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ACQUISITION OF EXPRESSIVE SIGNING BY AUTISTIC CHILDREN: AN EVALUATION OF THE RELATIVE EFFECTS OF SIMULTANEOUS COMMUNICATION AND SIGN-ALONE TRAINING

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Two methods of training autistic children to use manual signs were compared. Two children, one mute and one capable of some verbal imitation, were taught to use signs as expressive labels for pictures of objects. Using an alternating treatments design, speed of sign acquisition was compared across two training conditions in which signs were presented either accompanied by, or without, the corresponding verbal label. In both conditions, the training procedure incorporated reinforcement, modeling, prompting, fading, and stimulus rotation. The efficacy of training in both treatment conditions was demonstrated by the use of a multiple baseline control across signs, but no clear differences in acquisition speed across conditions were apparent. Posttests conducted to assess stimulus control of signing, and learning of verbal labels when these were present in training, showed that the behavior of the imitative, but not the mute, child was controlled by the verbal stimuli. The implications of the results both for understanding deficits characteristic of autistic children and for developing appropriate language training procedures are discussed.

DESCRIPTORS: language, sign language, simultaneous communication, sign-alone training, stimulus control, receptive speech, autistic children

A marked failure to acquire language is one of the four defining features of early childhood autism (Rutter, 1978), and is a characteristic problem among severely and profoundly retarded individuals (Jordon, 1967). A major remedial treatment goal is therefore to teach functional communication skills, and much research effort has focused on devising programs to train expressive and receptive speech (see McCoy & Buckhalt, 1981, for review). Recently, however, it has been recognized that in many cases these efforts have met with only limited success (Goetz, Schuler, & Sailor, 1979), and research interests have broadened to include the use of nonoral communication systems such as plastic symbols (e.g., Light, Remington,, & Porter, 1982; Premack & Premack, 1974) or manual signs (e.g., Faw, Reid, Schepis, Fitzgerald, & Welty, 1981; Fulwiler & Fouts, 1976) as substitutes for speech. Much of the enthusiasm for this approach stems from teachers of retarded and autistic children: The popularity of nonoral language as a treatment modality has far outdistanced the basic research required to validate its use. In the UK, for example, a majority of schools for language-handicapped children have some kind of sign training program (Kiernan, 1977), despite the fact that empirical support for much of this intervention effort is methodologically weak, or lacking entirely (see Remington & Light, 1983, for review).

One of the most popular techniques for teaching manual signs as substitutes for speech is *simultaneous communication training,* in which a teacher simultaneously signs and speaks the

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name of a referent (Creedon, Note 1). The procedure raises two obvious questions. First, is simultaneous communication a more effective way of teaching signing than the *sign-alone training* method which omits referent speech? Second, does simultaneous communication training in some way facilitate speech?

Although simultaneous communication has many adherents (e.g., Schaeffer, 1980), there are a number of theoretical arguments, based on indirect empirical evidence from studies of autistic children, that imply that it might be no more effective or speech facilitative than sign-alone training. These points have been discussed extensively elsewhere (e.g., Carr, 1979; Carr & Dores, 1981; Kiernan, 1983), but briefly, they bear on two main points. First, autistic children show overselective attention (Lovaas, Koegel, & Schreibman, 1979) and Carr (1979) has argued that, in situations where both gestural and speech stimuli are present, mute autistic children are likely to attend exclusively to gestural cues. Second, autistic children are poor at cross-modal association tasks (Bryson, 1970), and this ability is obviously crucial if a child is to associate (visual) sign input with (auditory) speech input.

Although empirical research that directly evaluates the relative efficacy of simultaneous communication is rare, a recent study by Barrera, Lobato-Barrera, and Sulzer-Azaroff (1980), using a mute autistic child as subject, compared simultaneous communication and sign-alone training by means of an alternating treatments design. Barrera et al. reported that the simultaneous communication method was "substantially superior" (1980, p. 21). However, they did not conduct pretraining tests to assess whether any of the words to be used in training were in the child's receptive vocabulary. It is likely that some words were because the training stimuli were "familiar object(s) from the child's environment" (p. 24). Thus, the superiority of simultaneous communication might have resulted from the fact that, in that condition, the child learned the sign as a translation of a previously acquired verbal referent rather than a unique referent (Remington & Light, 1983). Because this possibility would impose severe limitations on the generality of their findings, the first aim of the present study was to compare the two training methods while controlling the children's receptive speech skills. Additional controls for attentional cueing and trial presentation rate were included to ensure comparability across conditions.

