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AN ANALYSIS OF INDIVIDUAL DIFFERENCES IN GENERALIZATION BETWEEN RECEPTIVE AND PRODUCTIVE LANGUAGE IN RETARDED CHILDREN[1]

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Retarded subjects were taught generative pluralization rules concurrently in both the receptive and productive modalities of language. Receptive training established correct pointing to either one or a pair of objects, in response to a spoken singular or plural label of the object(s); productive training established correct spoken labels of one or a pair of objects presented visually. However, these pluralization rules were established in each modality only for a specific class of plurals: those ending in -s for one modality, those ending in -es for the other modality. This training was successful in establishing generative, or rule-governed behaviors, such that untrained examples of singulars and plurals were usually responded to correctly. Nevertheless, despite this concurrent, generative behavior, probes revealed little generalization between modalities: three of four subjects did not generalize clearly from receptive training with one class of plurals to correct productive use of that class, nor did they generalize from productive training of the other class of plurals to correct receptive response to that class. The fourth subject, however, did show strong generalization of both these types. It was concluded that automatic generalization between receptive and productive language is not necessarily an inevitable result of language training in such subjects, and therefore may require explicit, if temporary, programming, such as by direct reinforcement.

Normative studies of language development usually suggest that auditory comprehension (reception) precedes productive speech—*i.e.*, a child learns first to respond to speech and later to express himself in speech. This observation is supported by several research studies (McCarthy, 1954; Fraser, Bellugi, and Brown, 1963) and frequently appears as a statement of theory (Myklebust, 1957; Chomsky, 1967; Lenneberg, 1962). Thus, it is reasonable to ask whether the deliberate development of receptive language skills will facilitate acquisition of productive speech.

Some studies have demonstrated that the productive articulation of normal children can be improved substantially by receptive discrimination training, in the case of individual sounds (Winitz and Preisler, 1965) and lengthy nonsense words (Mann and Baer, 1971). However, some studies of retarded children have shown the reverse order of facilitation: verbal (productive) pre-training of relevant dimensions enhanced motor (receptive) performances of a match-to-sample concept formation task (Hamilton, 1966) and a geometric form discrimination task (Dickerson, Girardeau, and Spradlin, 1964).

Yet, when Guess (1969) examined the relationship between receptive language and productive speech in retarded children, using the plural morpheme as the unit of analysis, independence of the two was found. He established

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the receptive discrimination as correct pointing to single or paired objects in response to singular or plural labels, over a series of successive objects, until generalized correct performance was achieved. Unreinforced probe trials measuring the productive (spoken) use of singulars and plurals were interspersed in the receptive training sequence, to show possible generalization. Neither subject generalized from correct receptive plurals to correct productive plurals, each continuing to use singulars when labelling pairs. Next, both subjects were trained directly and quickly in correct productive plurals to an errorless criterion, thus establishing the relative ease of modifying productive plurals by direct methods (in contrast to generalization). The previous design was then repeated, but with the receptive repertoire reversed: pointing to pairs in response to singular labels was reinforced, and *vice versa,* and was quickly learned by the subjects. Again, unreinforced probes of productive plural usage showed independence from the reversed receptive repertoire just established, in that the unreversed plural usage (taught just previously) was still displayed. Thus, the independence of the productive repertoire (even when unreinforced and hence free to generalize) from the reinforced rules of the receptive repertoire was demonstrated as a substantial and easily achieved possibility.

Harrelson (*unpublished*) used the same research design as Guess, again with retarded subjects, but trained plural usage at the productive level and probed for generalization to the receptive level. His results indicated again the functional independence possible between the two language repertoires: training productive plural usage to errorless performance did not increase receptive discrimination (between singular and paired objects).

However, neither the Guess (1969) nor the Harrelson (*unpublished*) study was competent to demonstrate that training one language repertoire (either productive or receptive) would not facilitate *acquisition* of the other repertoire, even though there was no direct generalization from one to the other. Further, these studies used morphological grammar as the unit of analysis, and thus were not directly comparable to the previous research in which receptive discrimination training improved productive articulation (Winitz and Preisler, 1965; and Mann and Baer, 1971), or in which verbal pretraining enhanced related receptive discrimination (Hamilton, 1966; Dickerson *et al.,* 1964). Thus, the variety of relationships that may hold between receptive language and productive speech remains unclear: some conditions under which a functional relationship can exist have been indicated, and some other conditions allowing independence have been shown; but the dimensions connecting these conditions have not been investigated.

Consequently, to approach an integration, the present research combined some of the procedures used in previous studies. Furthermore, both receptive and productive training were scheduled concurrently, using two different classes of plurals as concurrent baselines for this training. These two classes, defined by the plural endings -s and -es[3], provided a useful experimental situation; the two topographies of response could remain constant, yet be suffixed to various nouns to discriminate singular and plural objects; and they could serve as a case for possible generalization: would a rule taught for all -es-ending plurals operate in the -s-ending plurals as well? And *vice versa?* The first question (Experiment I) was whether a plural rule would generalize between the two language modalities (receptive and productive) if *both* modalities were being maintained and extended simultaneously, a variable that had not been explored in the previous research on plural morphemes. The second question (Experiment II) was how to produce ap-

[3]The notation system used in this article follows that of ordinary orthography. Linguistically, these two inflectional endings are categorized under the plural morpheme, $\{Z_1\}$, /-z ~ -s ~ -iz/. The Gleason (1961) notation for the allomorph -s is /-s/; and for the allomorph -es, /iz/. The remaining variation of the $\{Z_1\}$ morpheme, /-z/, was not systematically evoked in the training procedures of the study.

propriate generalization, if it failed to emerge, or how to analyze any appropriate generalization that did occur.

EXPERIMENT I

METHOD

Selection of Subjects

This study required that each subject be able to label objects and articulate the -s and -es sounds necessary for plurals, but not display already generalized plural usage at either the receptive or productive level. A three-part screening test was used to accomplish this selection. (1) Subjects were requested to label 12 pictures; these labels all contained -s sounds in initial, medial, or final positions (bus, horse, dress, mouse, glass, soap, snake, soup, toast, stove, whistle, bicycle). (2) Subjects were shown 10 toy objects, each object shown both singly and as a pair. The experimenter first presented a single object, asking "What do you see?" If the subject identified the object correctly, he was shown a pair of the same objects and asked, "What do you see?". If the subject did not identify the single object correctly, the experimenter said the correct label, evoked an imitation, and then presented the pair of objects. The 10 objects used were chosen to exemplify both -s and -es plurals (cups, hats, books, spoons, rocks, horses, oranges, buses, boxes, and glasses). (3) The same 10 objects were then used to test for receptive plural responses. The experimenter placed a single object to the subject's left, and a pair of the same objects to his right, and asked the subject to point to either the singular or plural display, *e.g.,* "Point to the hat(s)." On a random half of the trials, singulars were requested; on the other half, plurals. Experimenter approval was offered occasionally during these three sections of the test, uncorrelated with any consistent response.

Each item in each part of the screening test was presented twice consecutively, and the entire test was administered three times on separate days. Subjects were selected for the study (1) if they could produce at least once per test both of the necessary terminal -s and -es sounds; (2) if they never labelled items productively in the plural form; and (3) if they responded approximately at a chance level (50%) when asked to point to singular or plural items.

