JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1969, 2, 55-64 NUMBER 1 (SPRING 1969)

A FUNCTIONAL ANALYSIS OF RECEPTIVE LANGUAGE AND PRODUCTIVE SPEECH: ACQUISITION OF THE PLURAL MORPHEME[1]

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Operant conditioning procedures were applied to two retardates to establish *receptive* auditory plurals: correct pointing to single or paired objects was reinforced after hearing singular or plural labels. This training proceeded until an errorless (generative) criterion of correct performance was achieved. Unreinforced probes measuring *expressive* use of singulars and plurals were interspersed in this receptive training. Neither subject generalized from this receptive training to expressive plurals, in that each used singulars when labeling pairs. Then, both subjects were directly trained in conventional expressive plurals to an errorless (generative) criterion. The previous design was then repeated, but the receptive repertoire was reversed: pointing at pairs in response to singular labels was reinforced, and *vice-versa*. Unreinforced probes of expressive plural usage again showed its independence of the current receptive repertoire in that conventional (unreversed) plural usage was displayed. Thus, the independence of the expressive repertoire (even when unreinforced) from the reinforced patterns of the receptive repertoire was demonstrated.

A common observation in the development of language indicates that auditory comprehension or reception[2] precedes productive speech. This observation is supported by a review of both theory (Myklebust, 1957) and research (McCarthy, 1954; Fraser, Bellugi, and Brown, 1963). Of considerable interest, however, to both psychologists and linguists is the relationship between comprehending the utterances of others and the actual expression of these utterances. A commonsense analysis would suggest that receptive language is highly influential in the development of productive speech. This interpretation is also supported by the fact that, developmentally, receptive comprehension emerges before expressive verbal behavior. Indeed, several theorists (Chomsky, 1959, Lenneberg, 1967) relate both reception and production to a single set of organizing principles which are reflected in understanding and speaking.

The relationship between auditory comprehension and expressive speech is especially relevant to the development of grammar. Basically, there is some disagreement as to whether the use of grammar reflects an underlying set of rules which the child develops through maturation (Chomsky, 1959, Lenneberg, 1967), or whether the development of grammar follows an echoic model (Skinner, 1957), in which sequential language stimuli are imitated by the child. In this latter point of view, meaning or understanding is not a necessary component of learning.

In support of the first position is a case study by Lenneberg (1962), in which knowledge of grammar was evident in a boy who had a congenital disability for the acquisition of speech motor skills. In reviewing this case the author stated: "In the processes of language learning, the acquisition of grammatical rules must occur first in connection with analyzing incoming sentences; then with producing outgoing sentences" (p. 424).

Logically, any theory should account for the possibility that a child can learn grammar without having the ability to speak and, accordingly, without having imitated at the expressive speech level. This possibility would be clarified if it were demonstrated that auditory comprehension and expressive speech

[1]This paper is based in part on a dissertation submitted by the author in partial fulfillment of the Ed.D. degree at the University of Kansas. The author is grateful to his advisor, Dr. J. O. Smith for his support and encouragement in this research project. The author is also grateful to Dr. Donald M. Baer for suggestions about experimental design, and to him and Mr. Wayne Sailor, University of Kansas, for assistance in preparing the manuscript. Reprints may be obtained from the author, Kansas Neurological Institute, 3107 West 21st Street, Topeka, Kansas 66604.

[2]Reception is used synonymously with auditory comprehension in this article and productive speech is used interchangeably with expressive speech.

were two separate classes of behavior which can, but need not, be established independently from one another.

In a previous investigation, Guess, Sailor, Rutherford, and Baer (1969) applied operant procedures to teach the productive use of the plural morpheme to a severely retarded girl who, prior to the study, did not use plurals. The rapid acquisition of the plural response class in this subject raised the question as to whether or not she already had possession of this concept at the receptive level, and the reinforcers merely encouraged her to verbalize what she "already knew". Conceivably the plural morpheme, as one form of grammar, may have been present at the receptive level, even though the child gave no evidence in her productive speech of having acquired this concept.

This possibility gave rise to the present study, in which the plural morpheme was used to analyze functionally the relationship or mutual independence between understanding speech and expressing speech. The plural morpheme was chosen as the unit of analysis because of its simplicity as a grammatical rule, and because of the relative ease with which imitative control can be shifted to control of speech by object presentation.

