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TRAINING GENERATIVE VERB USAGE BY IMITATION AND REINFORCEMENT PROCEDURES[1]

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Three retarded children were trained, using imitation and reinforcement procedures, to produce past and present tense forms of verbs in response to verbal requests. Two types of experimental sessions were arranged: training sessions and probe sessions. During training sessions, a child was trained to produce one verb in both the past and the present tense. Then, in a probe session, the generalization of this training was tested by presenting to the child a series of untrained verbs interspersed with previously trained verbs. Responses to untrained verbs were never reinforced. Training sessions alternated with probe sessions throughout a multiple baseline design involving four classes of verb inflections as the baselines. The results showed that, as past and present tense forms of verbs within an inflectional class were trained, the children correctly produced past and present tense forms of untrained verbs within this class. When verbs from two or more classes were trained, the children correctly produced the verb tenses from each of these classes. Thus, the imitation and reinforcement procedures were effective in teaching generative use of verb inflections.

In recent years, a number of published theoretical statements have attempted to account for the development of language in children. The primary emphasis in these accounts has varied considerably, from the learning theory accounts of Skinner (1957) and Staats (1968) emphasizing the role of reinforcement and imitation, to the accounts of Lenneberg (1969) and McNeil (1966), which emphasized the role of biological and innate components in language development. However, despite diversity of theoretical orientation, most students of children's language agree that very early in the development of language, children appear to exhibit "generative" repertoires. That is, children emit language that has not appeared in their repertoires previously, and that apparently has been neither directly taught nor demonstrated to them by other speakers. Ervin (1964) for example, has used the terms "analogic extension" and "building by analogy" to refer, among other things, to the occurrence of plural forms such as "feets", "foots", and "mans". Although these plural forms appear to be extensions of normal English pluralization forms to irregular forms, nevertheless, it appears unlikely that these responses were taught directly to the child, or heard by him in the speech of others. Brown and Bellugi (1964) have discussed similar phenomena under the label of "induction of the latent structure".

Most early studies of developmental linguistics have been descriptive or normative (*e.g.*, Velten, 1943; Leopold, 1953; Albright and Albright, 1958; Berko, 1958; Ervin, 1964). However, a study by Guess, Sailor, Rutherford, and Baer (1968) has provided a starting point for the experimental analysis of generative morphological development by analyzing the productive use of the plural morpheme. In this study, operant procedures were used to establish productive use of the plural morpheme in a severely retarded child with a meager verbal repertoire. After verbal imitation was established, the subject's correct imitation of labels of single and pairs of objects and her correct production of the labels without a model were reinforced. After both singular and plural labels had been taught for several objects, it was found that the subject could correctly produce plural labels for objects that had been directly taught to her only in the singular

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form. These results were replicated and elaborated in a study with two additional severely retarded subjects (Guess, 1969).

Sailor (1969) further illustrated the role that imitation and differential reinforcement can play in the formation of generative language, by analyzing the acquisition of appropriate or inappropriate pluralization. He found that subjects trained on items requiring the /-s/ allomorph for correct pluralization generalized this allomorph to the formation of plurals in words normally requiring the /-z/ allomorph. The converse was also true: subjects trained on items requiring the /-z/ allomorph generalized this allomorph to the formation of plurals of words normally requiring the /-s/ allomorph.

Wheeler and Sulzer (1970) used imitation and reinforcement procedures to teach a child to use complete sentences of a particular form in describing a set of pictures. They found that the child used complete sentences of this form when describing pictures for which he had received no direct training.

Thus, experimental research in the area of generative language, with the exception of the study by Wheeler and Sulzer (1970), has concentrated on pluralization as a case in point. The present study was designed to explore another language class, that of verb inflections, in an attempt to add further substantiation to the learning theorist's approach to the acquisition of language.

METHOD

Subjects

Three institutionalized patients from the Kansas Neurological Institute (Topeka, Kansas) served as subjects. Jimmy was an 18-yr-old boy, diagnosed as moderately retarded (I.Q. of 48 and an M.A. of six yr, 10 months). Ruth was a 14-yr-old girl, whose diagnosis was cultural familial retardation (I.Q. of 35 and an M.A. of three yr). Patty was a 16-yr-old girl, diagnosed as retarded due to prenatal maternal disease (I.Q. of 36 and an M.A. of four yr, six months).

The General Task

The generative production of the past tense and the present progressive tense of regular verbs was selected as the task to be taught. In conventional English usage, three types of regular endings or inflections can be added to verb stems to form the simple past tense, depending upon the sound or phoneme that terminates the verb stem (see Berko, 1958). Verb stems ending in most voiceless phonemes (/p/, /k/, /č/, /f/, /θ/, and /š/) require a /-t/ inflection to form the past tense, (*e.g.*, stopped, baked, touched, laughed, and splashed). Verb stems ending in voiced phonemes other than /d/ require a /-d/ inflection (*e.g.*, climbed, played, smiled, and rained). Verb stems ending in either /t/ or /d/ require a /-əd/ inflection (*e.g.*, paınted and graded).

Initially it was planned that each of the three types of inflections would be the three different past tense forms to be taught to subjects. However, during the initial phases of this study it was found that the production of the past tense form /-əd/ following the voiceless /t/ had to be taught separately from the /-əd/ ending following the voiced /d/. This became apparent when a subject who had been taught the /-əd/ inflection for a verb stem ending in a /t/ added not only the /-əd/ inflection but also the /t/ ending to a verb stem normally ending in /d/. Thus, instead of saying "lan*d*ed", the child said "lan*t*ed". The converse was also true. A subject who had been taught the /-əd/ inflection for stems ending in the voiced /d/ also added the /d/ to a stem normally ending in a /t/. Thus, the subject said "pain*d*ed" instead of "pain*t*ed". Because of these findings, two distinct behavioral classes were defined within the /-əd/ inflection for this experiment. They are hereafter referred to as the "ted" class and the "ded" class. For simplicity, the remaining two classes are referred to as the "t" class and the "d" class.

As the formation of the present progressive tense is completed through the addition of the same inflection, "ing", to all verbs, it was questionable whether several behavioral classes existed within this formation. On the assumption that these classes might exist, four classes were designated to correspond to the four past tense classes. They are: -ing following stems ending in the voiceless /t/ (*e.g.*, painting, skating); -ing following stems ending in the voiced /d/ (*e.g.*, grading, nodding); -ing following all other voiceless phonemes (*e.g.*, baking, stopping); and -ing following all other voiced phonemes (*e.g.*, playing, smiling). These classes are referred to as the "ting", the "ding", the "ing (t)", and the "ing (d)" present tense classes

and they correspond respectively to the "ted", the "ded", the "t", and the "d" past tense classes.

The verbs chosen were only those that were included in the above mentioned classes. No irregular forms (run, ran; go, went; *etc.*) were used. In order to give the subjects as much variety in their training as possible, care was taken to choose as many non-rhyming verbs as feasible.