The four subjects selected were residents of a state institution for the mentally retarded. All were considered severely retarded according to the A.A.M.D. classification system. Subject 1, David (CA 11), was considered retarded, but of unknown etiology; Subject 2, Dan (CA 21), Subject 3, Kevin (CA 20), and Subject 4, Gary (CA 13), were diagnosed as Down's Syndrome.

Setting

The study was conducted in a 10 by 12 ft soundproof room connected by one-way mirror and intercom system to an adjoining observation room. The subject sat at a table across from the experimenter. A microphone was hung from the ceiling directly above the table, and connected to a recording unit in the observation room. (All trials requiring a verbal response from the subject were tape-recorded to allow later verification of scoring.)

A small store containing numerous commodities, located across the hall from the experimental room, provided back-up reinforcers that could be purchased with tokens earned in the sessions.

Stimulus Objects

The training materials used in the study were 74 trios of identical objects, the labels of which are pluralized with either -s or -es endings. Forty sets of objects required -s endings in the formation of plurals; 34 sets required -es endings. Table 1 lists the objects and labels used for each plural morpheme. (It should be understood that many of the items named were toys, models, or doll house materials, as necessary for experimental convenience.)

Sessions

Training sessions were held each weekday, except for occasional illnesses or other un-

Table 1

The 40 sets of -s-ending objects and 34 sets of -es-ending objects, as labelled for all subjects.

		-s-ending Plurals		
hat	truck	cap	fork	plate
block	chip	pipe	goat	spoon
cat	rock	sock	book	rabbit
sack	boat	dart	mint	jet
stick	jack	chalk	cup	carrot
hook	bolt	hatchet	nut	mop
light	net	grape	barrette	bucket
paint	apricot	clip	butt	stamp
		-es-ending Plurals		
badge	horse	nose	dress	fish
dish	watch	sponge	fence	rose
peach	orange	branch	brush	bush
fox	squash	pouch	caboose	lettuce
wrench	patch	axe	house	box
bus	octopus	asparagus	compass	ambulance
necklace	couch	glass	bench	

avoidable absences of the subjects and experimenters. In general, each session lasted 30 min. Early in training, several sessions were often required to establish correct pointing and labelling responses to the object being trained; later, such responses often were trained to as many as four different objects, and all appropriate probes for generalization were conducted, within a single session. Each successive object trained was a new one, not previously used in training, until the 40 objects requiring -s-ending plurals and 34 objects requiring -es-ending plurals were exhausted. At those times, the objects were re-used in the same order; these cycles were repeated until the end of the study. However, evidence of generative plural usage (with both classes of plural endings, -s and -es) was examined before the lists were repeated. (If necessary, the lists could have been extended until such evidence appeared.)

Training and Probe Baselines

The basic experimental procedures consisted of concurrent training of both speech (labelling) and receptive comprehension (pointing), as separate training baselines representing the basic modalities of language. Training in one baseline (modality) was restricted to objects requiring -s endings for pluralization (*e.g.*, hat/hats, cup/cups); training in the other baseline (modality) was restricted to objects requiring -es endings for pluralization (*e.g.*, bus/buses, horse/horses).

Possible generalization of either type of training to the other modality (within the same plural-ending baseline) was measured by repeated probes interspersed among training trials within each training baseline. These probes were presented in the response modality opposite to the one being trained in that baseline. Thus, probes in the productive (labelling) training baseline were presented as receptive (pointing) trials; probes in the receptive (pointing) training baseline were presented as productive (labelling) trials. The objects used for probes were chosen to represent words that are always pluralized in conventional English with the same ending (-s or -es) characterizing the training baseline in which they were inserted. These repeated probes thus constituted two further baselines, in addition to the training baselines in which they were inserted.

Two subjects were trained to use -s-ending plurals productively and respond to -es-ending plurals receptively. For one of these subjects, the first item of each session was taught productively, and the second receptively (alternating there-

after); for the other subject, the reverse order was used. Two other subjects were trained to use -es-ending plurals productively and respond to -s-ending plurals receptively. For one of these subjects, the first item of each session was taught productively, and the second receptively (alternating thereafter); for the other subject, the reverse order was used. This counter-balancing of the plural endings, the modalities of the two training and two probe baselines, and the sequence of trainings across subjects, is shown in Table 2.

Specific Procedures

Reinforcers. Plastic tokens and verbal praise were used as reinforcers for correct responses. The tokens were redeemed for a variety of sweets, toys, games, articles of clothing, records, after-shave lotion, rings, and privileges (*e.g.,* trips to a local candy store). The cost of these back-up items ranged from 1 to 75 tokens. The tokens could be traded for their back-up items only at the end of each session, as defined by the experimenter.

Pretraining. The experimental design required that the probes (usually unreinforced) be interspersed within a sequence of training trials. Thus, it was necessary to adapt the subject to nonreinforcement of some correct responses. A simple size-discrimination task was used as a preliminary problem in which to establish an intermittent reinforcement schedule, specifically, variable ratio 3 (VR 3). The subject was shown two balls, and received reinforcement for pointing to either the small (4-in. diameter) or the big (12-in.) one, as requested in random order by the experimenter, who said, "Point to the big (little) ball." The reinforcement schedule was extended from fixed ratio 1 to fixed ratio 6, and then converted to VR 3. Thereafter, all further training conditions (described next), after establishing the initial labelling and/or pointing responses to be trained, used a schedule approximately VR 2 to accommodate probe trials.

Receptive plural training. The procedures for receptive plural training were identical for items requiring either -s or -es pluralization. Training followed a three-stage sequence with each object involved.

In Stage 1, a single object was placed to one side of the subject, and a pair of the same objects was placed to his other side. (The left-right positions of the single and paired objects were varied randomly over the training trials.) The subject was then asked to point to the object labelled by the experimenter in the singular form (*e.g.,* "Point to the cup."). If the subject pointed to the single object, he received reinforcement. If he pointed incorrectly to the pairs of objects, the experimenter said "No", withdrew the objects from the table for 10 sec, and then replaced them for the next trial. If no response was given within 5 sec, the Experimenter repeated the request, every 5 sec if necessary,

Table 2

Assignment of -s and -es plural endings to the training baselines and probes, and initial sequence of training procedures, across subjects.

Subject	*Initial Sequence*	*Plural Ending*	*Training Baselines*	*Probe*
S1, David	first object	-s	productive	receptive
	second object	-es	receptive	productive
S2, Dan	first object	-es	productive	receptive
	second object	-s	receptive	productive
S3, Kevin	first object	-es	receptive	productive
	second object	-s	productive	receptive
S4, Gary	first object	-s	receptive	productive
	second object	-es	productive	receptive

until a response was made (however, this repetition was rare). Criterion performance was three consecutive correct responses.

In Stage 2, the subject was asked to point to the objects labelled in the plural ("Point to the cups."). Pointing to the pair of objects was reinforced; no response or errors were treated as in Stage 1. The criterion was again three consecutive correct responses.

In Stage 3, a random sequence of singular and plural requests was presented. Correct responses, no response, and errors were treated as in Stages 1 and 2. Criterion performance in this stage required correct response to three singular requests and three plural requests intermixed, without intervening errors. Following Stage 3 criterion performance, the reinforcement schedule was quickly thinned to an approximate VR 2, and productive probe trials (described later) were inserted in the schedule; responses to these probes were never reinforced in Experiment I.