METHOD

Selection of Subjects

It was crucial to the study that each subject did not already have a plural concept, and that he could articulate the phonemes /s/ and /z/ necessary to express plural words. A short screening test was devised to measure the use of regular plurals and the ability to produce the necessary phonemes for plural words. The initial part of the screening test consisted of 14 pictures of various objects representing words with the /s/ or /z/ sound in the initial, medial, and final positions. The following pictures were selected for this phase of the screening test: horse, bus, bicycle, whistle, glass, soap, soup, toast, glasses, dress, zebra, snake, mouse, and stove.

To test for regular plurals, the subject was shown objects, first singly, and then in pairs. The experimenter presented the single object and asked: "What do you see?". If the subject correctly identified the object, he was presented with two of the objects and again asked: "What do you see?". Should the subject fail to identify the single object correctly, the experimenter would provide the correct label, ask him to repeat it, and then present the pair of items. The following seven objects were used in testing for regular plurals requiring the allomorphs /s/ or /z/: spoon, cup, hat, car, shoe, book, and button.

Subject I. The first subject selected for the study was a 13-yr, 10-month-old male, Bob, who had been diagnosed as a Mongoloid. He had been institutionalized for approximately 7 yr. Bob had a measured IQ of 40 with a resultant mental age of 4 yr, 5 months. His expressive speech was characterized by the use of single words and short simple phrases. Bob was enrolled in a pre-school special education class at the institution where the study was performed.

Bob was given the screening test for plurals on three separate occasions before his inclusion in the study. It was evident from these tests that Bob could form the /s/ and /z/ sounds in the final position, although there was some articulation problem. The subject was subsequently referred to a speech clinician for an articulation evaluation. Results from the *Photo Articulation Test* (Pendergast, Dickey, Selmar, and Soder, 1965) indicated a moderate articulation problem, but it was again confirmed that Bob was able to form the /s/ and /z/ phonemes in the final position, which would enable him to produce regular plural words.

On the second part of the screening test, Bob failed to use correctly, regular plural words when shown two objects. On each case he responded in the singular form to the pairs of objects. Bob typically provided the correct numerical value in labeling both single and paired objects (*e.g.*, "one cup"—"two cup".)

Subject II. The second subject selected for the study was a 13 yr, 8 month old male, Ken, who also had a diagnosis of Mongolism. Ken had a measured IQ of 42 and a mental age of 4 yr, 5 months. He was quite verbal and often used simple sentences. Ken attended special education classes at the institution where he had resided for about 3.5 yr.

Ken was given the screening test for plural usage on three separate occasions before his selection as a subject; he failed to use any plural words. Like Bob, Ken had a definite articulation problem, but he too demonstrated

an ability to produce the /s/ and /z/ phonemes in the final position of words.

Setting

The study was performed in a small, soundproof room connected by a one-way mirror to an adjoining observation room. The subject was seated at a table directly across from the experimenter. A tape-recorder microphone was placed next to the subject. Each session was taped to allow later verification of scoring. Numerous small objects used in the study and a tray containing a variety of reinforcers were placed on another table in the experimental room.

Procedure

Pre-training. In Condition I, the subject was to be trained to discriminate auditorally between the auditory presentations of singular and plural words. In the process, he was to be probed repeatedly to determine whether this type of receptive language training generalized to the subject's expressive ability to produce singular or plural words. Because the probing technique (explained in a later section) was interspersed repeatedly between series of training trials and involved unreinforced responding, the subject had to be previously well adapted to not receiving a reinforcement for every correct response. The pre-training procedures were used to establish an intermittent reinforcement schedule, specifically, variable ratio 3 (VR 3). This schedule of reinforcement was used because it could accommodate the four unreinforced responses required in each probe. The subject was given a simple size discrimination task and required to point to either the "big" or "little" ball. The reinforcement schedule was expanded step-wise from FR 3 to FR 6 and then converted to a VR 3 schedule which was used throughout all further training conditions.

Chips were used as reinforcers for correct responses. The chips were redeemed at the end of each session for a variety of sweets and/or small toys contained in a tray. The subject was required to match the chips he earned in each session with stacks of chips representing the cost of each item in the tray.

Condition I. Receptive training. Receptive auditory training of the singular-plural word dimension followed the establishment of stable performance on the VR 3 schedule of reinforcement. This training followed a three-stage sequence with each object involved.