The second aim of this research related to the general question of how simultaneous communication training affects speech skills. This implies four more specific questions because the method may be used to teach expressive and receptive signing, and speech may also involve expressive and receptive skills. Carr and his colleagues have investigated some of these combinations. Carr, Binkoff, Kologinsky, and Eddy (1978) trained expressive signing via simultaneous communication, and then examined stimulus control of signing by both the visual referents of the signs, and by their corresponding verbal labels. Evidence of control by stimuli of the latter kind implies a change in receptive vocabulary. Carr et al. found that, although signing in all four of their subjects was controlled by visual stimuli, only one subject showed stimulus control by speech. The visual stimuli used were, however, all food items which functioned as reinforcers for appropriate signing during training. Because it is known that the presence of a reinforcer can facilitate further responding during extinction (Reid, 1957; Spradlin, Girardeau, & Hom, 1966), the comparison may have been systematically biased in favor of visual stimulus control. In a more recent study, Carr and Dores (1981) investigated the effect of simultaneous communication training of receptive signing on receptive speech. They found that imitative, but not mute, children acquired some receptive speech as a result of training.

In addition to the training method comparison, the present study assessed the effects on receptive speech of expressive sign training using the simultaneous communication method. First, it replicated the stimulus control test of Carr et

al. (1978) while controlling for presence of reinforcers. Second, it assessed the acquisition of receptive speech skills more directly, using a matching task. Because Carr and Dores (1981) found differences in outcome between mute and verbally imitative autistic children, one mute and one imitative child participated in this study.

METHOD

Participants

Two children (Diane, age 10 yrs, and John, age 15 yrs) were selected from a school for autistic children to participate in the study. Both were categorized as autistic, and clearly satisfied the formal diagnostic criteria outlined by Rutter (1978) in terms of early onset, impaired social development, stereotyped behaviors, and limited language development. Diane had additionally been categorized as severely mentally retarded, but a reliable IQ had never been obtained. The most recent IQ available for John was 101, although his daily behavior was not easily reconcilable with this assessment. Autistic behaviors prior to the start of the study precluded a more precise assessment of IQ for either child. Although evidence suggested that several years prior to the present study John had been capable of some self-initiated speech, at the time of training neither child spoke spontaneously. John was capable of verbal imitation but his articulation was generally very poor. Diane, however, was unable to imitate verbally, and her verbalizations were confined to simple babbling sounds. A Reynell Developmental Language Scale (comprehension) indicated Diane was functioning at the 2 yr, 1 mo level, and John at the 3 yr, 3 mo level. Both children had good gross and fine motor control, and were capable of motor imitation. Neither child suffered from auditory or visual defects.

Experimental Design

The experiment involved three phases: pretesting, training with interpolated probes, and posttests. In the pretest, children were assessed for their comprehension of the names of potential to-be-trained items. Next the training procedure involved teaching the children to use expressive sign labels for items whose verbal labels they did not comprehend in the pretest assessment. An alternating treatments design (Barlow & Hayes, 1979) allowed the effects of training expressive signing to be compared under simultaneous communication and sign-alone training conditions. As each sign was trained to criterion in each condition, a series of probe trials was conducted for all the signs used in that condition. This procedure constituted a multiple baseline across responses design (Baer, Wolf, & Risley, 1968), and closely resembled that used by Carr et al. (1978) to train expressive signing. Thus, this phase of the study consisted of an alternating treatments design, with a multiple baseline control procedure built into each treatment condition. Finally, posttests were conducted to assess stimulus control of signing taught via simultaneous communication, comprehension of verbal labels corresponding to signs trained, and maintenance of signing following training.

Procedure

Experimental setting. All training and testing sessions were conducted on a 1:1 basis in a quiet room in the children's school. The teacher sat across a table from the child, whose performance was videotaped for later analysis. Except on the few occasions where practical constraints prevented it, training or testing was carried out on a daily basis during weekdays.

Pretesting for verbal comprehension. The comprehension pretest was conducted to select for training only those signs corresponding to words which were not in the children's receptive vocabulary. There were two reasons for this. First, it avoided confounding the comparison between treatment conditions that might have occurred if a child could have used preexisting knowledge of what was said in the simultaneous communication condition to interpret the sign. Second, it allowed an unconfounded posttest assessment of the effect of simultaneous com-

munication training of expressive signing on the children's receptive verbal vocabulary.