The Pre-test

Children were chosen for this study on the basis of the following characteristics: when questioned they emitted appropriate phrases about their environments with approximately correct articulation of words but did not exhibit the proper use of regularly-formed past tense verb forms. A three-part pre-test was used to screen subjects. In the first part, the experimenter spoke with ward personnel about each child's use of the past tense. Next, the experimenter spoke with the child on the ward, actively engaged him in conversation, and asked him a series of questions about past events. ("What did you do yesterday?", "What did you do the last time you went home?", *etc.*) Finally, in an experimental room, the experimenter showed the child a series of magazine pictures depicting people and animals in action. The experimenter held up a picture and said to the child, for example, "This boy is fishing. He did the same thing yesterday. What did he do yesterday? Yesterday he . . . ?" The child was encouraged to give some form of the verb "to fish" before the next picture was presented. If the child answered with another verb, the same picture was presented once more. However, no consequences were contingent upon a correct or incorrect form of the proper verb; the experimenter merely listened to each response and recorded it. After all the pictures had been presented, the experimenter gave some candy to the child and sent him back to his ward.

The three subjects chosen for the study demonstrated no use of regular past tense formations in any part of the pre-test. However, some exhibited a few irregular forms in their conversation. Since the use of such irregular forms might rely entirely upon memorization of isolated cases (as in "I went home" and "I was in the canteen"), the children were not disqualified as subjects.

Experimental Sessions

Experimental sessions were held in a room in the research wing of the Institute. The experimental setting included: two chairs facing each other beside a small table, and a tape recorder placed close to the subject's chair with its microphone on the table. The experimenter held a notebook on her lap.

The subjects came to the experimental room once or twice each day depending on their individual class schedules. Upon arrival, the subject approached "the store", an array of small toys and penny candy, and chose an item to earn during the experimental session. He was then told how many poker chips were needed to "buy" that item; these chips and the chosen item were placed on the table and the session started. When the child had acquired all the designated chips, he traded them for the item, thus terminating the session. It was arranged that the subjects could earn at least one item per session, unless it became necessary to terminate a session due to behavioral problems (such as tantrums or refusal to respond). Experimental sessions lasted approximately 30 min.

There were two types of experimental sessions: training sessions and probe sessions. Each subject was trained on a verb in both its past and present tense form until a criterion performance was reached. Then the subject was probed to determine if this training had generalized to the production of the two tenses in untrained verbs. Another verb was then trained and the subject probed again for generalization of this training. This sequence was repeated throughout the whole experiment.

Training sessions. In these sessions, the subjects were trained not only to discriminate when to use the past or the present tense of a verb in response to verbal cues, but also to use the classes of inflections within each of these tenses. In general, the subjects were trained on verbs within one class of inflections, next on verbs within another class of inflections, and then on a discrimination between verbs of these two classes. The procedure for training one class was different from the procedure for training discrimination between classes. When one class was being trained, only one verb from that class was employed in each training session. When discrimination between two classes was being trained, one

verb from each of these classes was employed in each session. The basic format of all training consisted of the experimenter presenting a verb to the subject by saying, for example, "Now the man is painting. Yesterday he . . . ?" (or "Yesterday the man painted. Now he is . . . ?") The subject could correctly respond to this by saying, "Yesterday he painted." (Or "Now he is painting.") Verbal praise (*e.g.*, "Good boy." "That's right!" "Very good!" *etc.*) and a poker chip were given after every correct response in the training sessions. Incorrect responses were followed by, "No, that's wrong" and a 5-sec period of silence, after which the same stimuli were presented again. If the subject did not respond within 5 sec of the experimenter's request, the stimuli were presented again. If the subject failed to respond correctly after four successive presentations of the same stimuli, the experimenter modeled the correct response. The subject received praise and a poker chip for correctly imitating this response.

A variation in the form of presentation was used with both Patty and Ruth. During initial training sessions neither of the subjects seemed to discriminate between the cue words, "Now" and "Yesterday". To eliminate verbal stimuli that may have been competing with these cue words, the form of stimulus presentation was shortened for these two subjects. Presentation of the word "paint" became, "Paint. Yesterday . . ." in requiring the past tense and, "Paint. Now . . . " in requiring the present tense. The subjects could correctly respond to these presentations by saying, "Yesterday, painted" and, "Now, painting", respectively.

During training sessions, requests for the past tense and requests for the present tense were randomly sequenced in a nonalternating pattern. Training of both tenses continued until the subject met criterion performance. When the subject was trained on one verb, this performance was defined as correct responding through at least 10 successive switches, a switch being defined as a request requiring a different tense than the previous request. Because the tenses were presented in a non-alternating sequence, the subject also had to respond correctly to the interspersed non-switches. When the subject was trained to discriminate between classes, the criterion was defined as five correct consecutive responses to each verb in each tense within a random sequence. If criterion was not reached within one training session, training continued into the next session. When training the first two or three verbs within a new condition, subjects were initially given a series of 10 requests for the past tense form, then a series of 10 requests for the present tense form. The number of consecutive requests for each form was then gradually decreased until the sequence was a non-alternating sequence of requests for past and present tense forms.

Probe sessions. A probe session followed every training session in which a criterion was met. In the probe, previously trained verbs were interspersed with untrained (probe) verbs from each of the four classes of inflections. The same stimulus presentation form was used as in the training sessions. After each criterion training session, the newly trained verb plus verbs previously trained within the same class of inflections were randomly interspersed among the probe verbs on an average of one trained verb for every probe verb. For each probe session, the probe verbs were newly randomized. Thus, while the first class of inflections was being trained, the trained verbs from this class were interspersed among the probe verbs to form the complete probe. When the second class of inflections was being trained, only the trained verbs from this class were inserted into the next probe. During discrimination training between these two classes, only verbs trained in discrimination sessions were inserted into the list.

The probe lists for Ruth and Patty included 10 untrained verbs from each class of inflections. Since each verb was requested in both past and present tense form, their lists included 80 probe items. Since it was impossible to ask Jimmy for the past tense form of a verb without simultaneously presenting him with the correct present tense form, Jimmy's probe list included 15 verbs in the past tense form only, from each class of inflections. Therefore, his probe list included 60 probe items. However, Jimmy, as well as the other subjects, was required to respond in both tenses to trained verbs within the list.

Different consequences followed probe session responses to trained and untrained verbs. Correct responses to trained verbs produced verbal praise and a poker chip. Incorrect responses to trained verbs produced, "No, that's wrong", then a 5-sec period of silence, and then a repetition of the same stimuli. This was

repeated until the subject produced a correct response. Praise and poker chips were contingent on correct responses to trained verbs only. All responses to untrained verbs were followed by a short period of time in which the experimenter looked down at the recording sheet and recorded the response. Incorrect responses to untrained verbs did not result in presentation of the same stimuli. The probe session was terminated when the whole list had been presented to the subject. If 30 min elapsed before the list had been finished, the list was continued in the next session.

Scoring of Responses and Reliability

Each of the subjects' responses during training and probe sessions was written down by the experimenter. In addition, all probe sessions were tape recorded. A response to either trained or untrained verbs was scored as correct if it was inflected according to the morphological rules of spoken English. That is, a correct past tense response required the verb stem plus its appropriate inflection (verb stems ending in an unvoiced phoneme required a /-t/ inflection, verb stems ending in a voiced phoneme required a /-d/ inflection and verb stems ending in either /t/ or /d/ required an /-əd/ inflection). A correct present tense response required the correct production of the verb stem plus an "ing" inflection. All other responses (saying the verb stem with no inflection, inflecting the verb stem in ways other than that specified by English morphological rules, or saying nothing) were scored as incorrect. In addition, if a verb stem was incorrectly inflected, the experimenter recorded what type of inflection was added to the verb stem.