In Stage 1, a single object was placed in front of and to the right of the subject, and a pair of the same objects was placed in front and to his left. The subject was then asked to point to the object labeled in the singular form. For example, the experimenter would say: "Point to the dog." Pointing toward the single object was reinforced. If he incorrectly pointed to the pair, the experimenter said "No", objects were withdrawn from the table for 10 sec, and then replaced for the next trial. Criterion performance required three consecutive correct responses.

In Stage 2, the subject was asked to point to the object labeled in the plural ("Point to the dogs") and pointing correctly to the pair of objects was reinforced. If he pointed to the single object, the experimenter would say "No", withdraw the objects for 10 sec, and then replace them for the next trial. The criterion was again three consecutive correct responses.

In Stage 3, a random sequence of single objects and pairs of objects was presented. Criterion was met in this stage when the subject responded correctly to three singular requests and three plural requests intermixed without intervening errors.

Criterion for each stage was met before the experimenter began the next stage. Criteria on all three stages had to be met before the next object was introduced. Each new object thus required its own training series. The sample data sheet shown in Table 1 illustrates the three-stage sequence for one object and the scoring procedures used to evaluate performance in these stages.

As many as four objects were presented during some sessions. A pool of 30 different objects was used for this training. Most objects were represented by one or two syllable words.

A verbal probe for plural acquisition was given at the end of the training series for each object. For this probe, the subject was presented the object(s) of the preceding auditory training series and the object(s) to be used for the subsequent training series. The subject was first shown the single object used in the prior training task and asked: "What do you see?". He was then shown a pair of those objects and asked: "What do you see?". After that, he was presented with the object(s) to

Table 1

Sample data sheet for the receptive training of the plural morpheme, illustrating the order in which items were presented (singly or in pairs), and the recording and scoring of a performance to the criteria of receptive plural acquisition[a].

Item: *cup(s)*

Instructions to observer: Star (*) response if correct; cross it (x) if incorrect			
Stage 1 Request pointing to:		Stage 2 Request pointing to:	
*1. cup	(*etc.*)	x1. cups	(*etc.*)
*2. cup		x2. cups	
*3. cup		*3. cups	
4. cup		*4. cups	
5. cup		*5. cups	
6. cup		6. cups	
(*etc.*)		(*etc.*)	
Stage 3			
Request pointing to:			
*1. cup	(*etc.*)	(*etc.*)	(*etc.*)
*2. cup			
x3. cups			
*4. cup			
*5. cups			
*6. cup			
*7. cups			
*8. cups			
*9. cup			
10. cups			
(*etc.*)			

[a]This sample data sheet shows that the subject met the singular criterion of three consecutive correct trials on trials 1, 2, and 3 of Stage 1; that he met the plural criterion of three consecutive correct trials on trials 3, 4, and 5 of Stage 2; and that he met the criterion of three singulars and three plurals intermixed without error on trials 4 through 9 of Stage 3. To meet these three criteria required $(3 + 5 + 9) = 17$ trials; of these 17, 14 were correct, yielding a percentage correct of 82. A plural shift was not recorded for this object, in that the subject did not point correctly on the first trial of Stage 2. For early objects, meeting these criteria typically would require many more trials in each stage, and a complete data sheet therefore included more entries of potential trials. These are indicated by (*etc.*) in this table.

be used in the subsequent training task in an identical manner. Accordingly, the subject was required to give four responses during each verbal probe. These responses were not reinforced. The subject was corrected only if he mislabeled the single object.

Condition II. Productive training. The next phase consisted of expressive plural training.[3] Now, instead of pointing to the object, or objects, the subject was required to respond verbally with their singular or plural labels. The sequence of presentations was identical to that used for auditory discrimination training in Condition 1 (Table 1). The subject was now shown either one or a pair of objects and asked: "What do you see?". The same criteria were required for correct labeling responses (rather than pointing responses). There were no probes of any sort.

Condition III. Reversed receptive training. This condition consisted of reversed receptive plural training wherein reinforcers were delivered for pointing to a single object when given its plural label and for pointing to the pair of objects when presented with their singular label. Expression plural probes again were used, exactly as in Condition I.

Termination. Condition III was followed by training sessions that reversed the subject's receptive singular-plural responses and left

[3]It should be noted that Conditions II and III of the study were alternative procedures based on the findings of Condition I. If, in fact, generalization from receptive training to expressive speech had occurred in Condition I, the contingencies of reinforcement for receptive training would have been reversed in Condition II, to see if the subject's expressive usage also reversed. Condition III would have then re-reversed the reinforcement contingencies and, again, probed for changes in expressive usage.