During the first session each child was shaped to attend to the teacher when called. The teacher waited until the child was looking away before calling his or her name. Reinforcement was delivered contingent on the child engaging in eye contact with the teacher immediately on being called. The duration of eye contact required was gradually increased until each child would reliably look for at least 5 sec. This cueing technique was then used to initiate every trial throughout the remainder of the experiment, thus equating the salience of trial onset in the simultaneous and sign-alone training conditions. The reinforcers used to shape attending, and used throughout the experiment, were preferred foods and social praise.

Comprehension of spoken words was assessed using a task in which the child was required to point to a line drawing corresponding to an object named by the teacher. Each drawing was of approximately the same size, and each appeared on a 32 × 26 cm white card. To ensure that children were capable of this matching performance, a warm-up session was performed using seven drawings of objects, the names of which were believed to be familiar to the children on the basis of their school teachers' reports. Because performance on this test was satisfactory, tests of an identical form (detailed later) but using words believed to be unknown to the children were conducted on the next three days. The criterion for selection of these words was their unfamiliarity to the children. Words likely to be highly functional were necessarily eliminated because it was believed by their schoolteacher that they would be in the children's receptive vocabulary.

Drawings of *believed-unknown* items were blocked into groups of seven. A preselected six of these drawings were placed in front of the teacher, who cued the child's attention and then asked him or her to "Show me *name of object.*" Regardless of whether or not the response was correct, verbal and edible reinforcement was delivered at the end of the trial on an average of one trial in three, to maintain the child's motivation without training the discrimination. This noncontingent reinforcement procedure was subsequently used in all test procedures for the remainder of the experiment. Before the next trial, a preselected stimulus card from the array was replaced with the remaining card. A prearranged sequence of 42 trials was conducted in this way, such that each of the seven stimulus cards was presented on 36 trials and was the target card on six trials. Verbal comprehension was assumed, and the stimulus card therefore rejected, if the child made a correct response on more than two of the six possible trials. The binomially computed probability of obtaining more than one correct identification from six trials by chance is 0.27, and the corresponding probability for more than two correct identifications is 0.06.

This procedure was repeated five times for John, yielding a total of 13 unknown words, and three times for Diane, also yielding 13 unknown words. For both children an additional *believed-unknown* word was added to make two blocks of seven words, and each of these blocks was tested on two subsequent days using the same method and rejection criterion. The words selected as unknown were thus those that the children had failed to respond to correctly more than twice in six opportunities on each of three consecutive days.

Training. The training procedure included an alternating treatments design in which each child was taught five signs using the simultaneous communication method, and five signs using the sign-alone method. The drawings used as signing referents corresponded to words that a child had given no evidence of comprehending in the pretest. An attempt was made to equate the signs selected for the two conditions in terms of iconicity and ease of signing by having 20 undergraduate students rate the signs on these dimensions using 4-point scales. Iconicity was defined as the degree to which the physical similarity between sign and referent offers a

clue to its meaning (Konstantareas, Oxman, & Webster, 1978). East of signing was rated on the basis of such features as one- versus two-handed signs, simple versus complex movements, and the visibility versus nonvisibility of the sign to the child (Barrera et al., 1980). On the basis of these ratings, five pairs of signs were established such that members of each pair were roughly equated on iconicity and ease of signing ratings.

The comparison of two training conditions using an alternating treatments design required that each child participate in two experimental sessions per day during the second phase of the experiment. These sessions were held at the same times in the morning of each experimental day: They lasted for approximately 15 min, and were separated by approximately 45 min. The order of sessions was counterbalanced across days such that each condition appeared at the earlier of the two times on alternating days. Each session could contain a block of training trials, a block of probe trials, or trial blocks of both kinds, with the constraint that a test block was not begun unless it could be finished within 20 min of the start of the session.

Training blocks. The procedure used to train expressive signing was identical in both conditions, with the single exception that in the simultaneous communication condition the teacher spoke the name of the referent at the same time as she modeled the sign.

The procedure used to train the first sign was as follows. A trial was not initiated until the child was sitting quietly. Instances of self-stimulatory or disruptive behavior were punished by the teacher shouting "No!" A trial then began with the teacher standing a stimulus card on the table and cueing the child's attention by saying his or her name. Next, the teacher modeled the sign corresponding to the stimulus card drawing (while speaking its name in the simultaneous communication condition), and delivered reinforcement if the child made the appropriate sign within 5 sec. If the child failed to imitate, the sign was physically prompted by molding the child's hand(s) into the appropriate position(s) and guiding the child through the movements required. Following reinforcement, the stimulus card was removed, and a 5-sec intertrial interval occurred. As a child's signing became more reliable, first the physical prompt, and then the teacher's modeling of the sign were gradually faded. Where a physical prompt was not necessary, modeling was faded as soon as possible. Similarly, the teacher reinstated the prompt procedures if the child's signing appeared to be becoming less reliable at any point in the training. Prompted responding was reinforced with social praise but not preferred food, thus providing a differential consequence for spontaneously emitted signing (cf. Olenick & Pear, 1980). The sign being trained in any block was considered to be at criterion when the child responded correctly for 10 consecutive trials without any kind of prompting. At this point, a block of probe trials was introduced.