The tapes of probe sessions were independently scored by two research assistants to estimate the reliability of the experimenter's recording. One assistant listened to Jimmy's tapes and the other listened to Ruth's and Patty's tapes. The reliability observers were given lists of the verb stems in the order of appearance on the tapes, and recorded in writing the verb inflection (-ted, -ded, -t, -d, -ting, -ding, or -ing) they heard added to each verb stem. If no inflection was added to a word, they noted that also. Their data were compared to the data recorded by the experimenter during probe sessions. At least one probe session from each condition was compared for each subject.

Since the experimenter provided consequences for correct responses to trained verbs during probe sessions (praise and the delivery of poker chips), and these consequences were audible on the tape recordings of probe sessions, it is questionable to assume that the recordings of the reliability observers were independent of the experimenter's behavior. However, on untrained verbs, no consequences were provided for either correct or incorrect responses and thus, the scoring of the observers can be used as an independent record to estimate the reliability of the scoring of responses. For both trained and untrained verbs, an agreement was counted if both the experimenter and the reliability observer agreed on how a verb stem was inflected or if both agreed that no inflection was added to the verb stem. For Jimmy, there were 639 agreements about responses to 673 untrained verbs in the probe lists and 683 agreements about responses to 684 trained verbs in the probe lists. For Ruth, there were 665 agreements about responses to 678 untrained verbs in the probe lists and 661 agreements about responses to 662 trained verbs in the probe lists. For Patty, there were 442 agreements about responses to 452 untrained verbs in the probe lists and 459 agreements about responses to 460 trained verbs in the probe lists.

The Experimental Design

The experimental design involved multiple baselines (Baer, Wolf, and Risley, 1968), one for each of the four classes of inflections, running through several experimental conditions. The basic design was to train a series of verbs from one class (Condition I), next to train a series of verbs from a second class (Condition II), next to train a series of verb pairs, one verb from each of the first two classes (Condition III), next to train a series of verbs from a third class (Condition IV), then to train a series of verb trios, one verb from each of the first three classes (Condition V), and so forth. The criteria for changing from one training condition to the next were based upon the subjects' responses to untrained verbs. Table 1 shows the order in which classes of verbs were trained for each subject and the criteria for changing conditions.

Table 1

Multiple Baseline Design of Training Across Four Classes of Verbs for Each Subject

Conditions	*Verb Classes Involved in Training*	*Criteria for Completion of Condition*
I	Jimmy: t – ing (t) Ruth: ted – ting Patty: ted – ting	100% correct production of untrained verbs within class being trained, for two successive probes*
II	Jimmy: d – ing (d) Ruth: ded – ding Patty: t – ing (t)	100% correct production of untrained verbs within class being trained, for two successive probes.
III	Jimmy: t – ing (t) and d – ing (d) Ruth: ted – ting and ded – ding Patty: ted – ting and t – ing (t)	At least 90% correct production of untrained verbs within classes being trained, for two successive probes.
IV	Jimmy: ted – ting Ruth: t – ing (t) Patty: d – ing (d)	100% correct production of untrained verbs within classes being trained, for two successive probes.
V	Jimmy: t – ing (t); d – ing (d) and ted – ting Ruth: ted – ting; ded – ding and t – ing (t)	At least 90% correct production of untrained verbs within classes being trained, for two successive probes.
VI	Jimmy: ded – ding	100% correct production of untrained verbs within class being trained, for two successive probes.

*Due to an error, Condition I was terminated with Jimmy before he had exhibited 100% correct production to untrained verbs within the "t" class for two successive probes.

RESULTS

The procedure outlined in the Method section was used with Jimmy only after a short attempt with another procedure. First, Jimmy was taught five words simultaneously (in the present and past tenses) and then probed. The five words were from the "ted" class (float, paint, plant, bat, and lift). The probe list was presented three times after this training. Over the three probes, percentage of correct responses to untrained "ted" words decreased while the percentage of correct responses to untrained "t" and "d" words increased. These data showed no effect of the training of "ted" words, and suggested that Jimmy might have already learned to generate the past tense. To find out, he was twice given a probe list of nonsense words with which he could not have had prior contact. The list contained 15 words from each class of inflections. The results of these baseline probes are graphed in Fig. 6 as the percentage of correct responses to untrained past tense words in the probe list (probe sessions 1 and 2). Except for the "t" class, correct responses were between the 50% and 70% levels. Thus, it was concluded that although Jimmy could (correctly) produce the past tense part of the time, he had not formed complete morphological rules for the formation of the past tense with any new verb. From this point on, Jimmy was trained and probed only with nonsense words, using the procedures described in the Method section.

Training Sessions

The number of trials, plotted on a log scale (to the base 10), required to reach each successive criterion of training are shown in Fig. 1, 2, and 3 for Jimmy, Ruth and Patty, respectively. For Ruth and Patty, the number of trials required to reach criterion within each

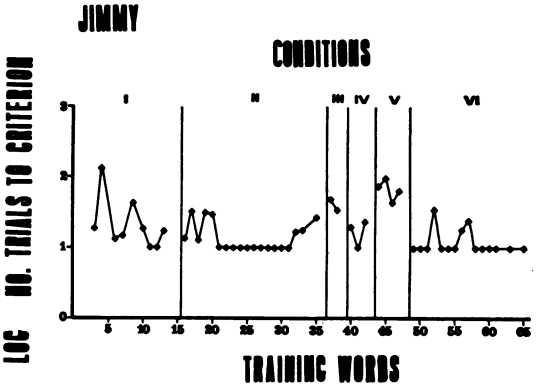

Fig. 1. (Jimmy). Number of trials to criterion for training verbs.

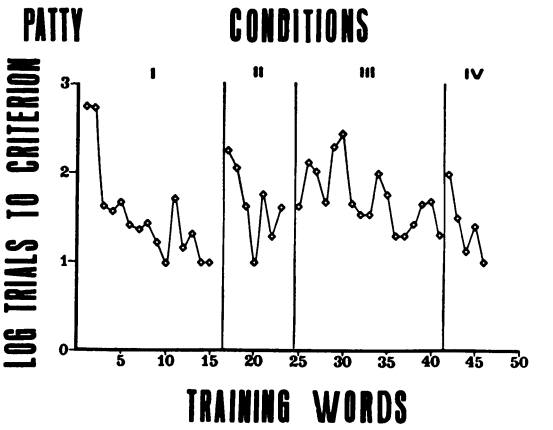

Fig. 3. (Patty). Number of trials to criterion for training verbs.

condition decreased. In addition, where only one verb was trained in each training session (Conditions I, II, and IV), both Ruth and Patty showed a decrease in the number of trials to reach criterion for the first verb over these conditions. For Jimmy, only Condition I appeared to show a decreasing number of trials to reach criterion within a condition.