Productive plural training. The procedures followed for productive training were identical for objects requiring either -s or -es pluralization. Productive plural training followed a three-stage sequence similar to that used for receptive plural training.

In Stage 1, a single object was presented to the subject, and the experimenter asked, "What do you see?". The subject received reinforcement for responding with the correct singular label (*e.g.,* "cup"), which he usually did. If he failed to respond in 5 sec, the experimenter gave the correct singular label and asked the subject to repeat it. In this case, the imitation was reinforced, but scored as incorrect, and the trial was repeated. If the subject gave an incorrect response, the experimenter said "No", withdrew the object for 10 sec, and then presented it again as the next trial. Criterion performance was three consecutive correct responses.

In Stage 2, a pair of the same objects used in Stage 1 was held in front of the subject, and the experimenter asked, "What do you see?". Correct responses (*e.g.,* "cups"), no response, and errors were treated as in Stage 1. Criterion for Stage 2 was three consecutive correct responses.

In Stage 3, a random sequence of single and paired objects was shown to the subject. Correct responses, no response, and errors were treated as in Stage 1 and 2. Criterion was met in this stage when the subject responded correctly to three plural presentations and three singular presentations intermixed, without intervening errors. Following Stage 3 criterion performance, the reinforcement schedule was quickly thinned to an approximate VR 2, and receptive probe trials were inserted in the schedule; response to these probes was never reinforced in Experiment I.

Probes. Probes were administered to determine the extent to which training in one modality with a given plural ending generalized to use of that ending in the other modality. Thus, if an object had been trained productively (as a label), the interspersed probes demonstrated any generalized receptive (pointing) response both to that object and a new one; if the object had been trained receptively (as pointing), the interspersed probes demonstrated any generalized productive (labelling) response both to that object and a new one. Receptive probes were administered in a manner identical to receptive training trials, but without any reinforcement of correct responses, correction of incorrect responses, or repetition after no response (in Experiment I). Similarly, productive probes were presented exactly as for the productive training trials, but again without reinforcement, correction, or repetition (in Experiment I).

Eight probe trials were inserted within the training of each object, after Stage 3 of the training sequence. Four probe trials, two single-object presentations and two paired-objects presentations, were given using the object(s) just trained; then, four more probe trials, again two single-object and two paired-object presentations, were presented using the object(s) to be taught next in the training sequence. (Almost without exception, all of the subjects already knew the name of each "new" object presented. Thus, in-

Table 3

An Example of the Sequence of Training and Probe Procedure for the Training of two Successive Objects Per Baseline[1]

		TRAINING SEQUENCE FOR "CUP" AND "AXE"			*NEXT TRAINING SEQUENCE FOR "HAT" AND "BUS"*			
Plural Ending	*Objects Being Trained*	*(Objects to be Trained Next)*	*Productive Training (label)*	*Receptive Training (point)*	*Objects Being Trained*	*(Objects to be Trained Next)*	*Productive Training (label)*	*Receptive Training (point)*	*etc.*
-s	cup	(hat)	Stage 1: cup Stage 2: cups Stage 3: cup/cups, VR2 schedule, *receptive probes:* cup/cups, hat/hats		hat	(truck)	Stage 1: hat Stage 2: hats Stage 3: hat/hats, VR2 schedule, *receptive probes:* hat/hats, truck/trucks		etc.
-es	axe	(bus)		Stage 1: axe Stage 2: axes Stage 3: axe/axes, VR 2 schedule, *productive probes:* axe/axes, bus/buses	bus	(fox)		Stage 1: bus Stage 2: buses Stage 3: bus/buses, VR 2 schedule, *productive probes:* bus/buses, fox/foxes	etc.

[1]This example sequence of training and probe procedures corresponds to the assignment of plural endings for Subject 1 (see Table 2).

correct responses to these "new" probes almost invariably represented a singular-*versus*-plural error, rather than a failure to respond.)

An example of a typical sequence of training and probe trials is shown in Table 3.

Criterion for scoring productive responses. The primary purpose of the study was to evaluate generalization from one language modality (productive or receptive) to the other modality. Accordingly, criteria for scoring singular-*versus*-plural responses were liberal, to allow the subject maximum opportunity to demonstrate generalization. A singular response was scored only if the subject did not include either the -s or -es allomorph in the final position of the label (providing of course that the label was appropriate to the object). However, a plural response was scored when (1) the allomorphic endings -s or -es were added appropriate to the objects shown; (2) an allomorphic ending was present but inappropriate to the object, *e.g.,* hat-es for hat-s; and (3) both allomorphs were included in the response, *e.g.,* hat-s-es.

Results and Discussion

Reliability

Reliability procedures were applied throughout the conditions of Experiments I and II: these procedures and their results are reported in Experiment II.

Generative Acquisition of the Trained Plurals

To display the degree of generative performance with the -s and -es plural endings being taught receptively and productively, the plural shifts displayed by each subject were examined on the final 10 items of the training list (*i.e.,* items 31 to 40 of the -s-ending plurals and items 25 to 34 of the -es-ending plurals listed in Table 1. These items were the final ones with which the subjects could show correct pluralization with *un*trained items, in that the lists were to be repeated in the remaining trials of Experiment I and throughout Experiment II). A plural shift was defined as a correct pluralization on the first two-object presentation of an item just trained to criterion in the singular, *i.e.,* in the first trial of Stage 2 of the training procedures just described (*cf.* Guess, Sailor, Rutherford, and Baer, 1968; Guess, 1969). The percentage of plural shifts, representing generative plural usage across 10 untrained items, is displayed in Table 4 for each subject. In general, there was a high probability of correct plural shifts, perfect in the receptive modality, and perfect or nearly so in the productive modality.

Table 4

Percentage of plural shifts (generative plural usage) in the last 10 items of the receptive or productive training lists.

Subject	*Plural Ending*	*Training Baseline*	*Percentage of Plural Shifts*
S1, David	-s	productive	100
	-es	receptive	100
S2, Dan	-s	receptive	100
	-es	productive	90
S3, Kevin	-s	productive	80
	-es	receptive	100
S4, Gary	-s	receptive	100
	-es	productive	80

Receptive-Productive Generalization

More comprehensive results of training, and the results of the nonreinforced probing are presented in Figure 1, graphed as the percentage of correct responses in the trials of each consecutive object. Responses to training trials, both receptive and productive, are depicted as bar graphs; responses to nonreinforced probe trials are presented as line graphs superimposed on the bar graphs, corresponding point-for-point with the objects used in that training condition. (Recall that probe trials included the object currently being trained plus the object to be trained next in the training sequence.)