The procedure for training the second and subsequent signs in each condition differed from training the first in that trials involving the new sign were interwoven with trials on the previously trained sign(s) in a ratio of two to one. This stimulus rotation procedure (Carr et al., 1978) ensured that the child not only acquired the new sign, but also learned to discriminate between new and mastered signs. The criterion for introducing a probe block remained the occurrence of 10 consecutive unprompted correct responses, and these could include the new or previously trained signs.

Probe blocks. Fifty probe trials were conducted prior to the start of training and after each sign reached criterion, for each experimental condition. Thus the occurrence of a probe block in one condition on a particular day did not imply a similar probe in the other condition. Probe trials were identical in both experimental conditions, with the exception that in the simultaneous communication condition verbal labeling accompanied the presentation of the stimulus card. Probe trials were similar to training trials in terms of the sequence of events

but differed in three main ways. First, the teacher never modeled or prompted the correct response. Second, reinforcement was delivered noncontingently on an average of one trial in three. Third, the prearranged sequence of target responses was organized differently. On the blocks administered prior to training, each of the five to-be-trained stimuli was presented 10 times in a randomized order. Following acquisition of every new sign, a child received five trials on all remaining untrained signs, and the remainder of the 50 trials were divided as equally as possible between the trained signs, presentation sequence again being randomized.

Posttests

Stimulus control. The aim of the stimulus control test was to establish which component(s) of the stimuli present in the simultaneous communication training situation controlled expressive signing. Following Carr et al. (1978), tests were performed on the five signs trained in this manner to establish whether the stimulus card itself, the spoken word corresponding to the card, or the lip movement entailed in saying the word had become effective discriminative stimuli. Apart from the stimuli presented, each block of test trials was identical to the first (and last) block of probe trials. In the *visual* condition, the teacher presented the card without naming the item illustrated. In the *vocal* condition, she did not present a card, but rather named the item while simultaneously placing her hand over her mouth to eliminate any visual cues arising from lip movements. In the *lip-reading* condition, the teacher silently mouthed the name of the item without displaying the corresponding card.

Verbal comprehension. The posttest for verbal comprehension of the trained items was identical to the pretest. As before, a warm-up procedure was used prior to testing the children on the trained items. Because the test procedure required seven items per block, two additional (believed unknown) words were added to each group of five trained words. Both children received two blocks of 42 test trials on two consecutive days. In each block 30 of the 42 trials tested verbal comprehension of words corresponding to signs trained in one of the two treatment conditions. The test of words corresponding to pictures used in the sign-alone condition provided a control for any incidental learning that might have occurred during the course of training.

Maintenance. To establish whether the expressive signing trained was retained in the absence of further specific teaching input, a follow-up test was conducted approximately 4 weeks after the end of training. Separate tests of the signs trained under both treatment conditions were carried out.

The test procedure used in each condition was identical to that used in the first (and final) probe trial blocks used in training.

Reliability

Reliability scores for training were obtained on 4 arbitrarily selected days (days 2, 5, 9, and 13) of the second phase of the experiment, and thus reflected observations of expressive signing obtained during both training and probe blocks on those days. The mean number of trials for which reliability scores were derived was 71 per day for Diane, and 89 per day for John. Scores were obtained by having two independent observers separately rate videotapes of the sessions using clearly illustrated sign definitions. Only unprompted signing responses were scored as correct. Each treatment condition was rated separately, and reliability scores were computed as the ratio of number of trials on which the observers agreed divided by the number of trials on which they agreed plus the number on which they disagreed. A similar reliability assessment was carried out on the data from the 150 stimulus control trials.

RESULTS

The mean interobserver reliability scores obtained for the simultaneous communication con-

dition were: Diane—90% (range 87%-94%), John—87% (range 84%-90%); and for the sign-alone treatment: Diane—87% (range 87%-88%), John—91% (range 89%-92%). The stimulus control tests yielded interobserver reliability scores of 100% for John in the lip-reading test, and 94% in the visual and vocal stimulus control tests. For Diane, the scores for all three tests were 100%.