Probe Sessions

Trained verbs. The percentage of correct responses to the trained verbs contained within the probe list was generally high for both past and present tense requests, for all three subjects. (As stated earlier, only verbs that had been trained within a particular condition in training sessions were interspersed with the untrained verbs in the probe list). Table 2 lists these percentages for the three subjects across the experimental conditions. It may be noted that present tense requests were usually responded to with slightly higher accuracy than past tense requests.

Table 2

Percentages of correct responses to trained verbs contained within the probe lists.

		Experimental Condition					
Subject	*Tense*	*I*	*II*	*III*	*IV*	*V*	*VI*
Jimmy	present	99	99	100	98	99	99
	past	95	93	89	94	97	99
Ruth	present	97	96	98	97	99	
	past	95	90	97	97	88	
Patty	present	92	89	99	95		
	past	86	90	89	94		

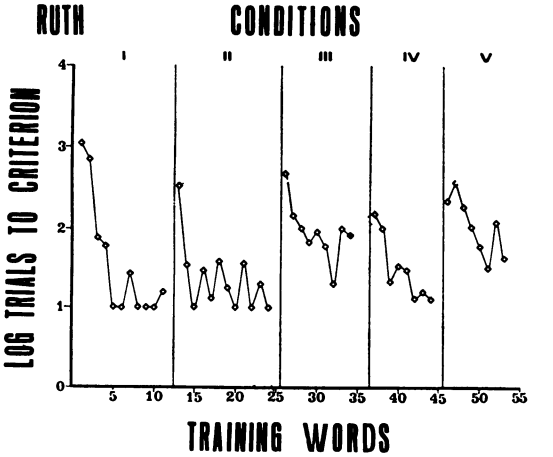

Fig. 2. (Ruth). Number of trials to criterion for training verbs.

Untrained verbs, present tense. The percentages of correct present tense responses to untrained probe verbs are shown in Fig. 4 and 5 for Ruth and Patty. (As stated earlier, the form of stimulus presentation for Jimmy in requesting past tense forms specified the correct present tense form; thus, responses with present tense inflections could not meaningfully be considered "untrained", and were not collected.) In Fig. 4 and 5, responses to untrained verbs are categorized according to the four classes of inflections: axes labeled "TING" show correct present tense responses to untrained verb stems ending in /t/; axes labeled "DING" show correct present tense responses to untrained verb stems ending in /d/; axes labeled "ING[T]" show correct present tense

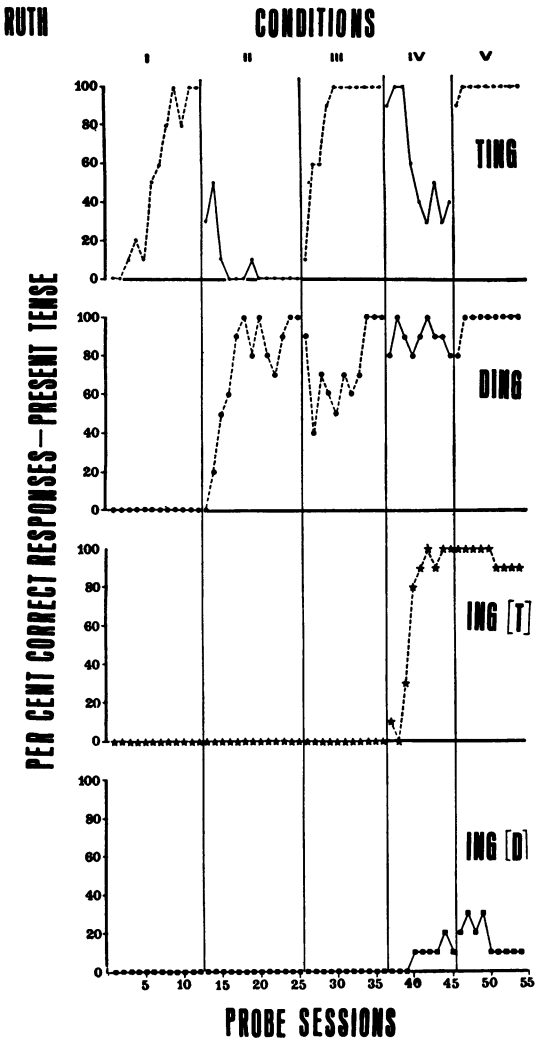

Fig. 4. (Ruth). The percentage of correct present tense responses to untrained verbs in the probe list. The dashed lines represent simultaneous training of other verbs from the same class.

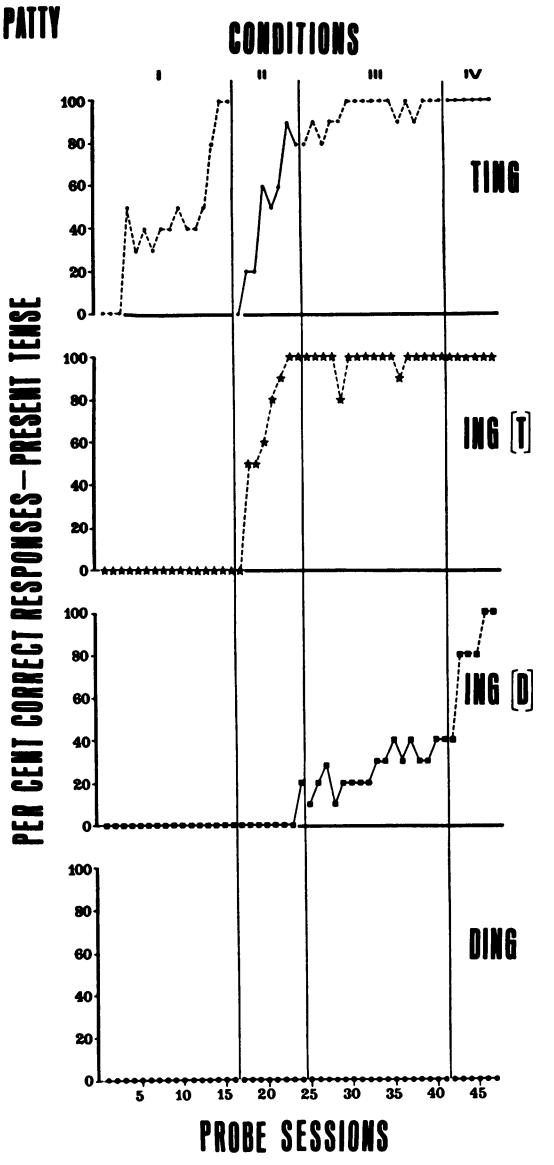

Fig. 5. (Patty). The percentage of correct present tense responses to untrained verbs in the probe list. The dashed lines represent simultaneous training of other verbs from the same class.

responses to untrained verb stems that required a /-t/ inflection to form the past tense; and axes labeled "ING[D]" show correct present tense responses to verb stems that required a /-d/ inflection to form the past tense. Each figure presents these four categories in a column, in the order (from top to bottom) in which these tense inflections were trained across conditions. In general, it can be seen that large initial increases in correct responses to untrained verbs occurred only when other verbs from that class were trained (Conditions I, II, and IV), although both Ruth and Patty showed a slight increase in correct "ing(d)" responding before the training of corresponding verbs. It is also apparent that training verbs from the second class (Condition II) produced decrements in probe performance on verbs from the first class. In Ruth's case, this decrement was reversed by the discrimination training of Condition III. In Patty's case, a considerable recovery had already occurred by the time Condition III was instituted. Training of verbs from the third class (Condition IV) dis-

rupted Ruth's performance on the first two classes somewhat, but a high level of correct performance was recovered by the discrimination training of Condition V. Patty's performance on verbs from the first two classes was not affected by the training of the third form in Condition IV.