In general, Figure 1 shows that the concurrent training of productive and receptive plurals (with different endings) was successful. Each subject's training baselines (bar graph) rose promptly from the 50% levels that might be

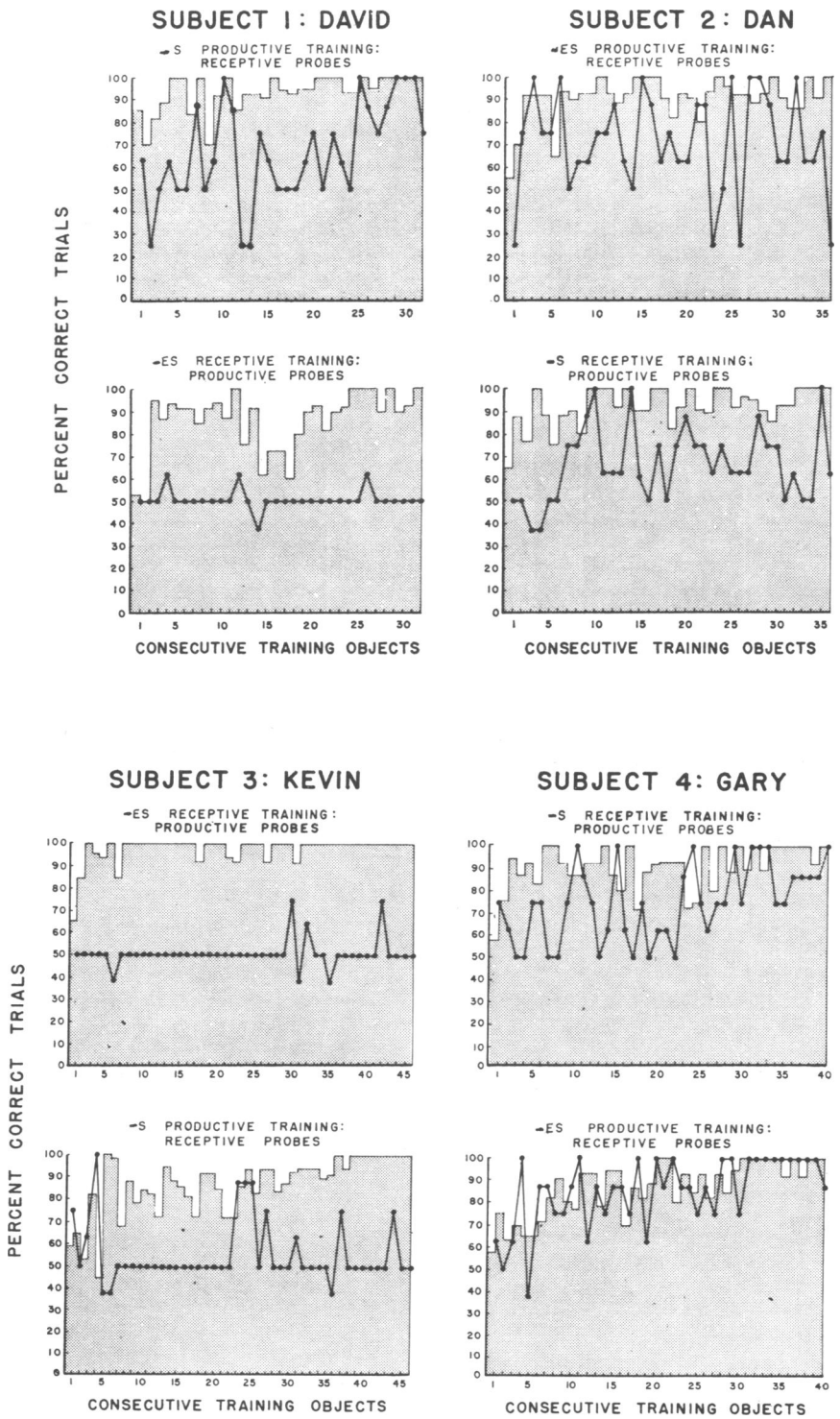

Fig. 1. Percentage of correct trials for two training conditions and their associated probes in four subjects. Bar graphs depict reinforced training trials in each of two response modalities. Each corresponding point on the line graphs represents the percentage of correct responses for eight probe trials: two singulars and two plurals for the trained object, and two singulars and two plurals for the object coming next in the training sequence.

expected initially, toward roughly 90% levels of correct response. Perfect correct performance was seen repeatedly in all subjects, but was consistent only for Kevin's receptive training.

However, Figure 1 also shows that generalization from this training to its unreinforced (opposite modality) probes within the same plural ending (line graphs) was extremely variable, both within and across subjects. In fact, these results indicated strong generalization from training to probe trials only in the case of Gary, Subject 4. As receptive training with objects requiring -s plural endings progressed with Gary, his percentage of correct labels increased to a high level in the productive probe trials; similarly, as he learned to label paired objects correctly with the -es plural form, he also began to point correctly to single or paired objects in response to singular or plural labels in the receptive probe trials. Subject 1, David, showed some generalization from productive training using -s plurals to their receptive probe trials; however, his receptive training (-es plurals) did not generalize to correct productive labels in the probes. Subject 2, Dan, showed partial generalization from productive training (-es plurals) to their receptive probe trials and from receptive training (-s plurals) to their productive probes. However, in both training conditions, the probe trials were highly variable and well below the level of accuracy maintained in the training conditions. Kevin, Subject 3, showed the least amount of generalization from training conditions to their corresponding probe trials. Correct responding in the receptive -es plural training condition was very high across objects, yet productive probes of that baseline varied little from the 50% level of correctness. Similarly, productive training (-s plurals) showed a steady acquisition across objects, yet its receptive probes remained at the chance (50%) level of pointing.

Thus, despite the fact that the subjects had learned near-perfect generative[4] pluralization rules *concurrently* in both receptive and productive modalities, and were receiving reinforcement for maintaining these rule-bound behaviors, nevertheless, as a group they showed relatively little tendency to generalize these rules across those modalities, even though the rules were separated by no more than the use of -s or -es endings for correct pluralization. For these subjects in this training situation, automatic generalization across modalities in either direction remained more the exception than the rule.

EXPERIMENT II

In Experiment I, Gary (Subject 4) showed clear generalization of training rules to probes of the same rules in the opposite modality; by contrast, David, Dan, and Kevin (Subjects 1 to 3) showed partial, weak, or no such generalization. The purpose of Experiment II was to analyze both patterns, by finding procedures that would produce or solidify the level of correct response in the modality where it was absent or weak, or would reduce generalization between modalities where it did occur. The procedure used was an appropriate contingency of reinforcement in each case. The goal sought, however, was always a terminal pattern of correct response in both modalities. Thus, Gary's initially strong (and correct) generalization was undone only briefly for purposes of experimental analysis; he finished the study with the same pattern of correct generalization that he displayed initially in his training. David, Dan, and Kevin were taught rules of plural usage in a manner that not only displayed experimental control but also left them with correct and apparently durable patterns of pluralization in both modalities.

[4]The phrase "near-perfect generative pluralization" as used in this context refers to the fact that the subject usually responded correctly with a plural label on the first presentation of paired objects in Stage 2 of the training sequence as shown in Table 4. The percentages of correct trials in Figure 1 do not demonstrate this phenomenon (except when they are 100%); a subject often provided a correct plural response (either productive or receptive) on the first presentation of the paired items, and yet still responded incorrectly on other trials included in the three-stage training sequence.

METHOD

As in Experiment I, the same four baselines were observed within each subject: with one form of plural, (1) a productive singular-plural labelling rule was taught, and (2) receptive probes of the same singular-plural rule were made; with another form of plural, (3) a receptive singular-plural pointing rule was taught, and (4) productive probes of that singular-plural rule were made. However, in this experiment, when probe performances failed to show generalization of the trained rules, correct responses to the probes were reinforced to see if the desired level of performance could be separately produced, and if so produced, whether it would remain stable when the responsible reinforcement of the probe responses was discontinued. When probe performances showed generalization of the trained rules, the probes were separately treated to see if the generalization could be separately undone, and if undone, whether it would be recovered after the contrary reinforcement of the probe responses was discontinued.