Diane required on average 8% more trials, and John 9% more trials, in the simultaneous communication than in the sign-alone treatment condition. The number of training trials conducted to teach each sign is shown in Table 1. For each condition, the first column indicates the total number of trials required to reach criterion on each sign. Thus, for Diane in the simultaneous communication condition, 26 trials (column 2) were needed to teach the first sign (*rifle*), and 95 were required to teach the appropriate conditional discrimination between the first and second signs (*penguin* and *rifle*). Trials requiring these signs were carried out in a 2:1 ratio, with 63 trials being conducted on the new sign (column 2) and 32 on the mastered sign (column 3) to achieve the criterion. As shown, Diane met criterion on the five signs trained by simultaneous communication after 444 trials, and the five signs trained using the sign-alone procedure after 409 trials. The corresponding figures for John were 317 and 293 trials, respectively. A chi-square test of differences in trial frequency between training conditions was not significant for either child (Diane: $\chi^2 = 1.44$, $0.3 > p > 0.2$; John: $\chi^2 = 0.94$, $0.5 > p > 0.3$).

Table 1

Numbers of training trials performed for each sign: Total trials include trials required to train each sign and associated stimulus rotation trials.

Simultaneous Communication Training				*Sign-alone Training*			
Sign	*Total Trials to Criterion*	*Trials to Criterion with New Sign*	*Additional Trials on Mastered Signs(s)*	*Sign*	*Total Trials on Criterion*	*Trials to Criterion with New Sign*	*Additional Trials on Mastered Sign(s)*
			Diane				
rifle	26	26	—	elephant	150	150	—
penguin	95	63	32	airplane	59	40	19
vacuum cleaner	73	49	24	boat	67	45	22
rug	196	130	66	kite	76	50	26
sheep	57	36	18	candle	57	38	19
Total trials	444	304	140	Total trials	409	323	86
			John				
jug	54	54	—	rifle	63	63	—
mushroom	59	40	19	flask	115	77	38
penguin	56	38	18	oven	64	43	21
sewing machine	59	40	19	flower	29	20	9
mixer	89	60	29	saucepan	22	15	7
Total trials	317	232	85	Total trials	293	218	75

The total number of sessions run under each condition did not differ greatly for either child. Diane required 17 sessions to master five signs taught via simultaneous communication, and 16 sessions for those taught via the sign-alone method. For John, the corresponding number of sessions were 14 and 13. The mean number of training and probe trials per session were also computed for each child. Diane received, on average, 43.8 trials in the simultaneous communication condition, and 44.3 in the sign-alone condition. For John, the corresponding mean trial rates were 44.1 and 44.6. Thus, for both children, trial presentation rate was very similar across the two treatment conditions.

Figure 1 shows the results of the multiple baseline control procedures for each child under both treatment conditions. In each case, the acquisition of expressive signing was a function of the specific training procedure used rather than the result of any nonspecific factors such as extraexperimental classroom experience or maturation. For every sign, correct performance was never observed before training, but in almost every case a child was correct on 80% or more of trials following training. The results of the final probe session indicated that all but one sign for each child was performed correctly on 100% of probe trials.

Taken together, these data indicate the method used to train expressive signing under both conditions was highly effective, but that the conditions did not differ in terms of outcome: Signs were acquired at about the same rate whether taught via simultaneous communication or sign-alone training.

The results of the stimulus control assessment for the signs trained using simultaneous communication are shown in Figure 2. In order to facilitate comparison, the first bar of each histogram shows expressive signing performance on the last block of probe trials (involving both visual and auditory stimuli), and this was at 100% for both children. Correct signing remained at 100% for Diane when assessment was made of control by presentation of the stimulus card alone (*visual* condition), but John's performance declined somewhat. When the stimulus control of expressive signing by verbal referents was assessed (*vocal* condition), John's performance was slightly better than in the visual condition, and close to 100%, but Diane was completely unable to perform this task. Neither child responded appropriately in the *lip-reading* condition. In summary, as a result of simultaneous communication training, John's expressive signing came under the control of both visual and auditory stimuli whereas Diane's was controlled exclusively by visual stimuli.

A similar difference between the children was also seen in the posttest for verbal comprehension, the data from which appear in Table 2. This shows the number of times a child correctly indicated the stimulus card matching the word spoken by the teacher for each of the words corresponding to trained signs. The maximum score for any word on either of the test days is six. Table 2 reveals that Diane's performance on verbal comprehension was generally no better

Table 2

Verbal comprehension posttest data. The number of correct responses (from a possible six) is shown for the words corresponding to each sign trained in both conditions.

