding reached 67% for trained items and 58% for untrained items; singular sentence responses decreased to 0% for both types of probes. Reinstating training for singular sentence imitation resulted in an increase in singular sentence probe responses to a high of 83% and 75% respectively for trained and untrained probe items. Plural sentence responding decreased to 0%. There was a failure to recover generalized singular sentence labelling to as high a level as that occurring during the initial condition in which singular sentence labelling was reinforced. This was true for probe trials utilizing both trained and untrained items. Yet, in all cases, when one type (singular or plural) of response to probe items increased, the other concurrently decreased.

These data demonstrate the function of the reinforcer in controlling selection between the sentence behavior of two models and suggest its importance in the generalized use of that sentence structure. Recent work by Steinman (1970) suggested that factors other than procedural reinforcement are operating in the production of non-reinforced imitation; it seems likely that these factors were operating here.

GENERAL DISCUSSION

The cumulative results of the present studies indicate the experimental development and control of simple syntactical usage. This form of behavior was trained in labelling a number of items; similar sentence labelling was shown to generalize beyond those items specifically trained. The training technique used modelling and differential reinforcement of imitation combined as one procedure. In each case, when this procedure was applied, accom-

panying control over non-trained exemplars of that behavior was also demonstrated.

Experiment I and Experiment II demonstrated the development of a single declarative sentence in both singular and plural form. In each of these experiments, a model was present and consequences were provided for producing the same verbal label as the model (imitation of the model). With these conditions in effect, accurate imitation was maintained and control of similar sentence labelling to items not trained was demonstrated. (The specific role of the scheduled consequences and the model in obtaining this control was not evaluated separately.) Experiment III was designed to evaluate the function of the scheduled consequences with respect to the control of the resulting singular and plural sentence labelling. Two models were provided, and consequences were arranged for imitation labelling. Two models were provided, and consequences were scheduled for imitation of first one, then the other. The results indicated imitation of the model for which consequences were provided, with control again extended to non-trained instances; accordingly, it is concluded that scheduled consequences were reinforcers.

The more interesting results concern generalized labelling in both sentence and single-word form. This exact form of generalization corresponded with reinforcement (training) of similar instance of that behavior. Consequently, a simple single sentence repertoire was developed in a child who previously did not exhibit this behavior.

In these experiments, a response similar to that of the model was termed an imitation. Yet at no time was the exact function of the model evaluated. It is conceivable that training responses were entirely under the control of their scheduled consequences (under mixed schedule control). Whether the model was in fact necessary, and if so, to what extent, remains unanswered.

The practical implications of these results are apparent; training a specific example of syntax leads to additional uses of similar syntax under

conditions not specifically trained. These results support those concerning generative mophological grammar reported by Guess, *et al.* (1968), Baer and Guess (1971), and Schumacker and Sherman (1970). In the present study, the generalized use of a simple sentence form due to similar syntactical training was demonstrated. Within a speech training program, an initial effort to train a syntactical repertoire might begin by isolating similar instances of speech used in this study. The anticipated result would be the acquisition of a simple syntactical skill. Further research in this area is needed to identify the function of similar training techniques during the direct acquisition of more complex syntactic structures and the generalization of such training.

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