Otherwise, experimental procedures remained identical to those used in Experiment I.

For David, Dan, and Kevin (Subjects 1 to 3), who showed little or no generalization, the desired performance was produced, by temporarily reinforcing *correct* responses to the probe, following exactly the same procedures used in training trials. That is, correct singular or plural labels, or correct pointing responses, were reinforced for each type of probe at separate times during the study, again to allow separate evaluation of the success of the technique in each case, and so that any effects of producing a high level of correct responses in one case could be observed on the current lack of generalization manifest in the other.

For Gary (Subject 4), who showed generalization, an analysis of the durability of that generalization was made by temporarily reinforcing *incorrect* probe responses. Specifically, a *reversal* of the pluralization rule was taught for these probes. That is, single objects were to be labelled in the plural, and pairs of objects in the singular, for productive probes of the receptively trained (-s-ending) baseline; or, single objects were to be pointed to in response to plural requests, and plural objects pointed to in response to singular requests, for receptive probes of the productively trained (-es-ending) baseline. These reinforced reversals of each of the two types of probes were conducted at separate times during the study, so that the success of modifying each could be evaluated separately, and so that any effects of undoing generalization in one case could be observed on the current generalization holding for the other case. (Otherwise, the training procedures used in these reversals of correct responses were identical to those used in the training baselines.)

RESULTS

Reliability

Agreement in scoring between the experimenter and an independent observer was assessed during both training and probe trials of all subjects during Experiment I, and during each of the reinforced probe conditions of each subject during Experiment II. These percentages were calculated as the ratio of all trials on which the two agreed to all trials observed, multiplied by 100. Reliability was uniformly high across all conditions and subjects, varying between 94% and 100% agreement, and averaging 99% (1883 agreements on 1896 trials).

David: Subject 1

Figure 2 shows the percentage of correct response in each of David's two training and two probe baselines. The training and probe trials shown previously in Figure 1 have been included for comparison and as baselines for the procedures of Experiment II.

When reinforcement was scheduled for correct productive responses in the probe trials of the -es-ending receptive training baseline (Objects 33 to 90), correct response rose gradually

to a near-perfect level of accuracy. Meanwhile, correct responding in the still unreinforced receptive probes of the -s-ending productive training baseline perhaps showed a transitory tendency to generalize, but after Object 58 declined to an apparently stable chance level. When nongeneralization of this probe baseline had become apparent, reinforcement was scheduled for correct response in it as well (Objects 73 to 90) in a simple multiple-baseline design. Correct response in these receptive probes then quickly rose to a high level of performance approximately 95% correct.

After reinforcement was discontinued for both probes, simultaneously with Object 91, correct response to the probes remained high. In other words, the high level of correct response produced by reinforcement scheduled in the simple multiple-baseline design had produced apparently durable effects. The extended durability of these effects could not be examined as thoroughly as desired, because David was assigned to a different program within the institution which did not allow for the scheduling of regular experimental sessions at the necessary times. However, he was spot-checked 5, 8, and 12 weeks after the last experimental session (Object 100), and his pattern of correct response in the unreinforced probes was still near-perfect at those times.

Dan: Subject 2

Success in David's case had been produced by reinforcement of both probes, which became

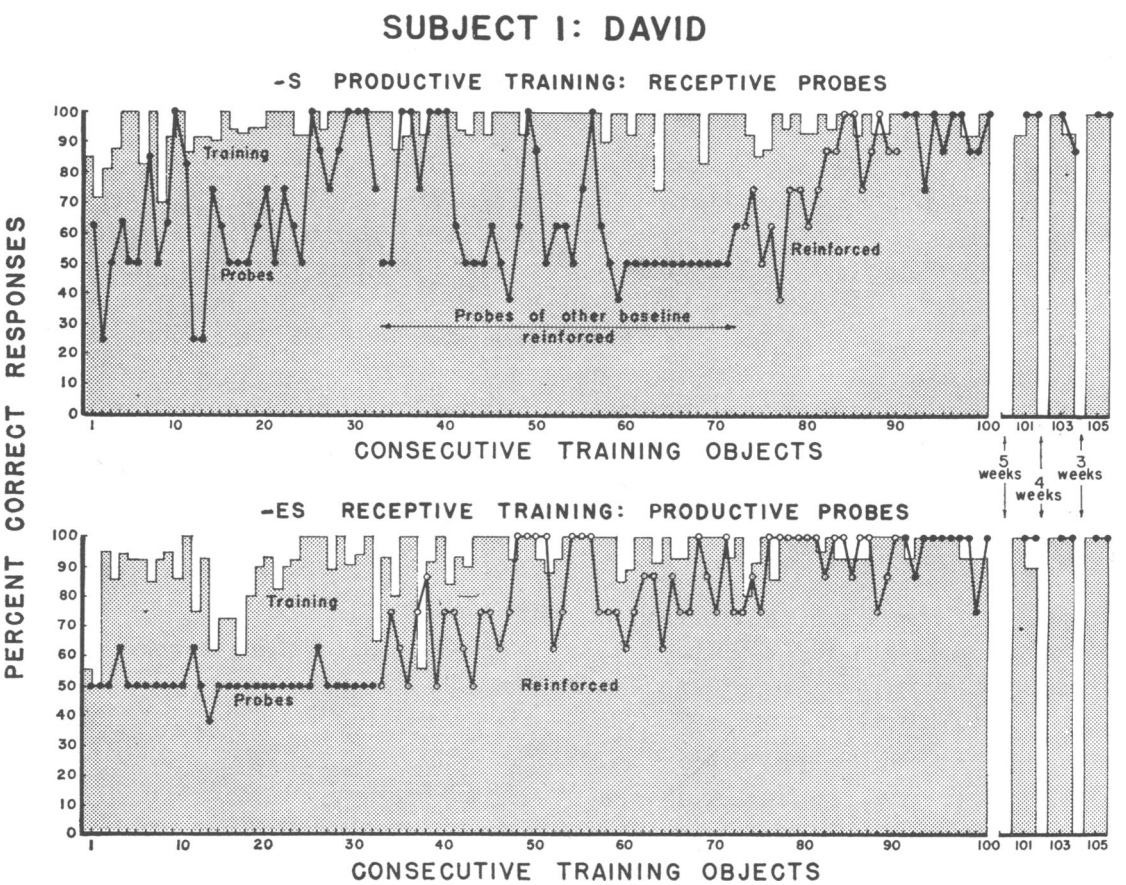

Fig. 2. (Subject 1, David). Percentage of correct trials for two training conditions and their associated probes. Reinforced probe trials are indicated by open dots. (Previous data from Figure 1 are included for comparison.)

concurrent reinforcement after Object 72. In Dan's case, it was asked whether the reinforcement need be concurrent.

Figure 3 shows the percentage of correct response in each of Dan's training and probe baselines. All trials shown previously in Figure 1 have been included for comparison and as baselines for the procedures of Experiment II.