	Simultaneous Communication			*Sign-alone Training*		
	Word	*Day 1*	*Day 2*	*Word*	*Day 1*	*Day 2*
Diane	rifle	0	1	elephant	1	0
	penguin	0	0	airplane	0	0
	vacuum cleaner	3	2	boat	0	1
	rug	1	0	kite	0	0
	sheep	1	0	candle	0	0
John	jug	4	6	rifle	1	0
	mushroom	6	5	flask	0	1
	penguin	6	6	oven	2	1
	sewing machine	5	5	flower	0	0
	mixer	4	5	saucepan	1	0

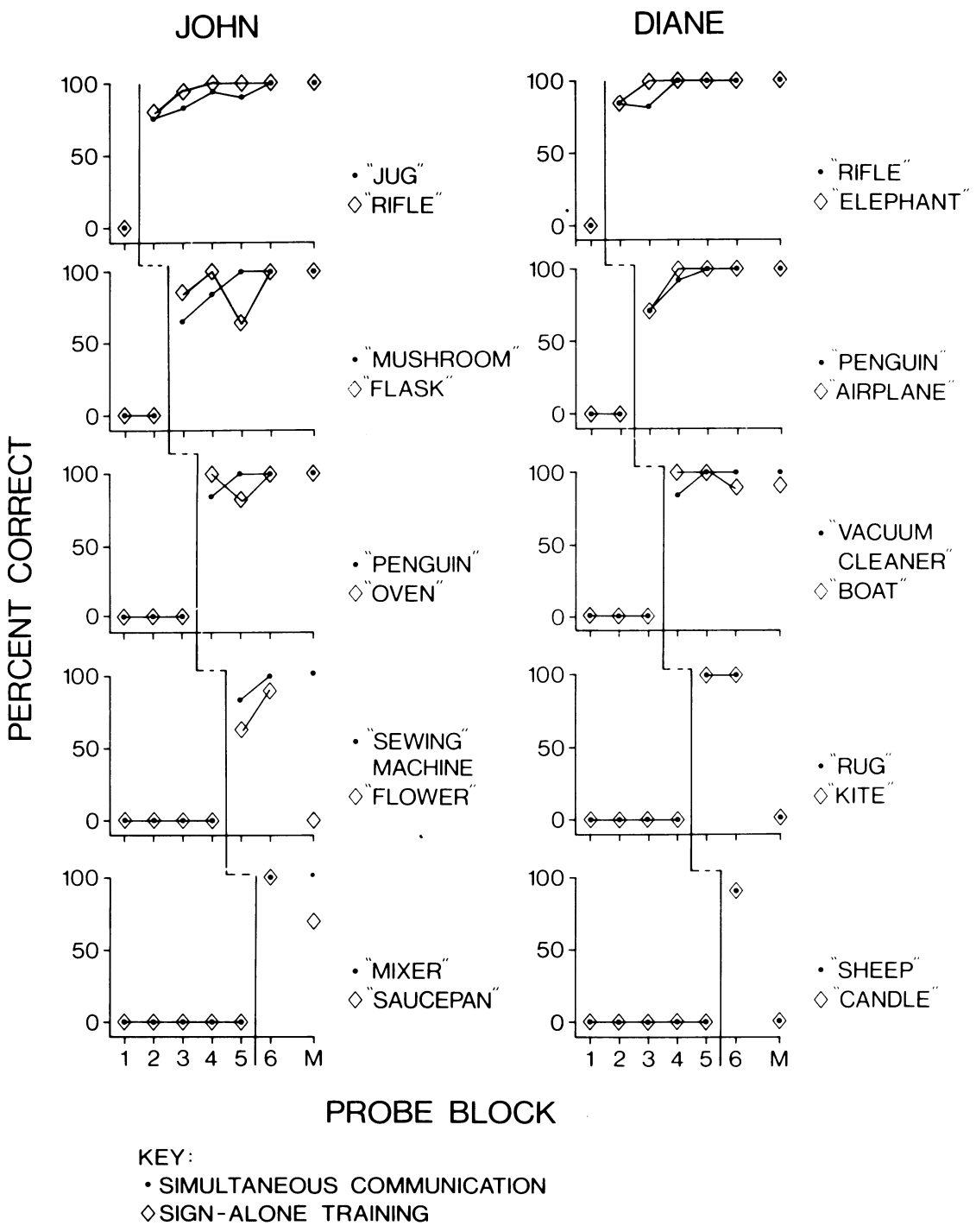

Fig. 1. Percentage of correct expressive signs obtained during probe blocks (1-6) and the maintenance test (M) in each condition. Percentages after training are to the right of the staggered vertical line.