Untrained verbs, past tense. The percentages of correct past tense responses to untrained probe verbs are shown in Fig. 6, 7, and 8 for Jimmy, Ruth, and Patty. Responses to untrained verbs are categorized according to the four classes of past tense inflections: axes labeled "T" show correct responses to untrained verbs requiring a /-t/ inflection, axes labeled "D" show correct responses to verbs requiring a /-d/ inflection; axes labeled "TED" show correct responses to verbs ending in /t/ and requiring a /-əd/ inflection; and axes labeled "DED" show correct responses to verbs ending in /d/ and requiring a /-əd/ inflection. Again, the ordering of the classes in each figure represents the sequence in which verbs from each class were trained. As was true with present tense responses to untrained verbs, large initial increases in correct past tense responses to untrained verbs generally occurred only when other verbs from the same class were trained (Conditions I, II, IV, and VI). Again, training of verbs from the second class produced decreases in correct performance of the first class (Condition II). However, these decrements were reversed by the subsequent discrimination training (Condition III). Training of verbs within the third class (Condition IV) again

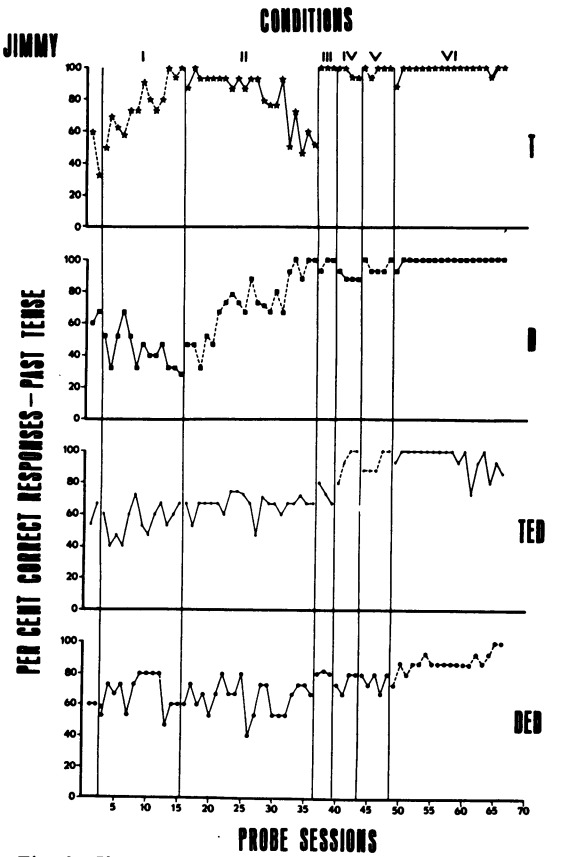

Fig. 6. (Jimmy). The percentage of correct past tense responses to untrained verbs in the probe list. The dashed lines represent simultaneous training of other verbs from the same class.

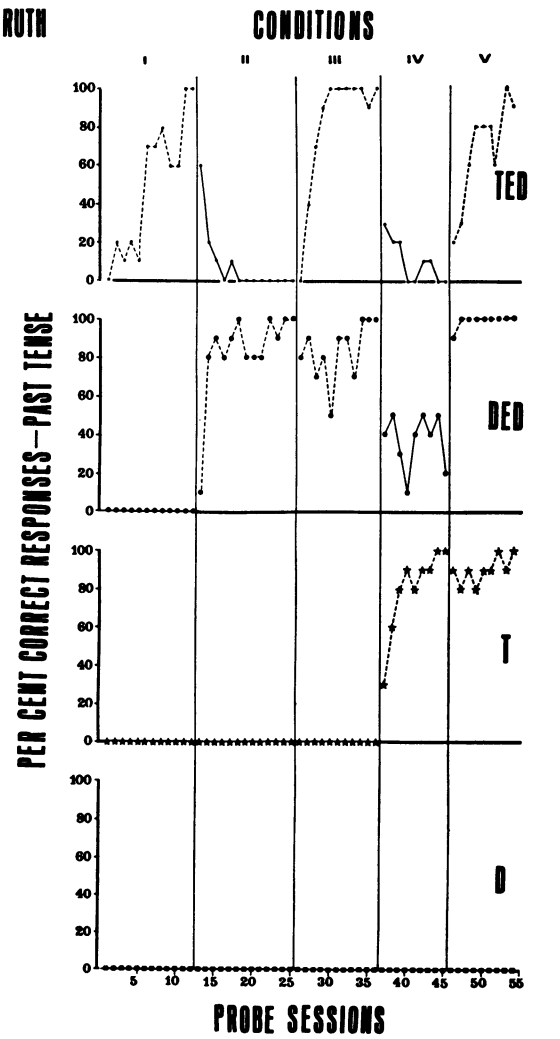

Fig. 7. (Ruth). The percentage of correct past tense responses to untrained verbs in the probe list. The dashed lines represent simultaneous training of other verbs from the same class.

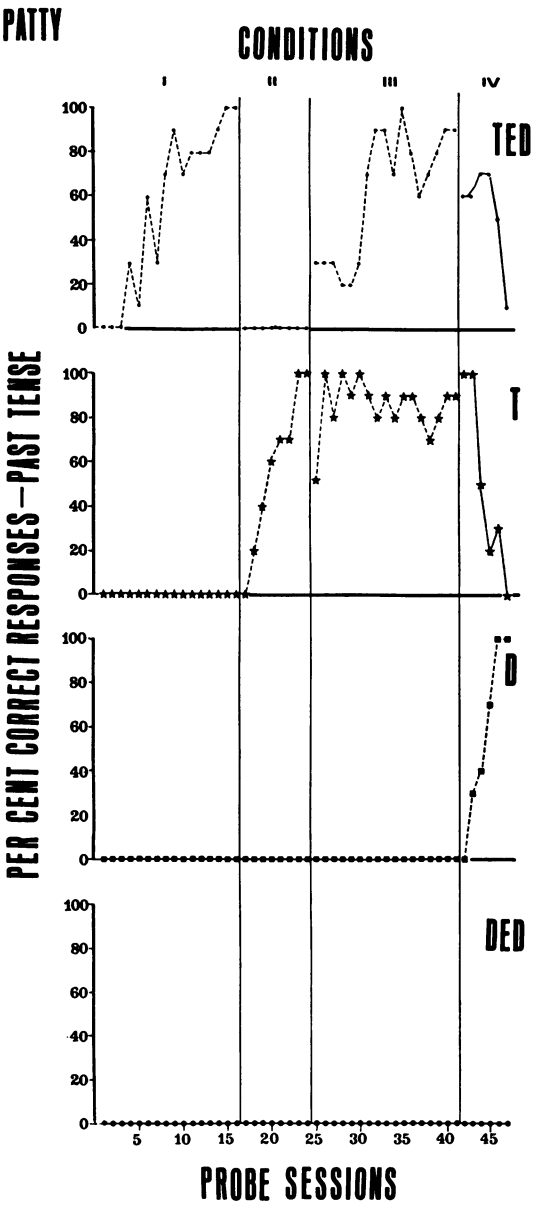

Fig. 8. (Patty). The percentage of correct past tense responses to untrained verbs in the probe list. The dashed lines represent simultaneous training of other verbs from the same class.

produced some decrements in correct responses to verbs from the first two classes, but these decrements were reversed by the following discrimination training of Condition V (except for Patty, who did not remain in the study long enough to be exposed to this condition). Jimmy alone was trained on verbs from the fourth class (Condition VI). This training was associated with a slight decrement in correct responses to untrained verbs from the "ted" class.