When reinforcement was scheduled for correct receptive responses in the probe trials of the -es-ending productive training baseline (Objects 37 to 54), correct response rose to near-perfect levels fairly promptly. Meanwhile, no change was seen in the level of correct response in the productive probes of the -s-ending receptive training baseline, which remained a little above chance as it had been before this reinforcement. After reinforcement was discontinued for the receptive probe (Object 55), the level of correct response in this probe declined gradually. However, before it could reach its prereinforcement baseline level, reinforcement was scheduled for correct responses in the productive probe (Objects 77 to 98), in a multiple-baseline design. Correct response in these probe trials quickly rose to a perfect level of performance; as this occurred, the now unreinforced receptive probes also recovered, again to a perfect level of accuracy. This pattern of perfect performance was maintained throughout the final trials of the study.

Kevin: Subject 3

In Dan's case, the recovery of the previously reinforced receptive probes when the productive probes were reinforced might be considered an induction effect. On the other hand, the transitory decline and recovery of that baseline be-

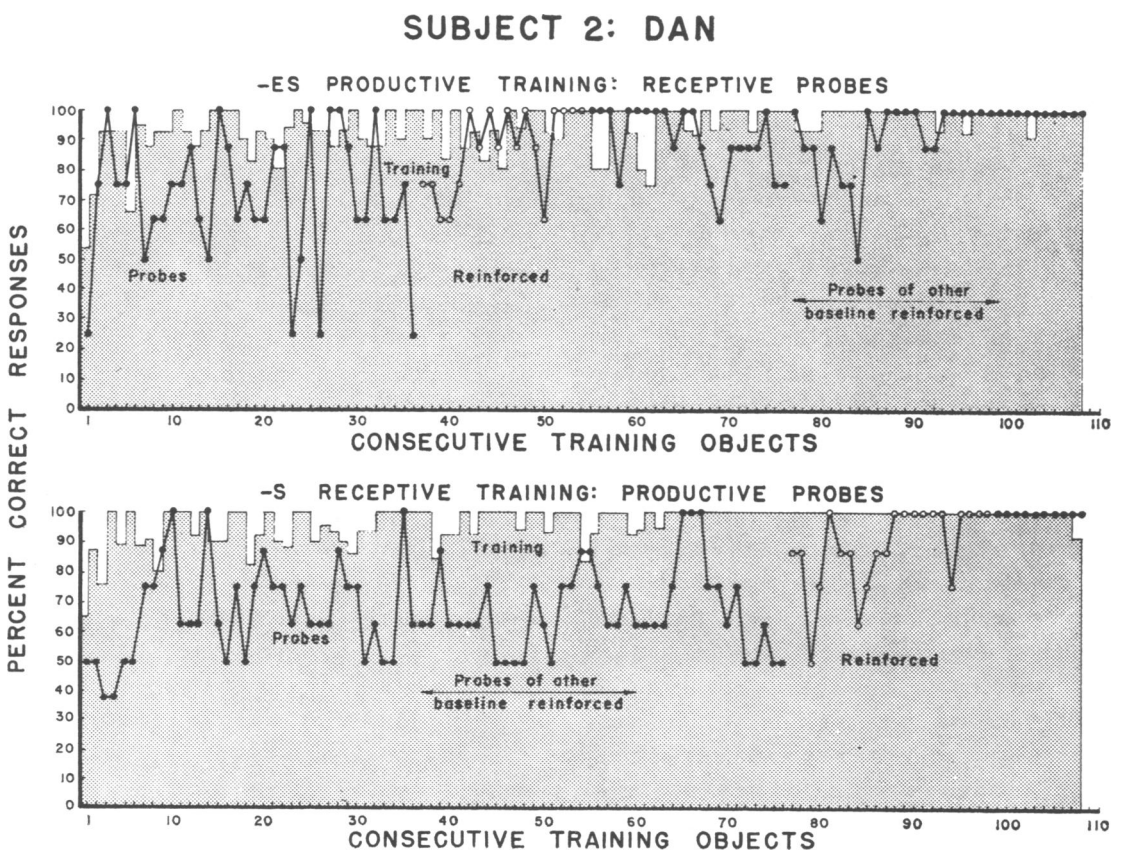

Fig. 3. (Subject 2, Dan). Percentage of correct trials for two training conditions and their associated probes. Reinforced probes are depicted by open dots. (Data from Figure 1 included.)

tween Objects 67 and 88 might be considered no more than chance fluctuation. Consequently, in Kevin's case, the effects of discontinuing reinforcement of the first probe baseline to be corrected were examined more thoroughly, before the second probe baseline was subjected to reinforcement.

Figure 4 shows the percentage of correct response in each of Kevin's training and probe baselines. All trials shown previously in Figure 1 have been included for comparison and as baselines for the procedures of Experiment II.

Reinforcement was scheduled for correct productive response in the probe trials of the -es-ending receptive baseline, first in two separate sequences (Objects 47 to 62 and 79 to 100). The percentage of correct response rose promptly in each case to the near-perfect or perfect levels of performance. After both sequences, when this reinforcement was discontinued, correct response returned to its baseline level, promptly the first time and more slowly the second. Meanwhile, the unreinforced receptive probes of the -s-ending productive training baseline remained at the 50% level (usually due to a strong predominance of the singular pointing response). When it was clear that the productive probes would decline systematically after the discontinuing of their reinforcement (as had not been thoroughly clear in Dan's case), reinforcement was scheduled for correct responses in the receptive probes for Objects 121 to 136, but not resumed for productive probes. Correct response promptly rose to a 100% level in the receptive probes. As this occurred, correct response began to recover in the unreinforced productive probes, but then declined again to the 50% level, the former singular response predominance reappearing. Reinforcement of the receptive probes was then discontinued (Objects 136 to 144), to see if correct response in the receptive probes would fall, as it had in the productive probes when reinforcement was discontinued there. Correct receptive probe response was maintained, however, at a near-100% level. Consequently, reinforcement was resumed briefly for correct response in the productive probe, raising these responses to the 100% level. When this reinforcement was discontinued (Object 159), near-perfect patterns of performance were maintained in both types of probes thereafter.

Thus, Kevin, like David and Dan, showed a final pattern of perfect and apparently durable level of correct response in both modalities. He differed from Dan, however, in that reinforcement of his second probe baseline did not produce a complete recovery of the declining first baseline, although at first his data suggested that exactly such a recovery would occur (as it had in Dan's case). However, a brief, final reinforcement of that baseline did recover it, while the second probe baseline was maintained without reinforcement, and both were maintained finally without reinforcement. In this respect, Kevin's case did resemble Dan's.

Gary: Subject 4

Figure 5 shows the percentage of correct response in each of Gary's two training and two probe baselines. The training and probe trials shown previously in Figure 1 have been included for comparison and as baselines for the procedures of Experiment II.

In two separate sequences (Objects 41 to 75 and 100 to 105), reinforcement was scheduled for incorrect (reversed) responses in the receptive probes of the -es-ending productive training baseline. The percentage of correct responses (conventional plural usage) declined slowly in the first sequence to about 20%, and promptly in the second sequence to about 25%. After both sequences, when this reinforcement was discontinued, correct (conventional) probe responses returned to baseline or near-baseline levels (85 to 100%) of correct generalization.