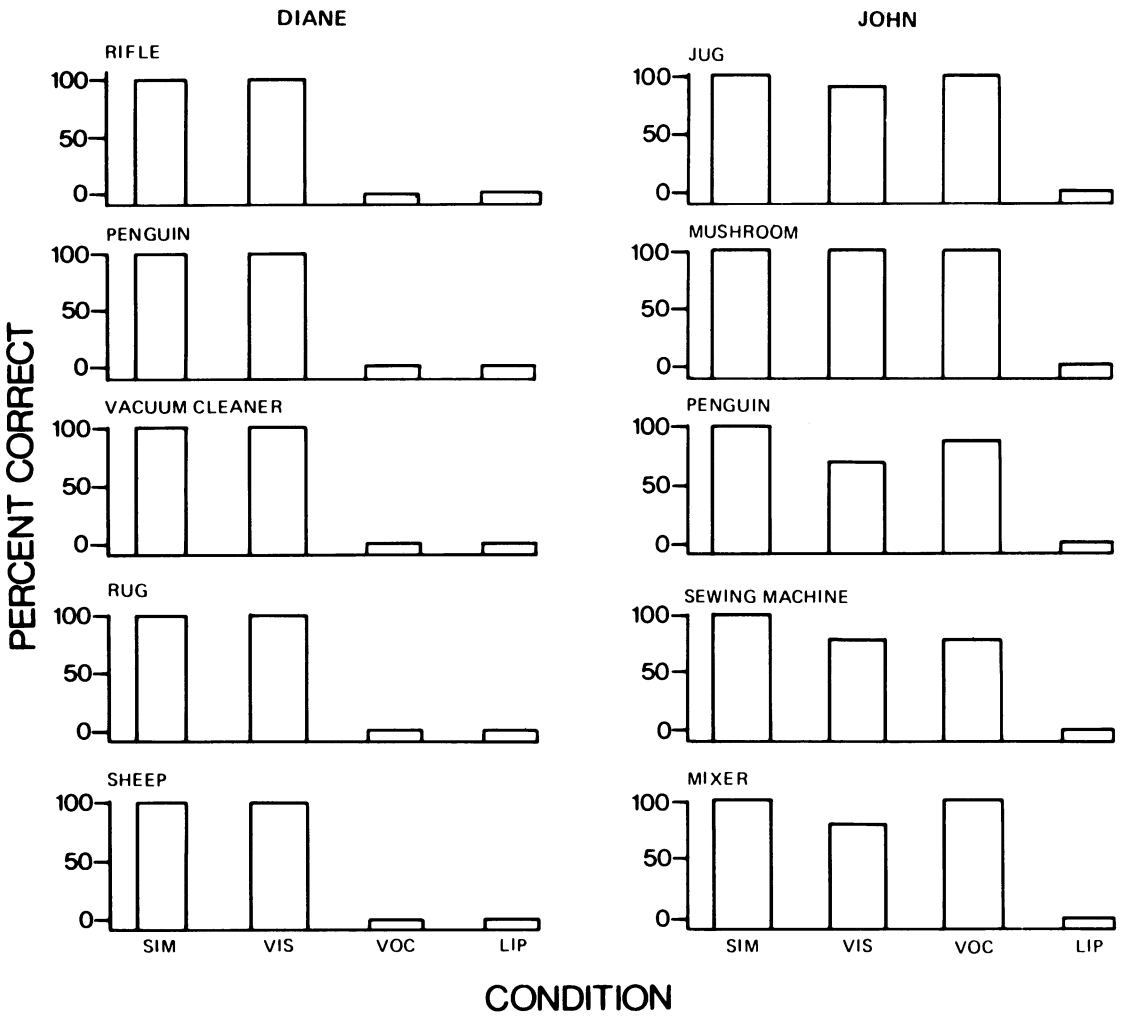

Fig. 2. Percentage of correct responses obtained during the stimulus control tests for each expressive sign trained using simultaneous communication. Data for both children are shown as a function of the stimuli presented. Under the visual condition (VIS), the teacher presented a picture to the child; under the vocal condition (VOC) she named an object while covering her lips; under the lip-reading condition (LIP) she silently mouthed the object's name. Data from the final probe block (SIM), in which stimuli in each of the above modalities were present, are included for comparison.

than at pretest on words corresponding to signs that had been trained by either method. Recall that stimulus cards were rejected as referents if a child was correct more than two times out of six on any of the three pretest trial blocks. Diane exceeded this criterion on only one of the signs taught by simultaneous communication on one test day. Conversely, John showed a high level of comprehension of all of the signs taught via simultaneous communication on both test days. Because John showed no improvement on word comprehension for words corresponding to signs taught via the sign-alone method, the results indicate that his improvement in comprehension was a function of the simultaneous communication method.