Generalization of trained inflections, present tense. In Fig. 4 and 5, decrements in previously trained classes were sometimes obtained with the introduction of a new class in training. This seemed to be correlated with "overgeneralization" of the inflectional form currently being trained to verbs conventionally requiring other inflections (thus, scored as an incorrect response). For example, during training of verbs within the "ting" class, a subject might produce a "present tense" form of "grade" (a verb in the "ding" class) as, "grating" and of "stop" (a verb in the "ing(t)" class) as "stopting". Figures 9 and 10 show the percentage of generalization of trained present tense inflectional forms to untrained verbs within each condition and class for Ruth and Patty, respectively. (It should be noted in Fig. 9 and 10, that generalization of the "ing(t)" inflection was scored for verbs in the "ing(d)" class when an "ing" was added to a "ing(d)" verb stem during training of "ing(t)" verbs. However, this was also scored as a correct present tense response to an untrained "ing(d)" verb, as exemplified in Fig. 4, Conditions IV and V).

Ruth, in Condition I, showed generalization of the "ting" inflection not only to untrained verbs within the "ting" class (correct generalization) but also to untrained verbs within the "ding" class and, to a lesser extent, to verbs within the "ing(t)" and "ing(d)" classes (incorrect generalizations). In Condition II, the "ding" inflection was incorrectly added to "ting" and "ing(t)" verbs and, to a lesser extent to "ing(d)" verbs. Discrimination training during Condition III produced correct use of "ting" and "ding" inflections to untrained verbs within each respective class, but also produced incorrect use of these inflections to verbs within the other two classes. Similarly, Condition IV produced correct as well as incorrect generalization of trained inflectional forms, while discrimination Condition V produced correct generalization of trained inflectional forms to untrained verbs within the three classes currently being trained, and a small degree of incorrect generalization to verbs within the "ing(d)" class.

Similar results were obtained for Patty, as shown in Fig. 10. When verbs from a class (or classes) were being trained, the subject dis-

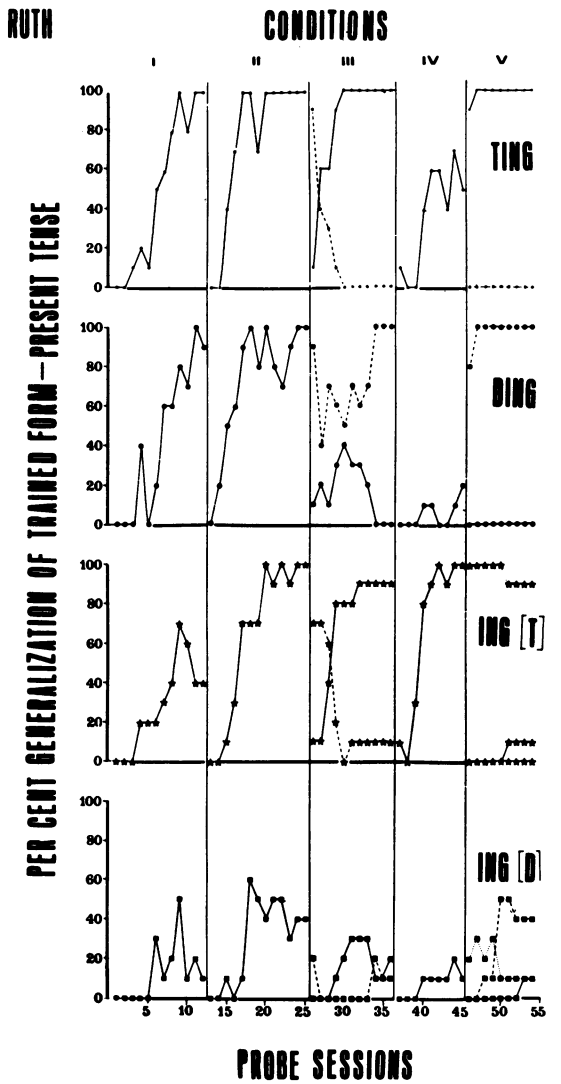

Fig. 9. (Ruth). Percentage of generalization of trained present tense inflectional forms to untrained verbs in the probe list. In Conditions I, II, and IV, the lines represent generalization of the "ting" form, the "ding" form and the "ing(t)" form, respectively. In Conditions III and V, the solid lines represent generalization of the "ting" form, the dashed lines represent generalization of the "ding" form, and the dotted lines represent generalization of the "ing(t)" form.

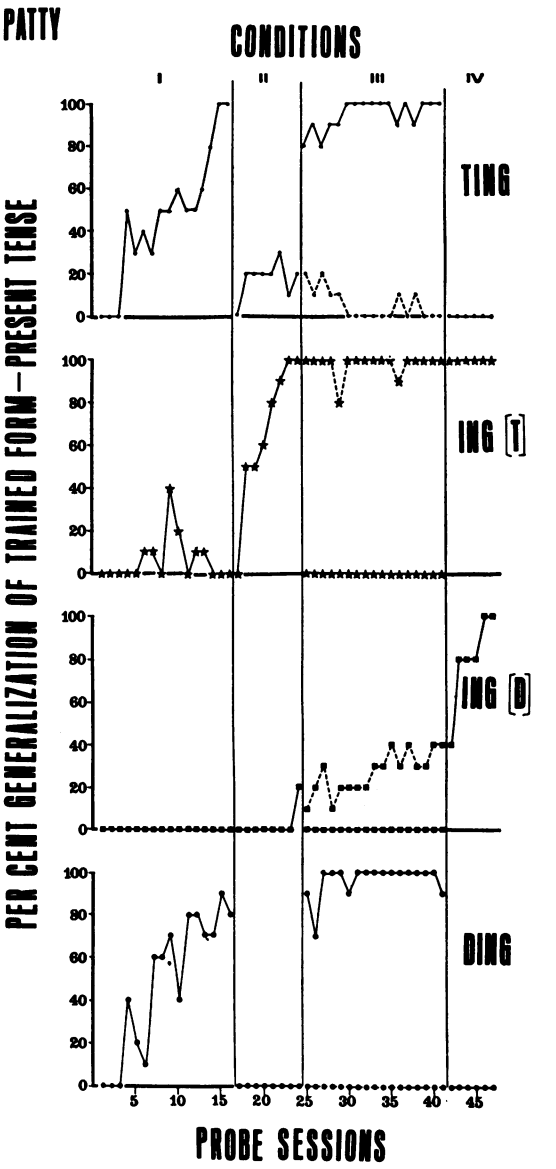

Fig. 10. (Patty). Percentage of generalization of trained present tense inflectional forms to untrained verbs in the probe list. In Conditions I, II, and IV, the lines represent generalization of the "ting" form, the "ing(t)" form and the "ing(d)" form, respectively. In Condition III, the solid lines represent generalization of the "ting" form and the dashed lines represent generalization of the "ing(t)" form.

played correct generalization of inflections to untrained verbs within that class (or classes) as well as incorrect generalization of the inflections to untrained verbs within other classes.