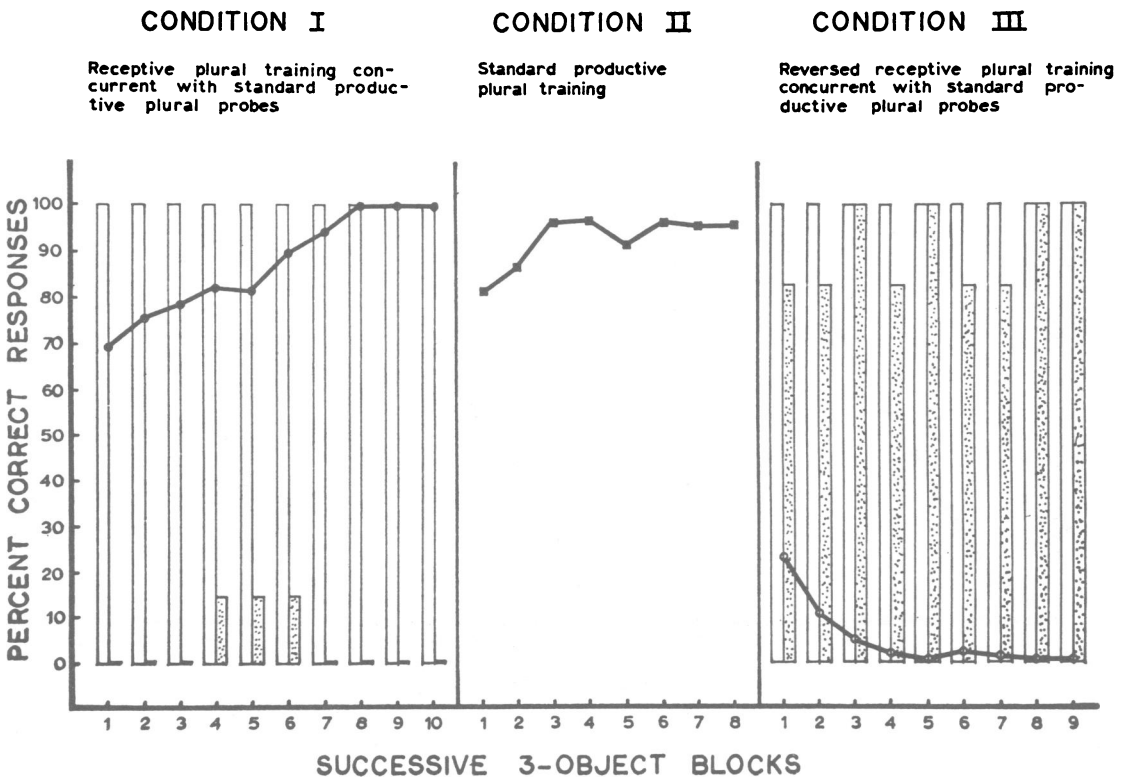

Fig. 1. (Subject 1, Bob) Per cent correct responses for training conditions and their associated probes. The graphs represent performance on the three training conditions. Each point depicts average per cent correct for three successive object training series. Expressive verbal probes are shown as bars. Each open bar represents per cent correct responses for six singular probes; each mottled bar denotes per cent correct for six plural probes.

him with a normal use of singulars and plurals at both the receptive and expressive levels.

RESULTS

Bob

A VR 3 reinforcement schedule was established in 10 sessions of the pre-training phase with Bob maintaining a high level of accurate performance on the size discrimination task.

Condition I. Receptive training with productive probes. Reliability of recording Bob's pointing to either the single object or the pair of objects was obtained by stationing an observer in the observation room. The observer used a data sheet identical to that used by the experimenter and scored Bob's responses during one training session. There was 100% agreement between the observer and experimenter for the session which included two different object training series and a total of 24 responses by Bob.

Results of the auditory discrimination training for receptive plural acquisition are presented as the percentage of correct responses in Fig. 1 (Condition I). The percentages were calculated by dividing the total number of correct responses by the total number of responses needed to meet the criteria of Stages 1, 2, and 3 for each object. (Refer to Table 1.) In order to condense the figure, each point on the graph represents the average per cent correct for three separate objects trained in succession. These data indicate a slowly improving discrimination between singular and plural words, across the 30 training series used in this condition. Errorless performance was manifest on the final three object blocks of Condition I.