Reinforcement of reversed responses in the productive probes of the -s-ending receptive training baseline, scheduled as a later sequence (Objects 115 to 140), yielded a steady decline in correct (conventional) responses to an ap-

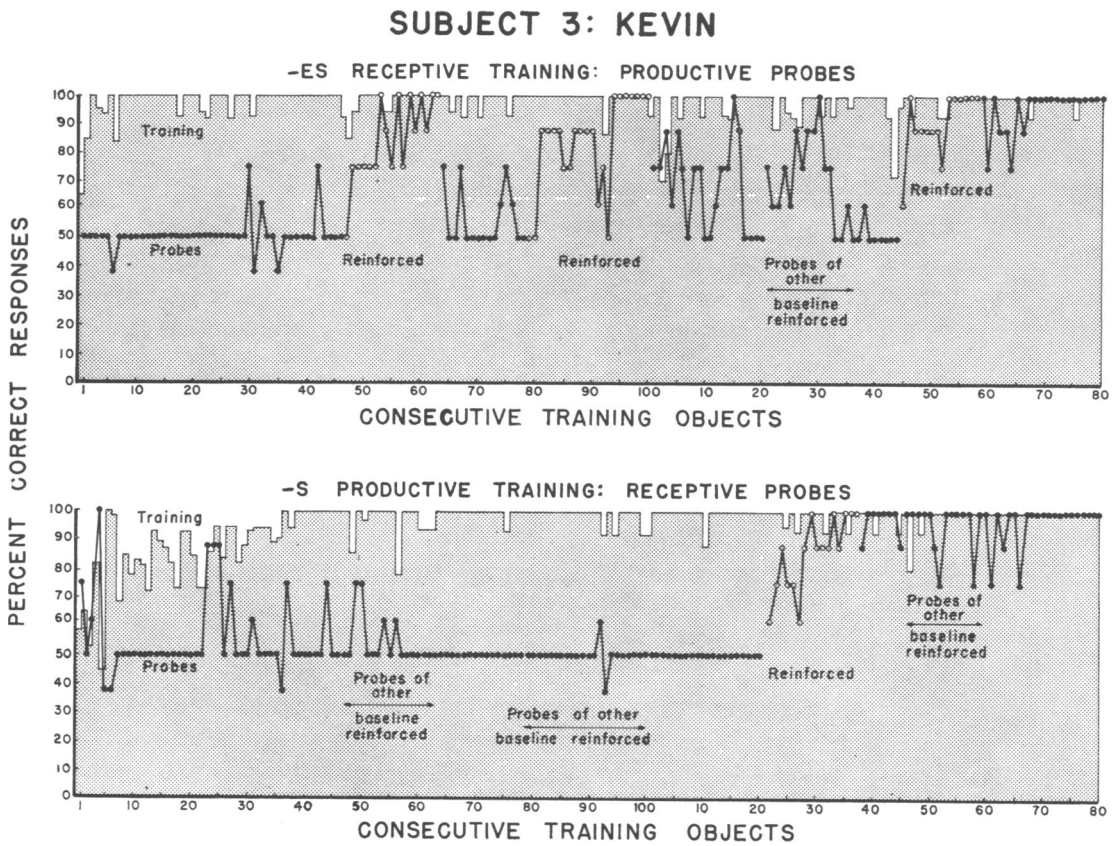

Fig. 4. (Subject 3, Kevin). Percentage of correct trials for two training conditions and their associated probes. Reinforced probes are indicated by open dots. (Data from Figure 1 included.)

proximate 40% level. When this contingency was terminated, correct responses in these probe trials promptly recovered to a near-perfect level and remained high thereafter.

Figure 5 shows that the reinforcement of reversed probes, receptive or productive, did not clearly affect the percentages of correct response in the training baselines within which they were inserted.

Thus, it was possible to decrease generalization from productive training to receptive probes by reinforcing incorrect (reversed) pointing responses in these probes, and it was possible to decrease generalization from receptive training to productive probes by reinforcing incorrect (reversed) plural labels in those probes. Under both conditions, these effects were temporary (as desired): generalization was recovered in nonreinforced probe trials soon after the reinforcement responsible for decreased generalization was discontinued.

Whether these techniques could have been used more extensively or more powerfully to produce permanently decreased generalization, simulating the cases of the other three subjects shown in Experiment I, remains unanswered, as that outcome was considered dysfunctional for the subject.

GENERAL DISCUSSION

The major question was whether an internally generative plural rule (*cf.* Table 4) would generalize between two language modalities, productive and receptive, if the rule were trained in both modalities concurrently with separate plural types. Training was accomplished successfully with the four subjects; each learned

the -s or -es-ending plural rule taught in each modality, extending it to untrained instances in that modality, and thus confirming the results of Guess *et al.* (1968). However, generalization from the trained modality to its opposite (non-reinforced) modality within the same plural ending was strong in only one subject, Gary (Subject 4); the remaining subjects demonstrated only partial generalization (Subject 1, David; Subject 2, Dan), or essentially no generalization (Subject 3, Kevin). These latter findings agree generally with those of the Guess study (1969) in which receptive plural training failed to generalize to the productive modality, and the Harrelson study (*unpublished*), which found no generalization from productive plural training to the receptive modality. Nevertheless, one subject in the present study did generalize from the trained modality of each plural rule to the opposite modality, and others showed some degree of partial generalization. Thus, the interdependence or independence of receptive and productive language is open to unexplained individual differences.

The second part of the study demonstrated, however, that this range of individual differences in performance, both between and within subjects, could be either produced or eliminated by appropriate reinforcement. Thus, the three subjects who showed only partial or no generalization were subsequently trained to a high and durable level of correct response in probe trials, and thereby were made to resemble the fourth subject, who did show generalization at the end