Generalization of trained inflections, past tense. Figures 11, 12, and 13 show the percentage of generalization of trained past tense inflectional forms to untrained verbs within each condition and class for Jimmy, Ruth, and Patty. As was the case with generalization of the present tense inflectional forms, when verbs from one class were being trained (Conditions I, II, IV, and VI for Jimmy, and Conditions I, II, and IV for Ruth and Patty), past tense inflections were correctly added to untrained verbs within this class but also were incor-

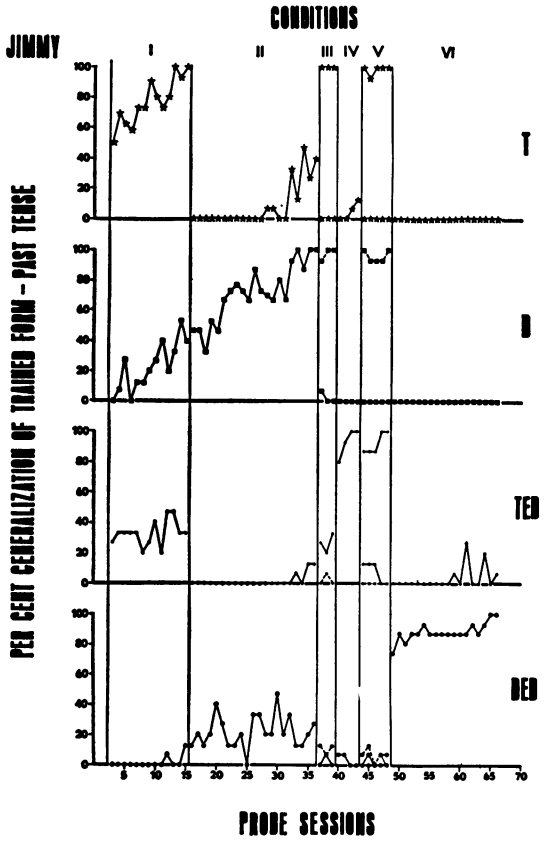

Fig. 11. (Jimmy). Percentage of generalization of trained past tense inflectional forms to untrained verbs in the probe list. In Conditions I, II, IV, and VI, the lines represent generalization of the "t" form, the "d" form, the "ted" form and the "ded" form, respectively. In Conditions III and V, the solid lines represent generalization of the "t" form, the dashed lines represent generalization of the "d" form and the dotted lines represent generalization of the "ted" form.

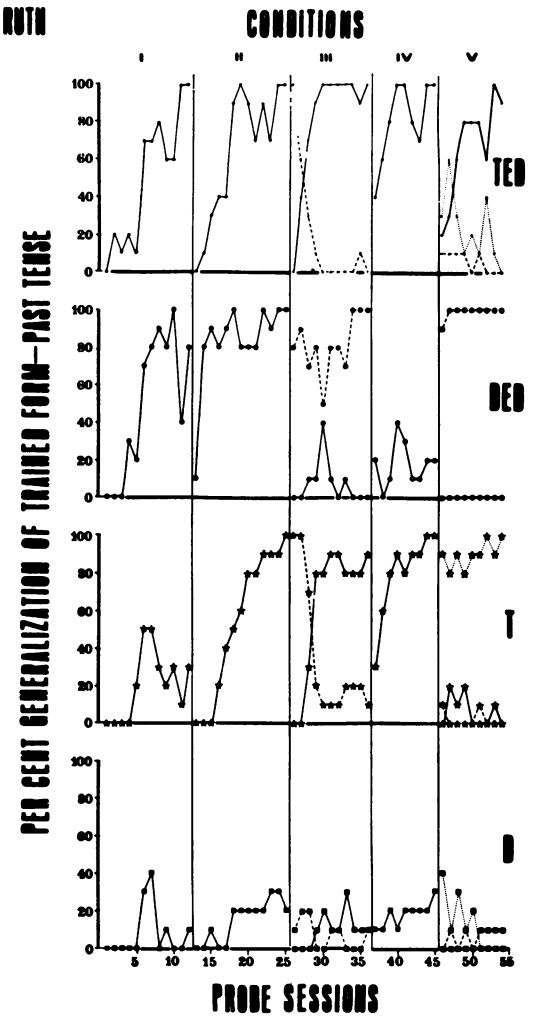

Fig. 12. (Ruth). Percentage of generalization of trained past tense inflectional forms to untrained verbs in the probe list. In Conditions I, II, and IV, the lines represent generalization of the "ted" form, the "ded" form and the "t" form, respectively. In Conditions III and V, the solid lines represent generalization of the "ted" form, the dashed lines represent generalization of the "ded" form, and the dotted lines represent generalization of the "t" form.

rectly added to untrained verbs within other classes. During discrimination training conditions (Conditions III and V for Jimmy and Ruth, and Condition III for Patty), past tense inflections were added correctly to untrained verbs within the classes currently being trained and incorrectly added to untrained verbs within the other classes. The amount of incorrect generalization of past tense inflectional forms was extensive for both Ruth and Patty, but was more limited for Jimmy, particularly during the last four training conditions. (For the purposes of scoring generalization of a trained past tense inflectional form to verbs that conventionally require other inflections, two arbitrary decisions were made. During training of verbs involving /-t/ inflection, generalization of the /-t/ inflection was scored for verb stems ending in /t/ [those verbs in the "ted" class] if a subject merely said the verb stem. Similarly, during training of verbs involving /-d/ inflections, generalization of the /-d/ inflection was scored for verb stems ending in /d/ [those verbs in the "ded" class] if a subject merely said the verb stem.)