A second measure of receptive discrimination of singulars and plurals is the plural shift: the subject pointing to the pair of objects on the first presentation of a plural label by the experimenter in Stage 2 (after having met criterion on the singular labels in Stage 1). Figure 2 (Condition I) shows that Bob failed to make the plural shift on the first three training series. However, only one other

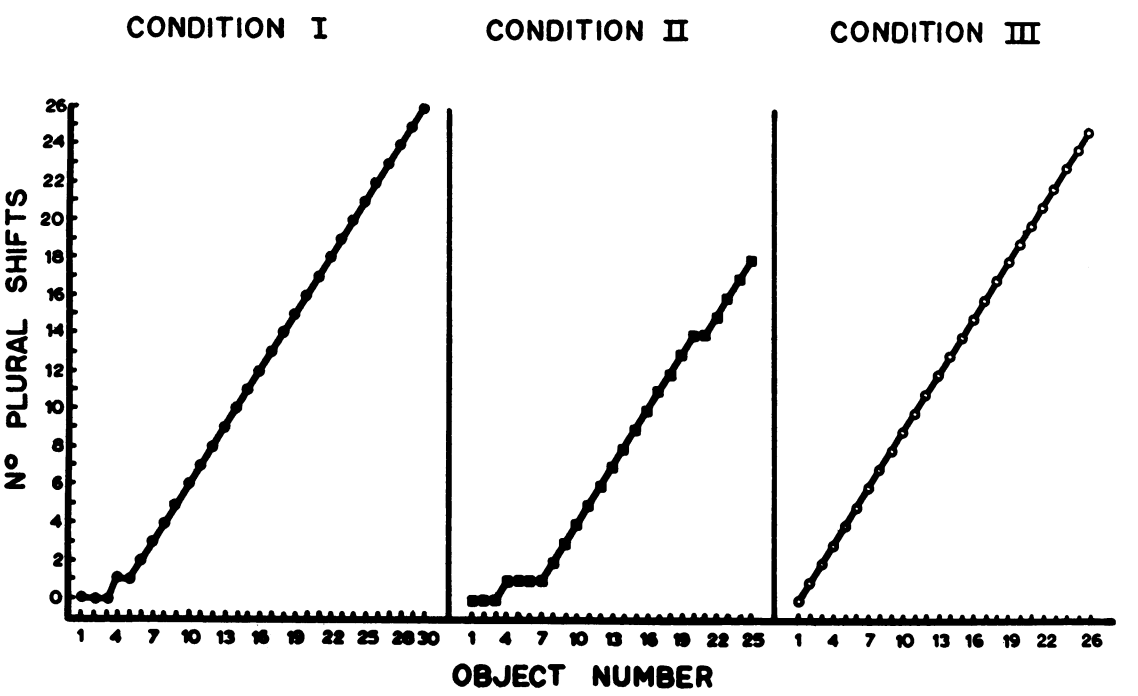

Fig. 2. (Subject 1, Bob) Number of plural shifts during the three experimental conditions. (Shifts in Condition III represent reversed plural usage; pointing to a single object in response to a plural label.)

failure (object #5) was recorded for the remaining 27 objects in this Condition.

Probes. Acquisition of productive plural usage was measured by the verbal probes interspersed between each object presentation in the receptive discrimination training. These probes encompassed the object previously trained on the receptive discrimination task, and the subsequent object to be presented for training. Performance on the expressive probes is portrayed in Fig. 1 as a series of bars superimposed over the graph of per cent correct receptive responses. These expressive probes are grouped separately for single and paired object presentations. Each open bar portrays the per cent correct responses for six singular probes (*i.e.*, probes before and after training on three separate objects). The mottled bars similarly depict per cent correct responses for the paired objects.

Reference to Fig. 1 (Condition I) indicates negligible, if any, generalization from receptive auditory discrimination training on the singular-plural dimension to expressive plural usage. With the exception of one error on Probe Block 4, Bob correctly responded to all singular items in the expressive verbal probes of Condition I. But, with the exception of three correct responses on Probe Blocks 4, 5, and 6, he failed to give plural word responses when presented with the corresponding pairs of objects.

Condition II. Productive plural training. In Condition II, the subject was required to give a singular-form verbal response when presented with a single object, and a plural response when shown two objects. For a reliability check of expressive responses in Condition I, an observer was stationed in the observation room and he, again independently, scored Bob's responses along with the experimenter. There was 100% agreement between the observer and the experimenter on 45 responses observed.