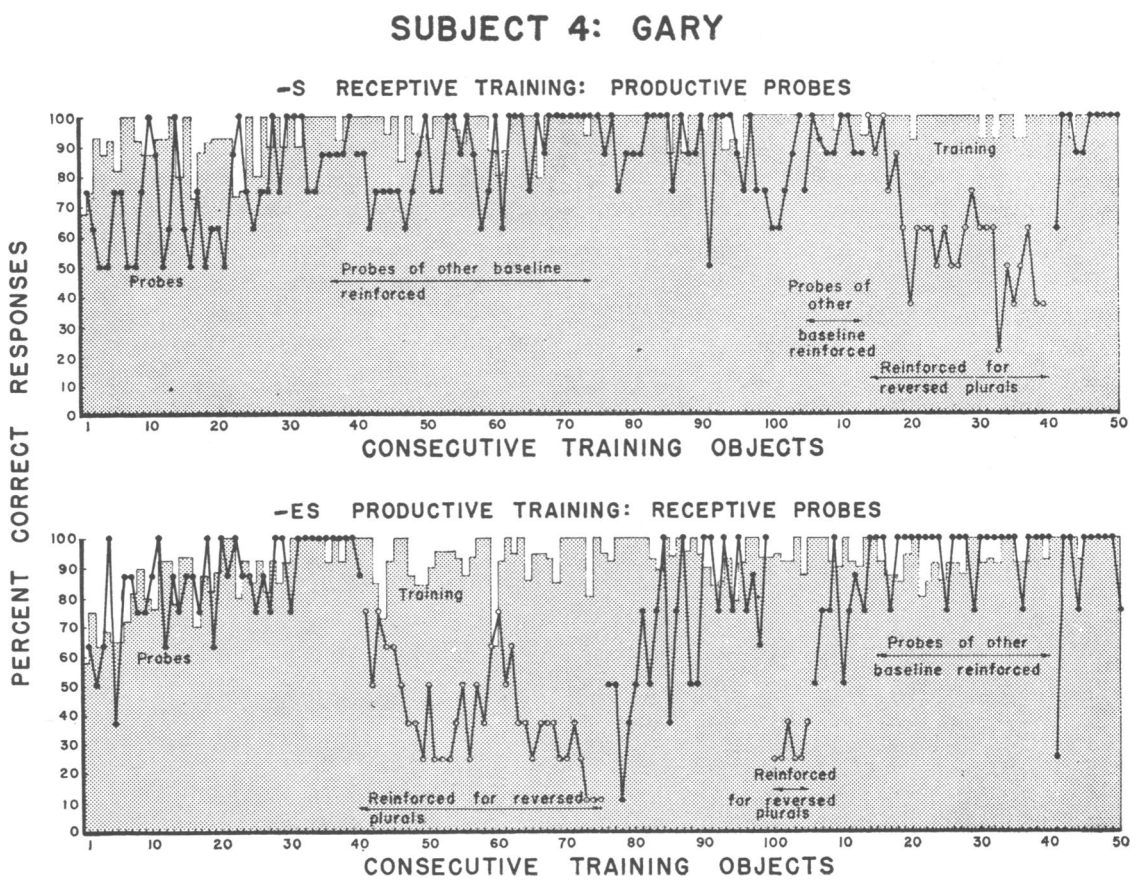

Fig. 5. (Subject 4, Gary). Percentage of correct trials for two training conditions and their associated probes. Reinforced probe trials for reversed (incorrect) plural usage are shown by open dots. (Data from Figure 1 included.)

of Experiment I. Conversely, the response pattern of the fourth subject (Gary) was made to pass through the non-generalization pattern shown by the three subjects who had not generalized by the end of Experiment I. Whether it could have been maintained in that pattern indefinitely is unknown, but it might have been, through currently known techniques of scheduling.

These results—especially, their discussion—present a problem in terminology. The basic pluralization performances in each of the training baselines can be said to have been rule-governed or *generative* (as shown by the data of Table 4). That is, previously untrained instances in which these pluralization rules might operate did show just such operation, which is the meaning of *generative* intended in this context. Put differently, the subjects showed application of an experimentally trained pluralization rule to words with which they had received no such training. The key to this usage of *generative* is correct performance with new (untrained) words (*cf.* Baer, Guess, and Sherman, 1972). However, while these *within*-modality performances were generative (demonstrably so until the word lists began to be repeated), there was little or no *cross*-modality *generalization:* meaning that three subjects who had a generative pluralization rule in their receptive modality did not adopt a similar rule with the appropriate words of their productive modality, and at the same time did not extend the slightly different generative pluralization rule already operating in their productive modality to the appropriate words of their receptive modality, (*appropriate* meaning simply words that take the same ending, -s or -es, in their plural). Subject 4, Gary, was an exception to this summary; his transfer of pluralization rules across modalities is termed *generalization,* to index his change in an untrained ending-modality combination paralleling his change in a directly trained same ending-different modality combination. (Thus, *generative* is used here to label extension to new words, with the implication that there are yet-to-be-learned words in the extension; *generalization* is used to label extension to the other modality, with the implication that there is only one already established other modality. This distinction is considered useful in the present context, but certainly is not descriptive of all the ways that these terms have been used in other contexts.) However, in Experiment II, for the three subjects other than Gary, the previously untrained ending-modality combination was briefly transformed into a trained one (by the reinforcement of correct responses in the probe trials). Can the results of this training be labelled *generalization* after the responsible reinforcement had stopped? One reason for doing so is that the words with which the subjects continued the pattern of correspondence of pluralization rules across both modalities generally were different words than those with which they had just been trained *to transfer* across modalities. That is, although these words had been encountered before (due to recycling of the 40-item -s-ending and 34-item -es-ending word lists), they had not been the object of training-to-generalize before. Being probe words for the ending-modality combination at issue, previous response to them had not usually been reinforced, whether correct (*i.e.,* generalized) or not: whereas those words with which correct generalization was established by direct reinforcement in Experiment II were not the words with which the subjects then showed enduring patterns of generalization after reinforcement of probe responses had stopped. Eventually, words reinforced in probes would recur, of course, as the lists recycled, but inspection of the data in Figures 2 to 5 shows maintenance of generalization patterns before that recycling would occur (as well as after).[5] Thus, that maintenance

[5]One case must be noted as an exception to this claim: when David's (Subject 1), correct response to the -es-ending productive probes was reinforced, the training exceeded the 34 objects comprising the -es-ending plural list (*cf.* Table 1), and the list was therefore re-cycled. Thus, subsequent correct response to these probes, after reinforcement was discontinued,

(*continued on next page*)

is termed *generalization.* (The distinction is admittedly a complex one, and the many usages of *generalization, transfer,* and *generative* in the literature of learning no doubt reflect this problem.)

Whatever terminology may be best to describe these results, a practical implication may be derived from them independently of those terms: training of comprehensive language skills in such children may do well to program direct training, perhaps from the outset, in both modalities of language, across many (if not all) of the grammatical cases to be encountered. In the present study, so slight a difference in pluralization as the -s-ending and -es-ending cases proved to be a formidable barrier to three of the four subjects, despite their generative performances within each of these cases, and within each modality, with one case or the other.

In addition, several more-technical points merit discussion: occasionally, plural responses in the productive probe trials deviated from conventional usage, yet were scored as correct to give the subject every opportunity to demonstrate generalization. David, Subject 1, sometimes omitted the terminal sibilants in words before adding the -es plural ending: *e.g.,* "roses" became "ro-es". David, dealing with singular terminal -s words (*e.g.,* "bus"), often omitted the terminal sibilant for the singular label ("bu") and then accentuated it for the plural ("busss"). Similar types of deviations have been reported in other studies that trained plural usage. Guess *et al.* (1968) found that correct plural responses decreased slightly for words with vowel endings compared to words with consonant endings. Sailor (1971) demonstrated that previously aplural children trained to use the -z plural generalized it to words ordinarily requiring the -s plural, and *vice versa.* Possibly, some of David's responses on productive probes of supposedly -es-ending plurals may have resulted from his concurrent productive training with -s-ending plurals, especially with those words in probe trials that ended with -s in their singular form. The productive probe responses given by Gary, Subject 4, sometimes showed a confused generalization across rules: probes requiring the -s ending (*e.g.,* "cup-s") occasionally also produced the -es ending being trained productively ("cups-es").

In reviewing responses to probe trials (productive and receptive) across all subjects, it was found that no differences existed in the percentage of correct responses to the object(s) just trained, as compared to responses to the object(s) to be presented next in the training sequence. This finding was consistent in both unreinforced and reinforced probe conditions.

In summary, the findings indicate that generalization between the language modalities (productive and receptive) of a pluralization rule is unlikely in language-deficient retarded children, even when both modalities are trained concurrently, at least with the procedures used in this study. Certainly, there exists the need to explore further other parameters that might affect the functional relationship between the two modalities. For it is apparent that generalization between the two modalities can occur, but by no means is an "automatic" phenomenon, even in conditions (such as this study) strongly emphasizing the functional similarity of both modalities.

cannot be said to involve words with which no training-to-generalize had occurred. In the other five cases applicable (David's receptive probes, Dan's receptive and productive probes, and Kevin's receptive and productive probes), it was true that the words with which correct response was shown immediately after reinforcement was discontinued were not the words to which correct response had been established during the previous period(s) of reinforcement.

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