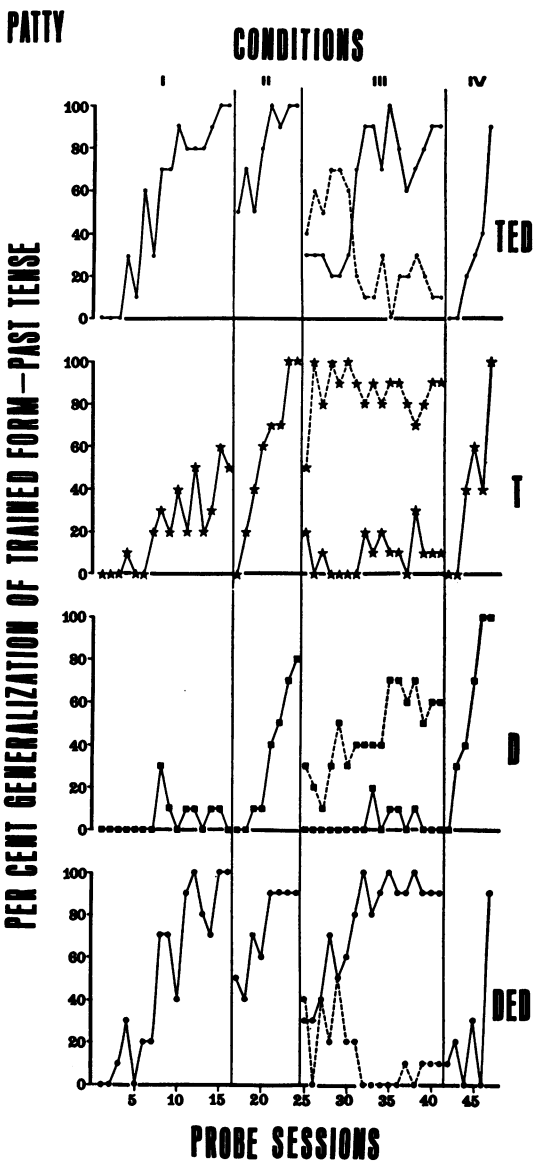

Fig. 13 (Patty). Percentage of generalization of trained past tense inflectional forms to untrained words in the probe list. In Conditions I, II, and IV, the lines represent generalization of the "ted" form, the "t" form and the "d" form, respectively. In Condition III, the solid lines represent generalization of the "ted" form and the dashed lines represent generalization of the "t" form.

DISCUSSION

The performance of the three subjects indicates that the generative use of verb inflections can be taught to retarded children through the use of imitation and differential reinforcement. As each child in this study was taught verbs within an inflectional class, he not only produced past and present tenses of trained verbs, but correctly produced past and present tense forms of untrained verbs within the class. When each child was trained in the discrimination among two or more classes of inflections, he generalized this discrimination training to verbs within these classes for which he had no prior training. Even though the three subjects learned the inflections in different orders, they appeared to learn them equally well. Furthermore, as the experiment progressed, two of the three subjects learned individual words faster. These results systematically replicate earlier work concerned with the development of generative response repertoires of plurality in retarded children (Guess *et al.*, 1968; Guess, 1969).

A further result of the present study was the generalization of trained inflectional forms to verb stems that conventionally require other inflections. This generalization was seen in all subjects, and occurred to verbs within classes that had not yet been trained as well as to verbs within classes that had been previously trained. Thus, current training conditions appeared to override past training such that verb stems that previously had been inflected correctly were now inflected with the new form currently being trained. These results are similar to those obtained by Sailor (1969) and provide a rough analogue to the systematic changes in inflectional forms exhibited by normal children in spontaneous speech (see Ervin, 1964).

In the generalization data were indications that some relationships existed between the classes of the verbs and the generalization of trained inflectional forms. A comparison of the discrimination Condition III for all subjects yields an example of this. Jimmy, who first learned the "t" and "d" inflections, generalized the "t" inflection more often than the "d" inflection to words normally receiving the "ted" inflection and generalized the "d" inflection slightly more often than the "t" inflection to words normally receiving "ded" inflections (Fig. 11). The converse was true for Ruth, whose first two classes were the "ted"-"ting" and the "ded"-"ding" classes. In Fig. 12 and 9, it can be seen that she generalized more "ted"-"ting" endings to words normally receiving "t" and "ing(t)" inflections than to words normally receiving "d" and "ing(d)" inflections. These

similar discriminations in the incorrect use of inflections may be due to similarities between the "t" and "ted" inflections and to similarities between the "d" and "ded" inflections.

On the other hand, Patty, who was trained on the "ted"-"ting" and "t"-"ing(t)" classes simultaneously in Condition III (Fig. 13 and 10), generalized more "ted"-"ting" endings to words normally receiving "ded"-"ding" endings than she generalized "t"-"ing(t)" endings to these words. She also generalized more "t"-"ing(t)" endings to words normally ending in "d"-"ing(d)" than she generalized "ted"-"ting" endings to these words. These results indicate that when the "ted"-"ting" and "t"-"ing(t)" classes are trained simultaneously, these endings are not predominantly generalized to words in each other's classes as was typical of Ruth and Jimmy. Instead, the "ted"-"ting" inflections were predominantly generalized to words in the "ded"-"ding" classes and the "t"-"ing(t)" inflections were predominantly generalized to words in the "d"-"ing(d)" classes.

The present results may also reflect some of the differences of learning the past tense *versus* the present progressive tense. With all subjects, the average percentage correct for trained words was higher for the present tense than for the past tense. In addition, both Ruth and Patty exhibited correct present tense production to untrained "ing(d)" verbs (even though this class had never been trained) during "ing(t)" training (Fig. 4, Condition IV, and V and Fig. 5, Conditions II and III) whereas no correct past tense productions to the "d" class of verbs was exhibited before training on this class (Fig. 7, Condition IV and V, and Fig. 8, Conditions II and III). These results may be attributable to the similarity among the present tense classes in that all required the same "ing" ending added to the verb stem. However, it also should be noted that neither Ruth nor Patty showed more rapid generalization of correct inflectional forms to untrained verbs in the present tense than in the past tense.

The major results of this study show how imitation and differential reinforcement may be used to teach a generative repertoire of verb inflections to retarded children. However, several important qualifications need to be stated. First, the verb inflections were taught in response to verbal cues ("Now" and "Yesterday"), not in response to temporal cues. Second, the usage of verb inflections was taught within the context of a simple sentence for only one subject (Jimmy) and for none of the subjects was verb usage taught in a "conversational" context. To approximate "normal" usage of verb inflection, they should be trained as responses to temporal, as well as verbal, cues and their usage should be established within simple sentences in a conversational context. Third, while both imitation and differential reinforcement were used in this study to teach the generative use of verb inflections, the results do not establish that these factors are responsible for the development of such language classes in normal children. It appears reasonable to suppose that models for various verb forms exist in the environments of most children and events that may serve as reinforcement do occur following a child's correct usage of various verb forms. However, whether these variables, at least partially, are functional in the "normal" development of generative repertoires is not known. Within this context, it is important to note that the training was lengthy. For example, 24 sessions of training were required to teach the present and past tense of one verb to Ruth. It appears highly unlikely that normal children in their usual environments are exposed to such systematic and concentrated training conditions. However, the present subjects were ones who, by selection, had failed to develop appropriate usage of verbs. It is perhaps the case that much more extensive and systematic training was required for them than would be required for normal children. Nevertheless, to begin to establish the functional role of speech models and differential reinforcement in the "normal" development of generative language repertoires will require evidence from a number of sources: a series of laboratory studies clearly showing the possible function of imitation and reinforcement in the development of a wide range of generative language repertoires under conditions that approximate the context of "normal" usage; precise and reliable observations of the development of various language classes in "normal" environments combined with data concerning the language models to which children are exposed and the environmental consequences of their language usage; and a number of experimental studies in which the language models presented to children and the consequences of their language are systematically manipulated in their "normal" environments.

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