Figure 1 represents per cent correct responses during the expressive plural training of Condition II. Again, each point on the graph represents the average per cent correct for three successive training series. These percentages were calculated in a manner identical to that used to measure receptive plural training of Condition I. Bob rapidly reached a high percentage of correct responses under this training condition. The productive acquisition of expressive singulars and plurals appears to have been faster than was the re-

ceptive discrimination of singulars and plurals of Condition I.

The plural shifts shown during the expressive training of Condition II are seen in Fig. 2 (Condition II). Only one failure was observed on the final 18 object presentations of Condition II indicating, as did the per cent graph (Fig. 1), that Bob had now learned the use of expressive singulars and plurals as a grammatically generative class.

Condition III. Reversed receptive training with productive probes. After having been trained in the expressive use of singulars and plurals, the third condition was implemented to test again the original finding of Condition I: that generalization failed to occur from receptive training to expressive speech. Reinforcers were now delivered for pointing to the pair of objects when given a singular label by the experimenter, and for pointing to the single object when provided a plural label. The graph of Fig. 1 (Condition III) depicts per cent correct responses by Bob under these reversed singular-plural contingencies. The rapid decrease in per cent correct responses indicates that Bob quickly learned the reversed receptive plural contingencies of this training condition. (In viewing Condition III of Fig. 1, the reader should keep in mind that per cent correct responses, as depicted on the ordinate, refer to the normal or standard use of plurals; thus successful reversed singular-plural training is reflected in a low percentage of correct responses.)

Reversed plural shifts were also recorded in Condition III. It was noted whether Bob pointed to the single object on the first trial in Stage 2 when first given a plural label (after having already correctly pointed three times in a row to the pair of objects subsequent to singular labels in Stage 1). As can be observed from Fig. 2 (Condition III), Bob failed to make the reversed plural shift on the first object, but successfully shifted on the remaining 25 objects included in this condition.

Probes. Expressive probes were again used, concurrent with the reversed receptive training of Condition III. These probes were presented in a manner identical to Condition I. Results of these probes show errorless performance with all the singulars and a high percentage of correct plurals. Bob did not drop below 83% on any of the plural probe blocks and he achieved 100% on four of the nine blocks presented on the graph. Thus, it appears that reversed receptive training had a negligible effect on the subject's expressive speech.

Ken

A VR 3 reinforcement schedule was established within eight sessions on the size discrimination task preceding Experimental Condition I.

Condition I. Receptive training with productive probes. Reliability for pointing to the single or pair of objects met 100% agreement between the observer and experimenter for three training series totaling 52 responses.

The graph in Fig. 3 (Condition I) represents per cent correct responses for the auditory discrimination training. Points on the graph again represent the average per cent correct for three successive training series. As can be observed from this figure, Ken performed at slightly below chance for the first three training series of this condition. This was followed by a sharp rise to near-perfect performance across the remaining receptive training series.

The number of plural shifts made by Ken in Condition I are presented in Fig. 4. After two failures on Object numbers 1 and 2, Ken successfully shifted to plurals on the remaining objects presented in this condition.

Probes. The subject achieved errorless performance on the singulars of the verbal probes in Condition I (Fig. 3) but never produced a plural during this condition.

Condition II. Productive plural training. Reliability for the productive use of plurals was achieved with no disagreements between observer and experimenter across four training series encompassing 53 responses.

The effects of productive plural training are demonstrated in Fig. 3 (Condition II). As can be noted from the graph, Ken maintained 100% correct performance on the final 12 training series (Probe Blocks 6, 7, 8, and 9).

Figure 4 shows the increase in plural shifts across Condition II which substantiates findings that he had acquired a grammatically generative class.

Condition III. Reversed receptive training with productive probes. The graph in Fig. 3 shows that Ken quickly learned the reversed receptive plural contingencies of Condition III, as is reflected in the low per cent of cor-

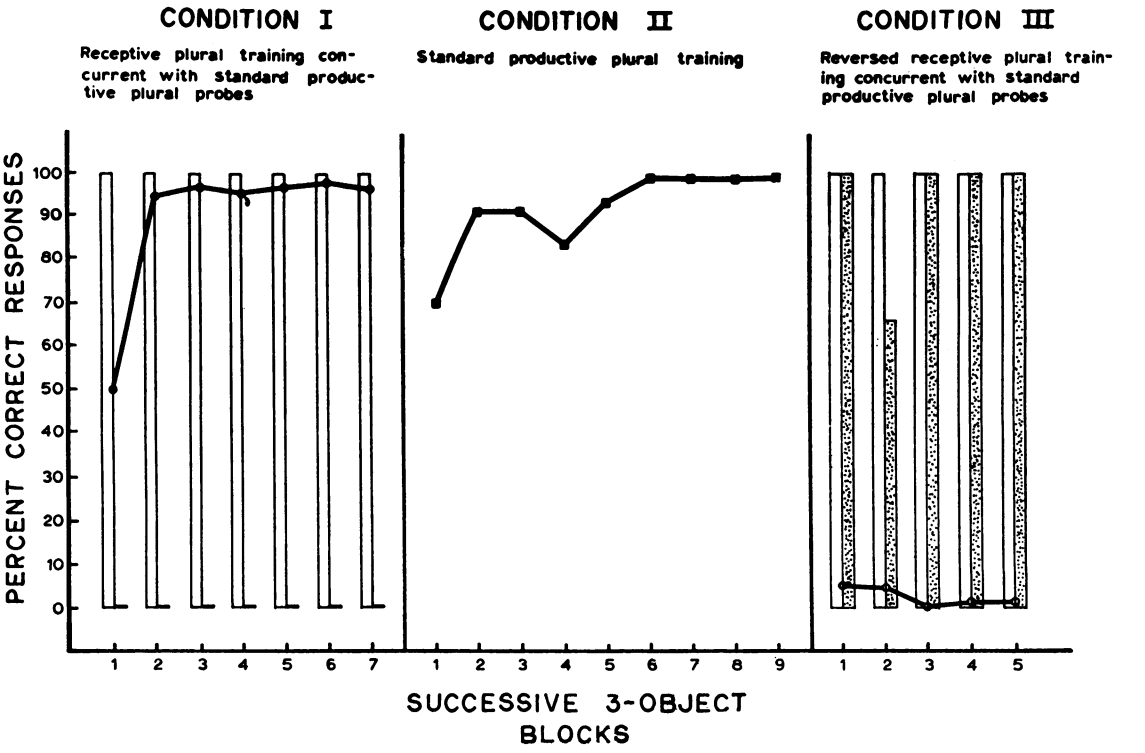

Fig. 3. (Subject 2, Ken) Per cent correct responses on the training and probe conditions. Refer to Fig. 1 for an explanation of the graphs.

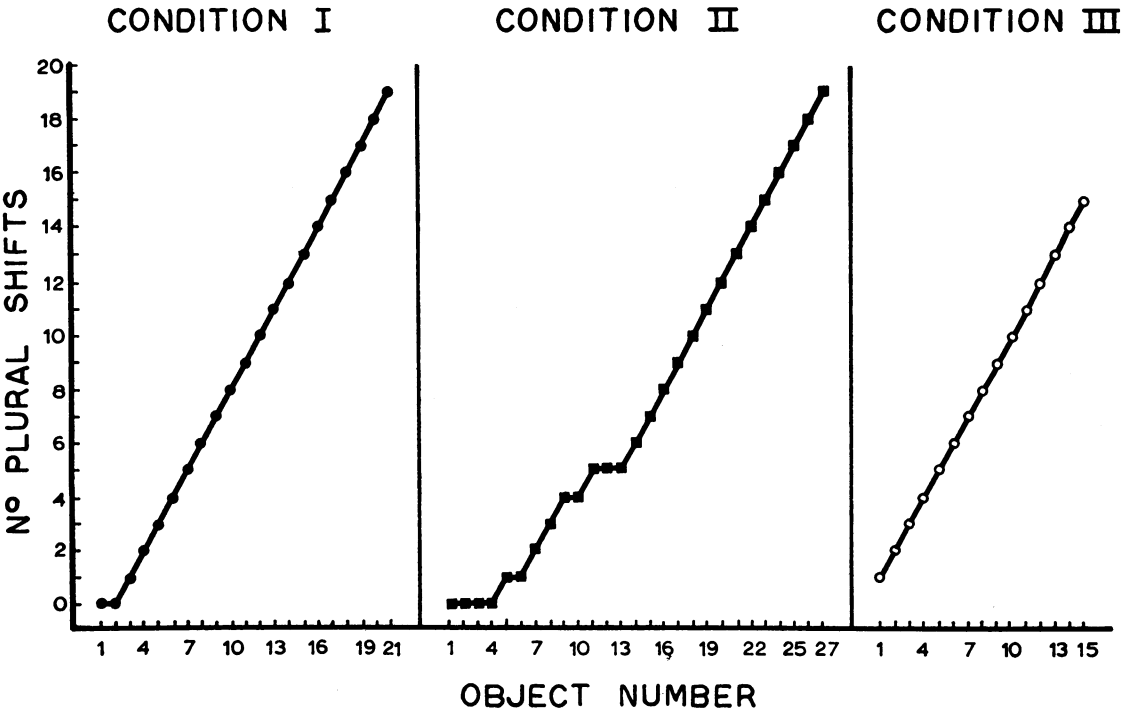

Fig. 4. (Subject 2, Ken) Number of plural shifts on the three training conditions. Refer to Fig. 2 for an explanation of the graphs.

rect responses (defined as the conventional use of singulars and plurals). It can also be observed in Fig. 4 that he made all the reversed plural shifts on the 15 objects presented in this condition.

Probes. Figure 3 shows that Ken achieved 100% correct responses on all the singular object probes of Condition III and, with the exception of Probe Block #2, also responded to all the paired objects with plurals.

DISCUSSION

Performance of the two subjects indicated that their receptive comprehension was functionally independent of their expressive speech in the grammatically productive acquisition of the plural morpheme. In Condition I, both Bob and Ken learned to make a receptive auditory discrimination between singular and plural words. The auditory discrimination of singular and plural words, even though grammatically generative, did not, however, generalize to the productive speech of either subject as measured by the concurrent probes. The two subjects were next given expressive plural training in Condition II and correctly learned to add the /s/ or /z/ phoneme to their label when shown a pair of identical objects. They became, in fact, grammatically generative in this respect. Condition III was then introduced to ask the following question: would generalization occur from *reversed* receptive plural training to productive speech now that the verbal repertoires of the subjects included the use of regular plural words as a grammatically generative class? Results of Condition III clearly refuted this possibility: each subject continued correctly to use singulars and plurals in the unreinforced expressive probes (*i.e.*, they gave the normal conventional plural response when shown a pair of objects), while at the same time they were receptively reversing their pointing response in answer to singular and plural labels from the experimenter.

The study suggests that receptive language and expressive speech can be two separate and functionally independent classes of behavior. There do exist, however, several important questions which could not be answered with the present research design. In the present study, the receptive training in Condition I may have facilitated the productive learning of plural usage in Condition II, even though direct generalization was not demonstrated in the first or third conditions of the investigation. However, the acquisition rate in the productive use of plurals for both Bob and Ken was no greater, and in fact slower, than the learning of this task for a previous subject (Guess *et al.*, 1969) who was not provided with prior training at the receptive level. Yet, in consideration of the small number of subjects available for comparison, the general role of receptive language training in facilitating the acquisition of productive speech training remains open to further experimentation.

A second question concerns the effects of productive plural training on receptive comprehension.[4] Expressive training has been shown at least sometimes to generalize to receptive discriminations (Dickerson, Girardeau, and Spradlin, 1964; Hamilton, 1966). It remains to be seen under what range of conditions the two repertoires are independent, and under what range they are dependent. There exists, for example, the interesting possibility that productive speech may be more influential in the development of receptive language than the generally assumed opposite: that receptive language precedes and guides the development of productive verbal behavior. In other words, the grammatically productive imitation of verbal sequences, exemplifying "rules of grammar" may in fact encourage a comprehension or understanding of these rules. This suggestion would certainly be at odds with those theorists who postulate that an "understanding" of the rules of grammar is a prerequisite to the production of speech in which those rules or principles are applied (Chomsky, 1959, Lenneberg, 1967).

It might be maintained that the present results are not representative of language development for non-retarded persons. A deficit rather than developmental approach could be argued for the findings. An even more ardent critic could maintain the findings were idiosyncratic to Mongolism. However, any theoretical approach should be able to account for the differential learning rates of all human

[4]This question is currently being pursued in a further study (Harrelson, Baer, and Guess, 1968) in which subjects are being trained on the productive use of plurals and probed at the receptive level. The research design is, in fact, exactly reversed from the present one.

organisms. Thus, while the present subjects may be exceptions, their performance shows at least the possibility that receptive language and productive speech may be dissociated from one another.

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Received 20 August 1968.