The data from the maintenance test conducted 4 weeks after the end of training are also shown in Figure 1. Expressive signing of the first three signs taught was maintained completely on retest for both children. Diane, however, showed a marked performance decrement on the

last two signs taught under both treatment conditions, whereas John showed a less marked decrement for the last signs taught via the sign-alone method, and no decrement for signs taught via simultaneous communication.

DISCUSSION

The central finding of this study was that, in terms of speed of acquisition of expressive signing, there was little difference between simultaneous communication and sign-alone training in two children of markedly different verbal ability. Although there was some variability across signs in the trials to criterion data obtained with each training method, sign-alone was as efficient as simultaneous communication in the context of the present experiment.

It is worthwhile to consider why these results conflict with those obtained by Barrera et al. (1980). Apart from minor procedural differences, the studies differed in that Barrera et al. did not pretest for comprehension of words corresponding to the signs trained. Thus, it is possible that their subject was able to make use of verbal labels used in the simultaneous communication condition to aid sign learning, a possibility obviously precluded in the sign-alone condition. A rather similar asymmetry exists between the acquisition of a first and second language. The role of existing receptive speech skills is important in this context because it may be that simultaneous communication training is *normally* more effective than sign-alone training precisely because of this factor. It would be valuable, therefore, to manipulate, rather than control, the degree to which words corresponding to to-be-trained signs were in a student's receptive vocabulary prior to sign language training. In this study, however, where extraneous factors such as this were controlled, the rate of sign acquisition was not sensitive to the use of verbal reference during training. Although a necessary implication of this control was that many of the signs taught were not highly functional outside the experimental context, the findings obtained have immediate applied significance to those involved in choosing appropriate language remediation programs for autistic children.

Signing acquisition data indicated that children learned signs quite rapidly, usually requiring fewer than 100 trials. These figures are comparable with those reported by Barrera et al. in the simultaneous communication condition, but much faster than those reported by Carr et al. (1978). This discrepancy may have arisen as a result of differences in acquisition criterion, procedure, or individual differences between the children trained. However, the rapidity with which signs were learned under both conditions could mask potential differences between the training methods which might emerge using a more complex and demanding task. Further research would be necessary to evaluate this possibility.

The second major finding of the study was that the simultaneous communication training method did affect the receptive speech skills of one of the children trained. This was seen in both the stimulus control test and the posttest for verbal comprehension. Data from the former test provided a replication of the Carr et al. finding while controlling for reinforcer facilitation effects. In the Carr et al. study one of the four participants (Bob) showed stimulus control of signing by vocal stimuli; in this study John produced a similar result. Interestingly, these were the only children in either experiment who gave evidence of verbal imitative responding prior to training. This pattern of results is reminiscent of Carr and Dores's (1981) finding that only verbally imitative children acquire receptive speech as a result of receptive training via simultaneous communication. Although differential performance may have resulted from IQ differences in the present study, the MA scores reported by Carr and Dores (1981) were not correlated with imitative ability. Carr and Dores argue that mute and verbally imitative chilidren comprise separate subgroups of the autistic population, and that this categorization is predictive of the outcome of sign and speech

training programs. The data from the posttest for verbal comprehension conducted in this study support and add some generality to their interpretation. Only the verbally imitative child showed improvements in *receptive* speech following *expressive* sign training and these changes were specific to the words used in the simultaneous communication condition. Taken together with Carr and Dores's work, these findings suggest that verbal imitation ability may be an important factor in predicting the outcome of simultaneous communication training, regardless of whether expressive or receptive signing is being taught. Because previous research has produced contradictory results regarding the effects of simultaneous communication on speech (see Kiernan, 1983), future work should incorporate a verbal imitation pretest of the kind devised by Carr and Dores (1981) in order further to evaluate the role of imitative ability in determining training outcome.

Carr and Dores's view that mute autistic children may be considered as "functionally deaf" receives only limited support from the present data. Although Diane, the mute child, acquired no receptive speech during training, her pretest data indicated that in fact she had a considerable receptive vocabulary. She was able to perform the warm-up task with a far higher success rate than would have been expected by chance, and performed similarly with 8 of the 21 words that her teacher believed she did not comprehend. These results suggest that the concept of functional deafness is too broad, and the results obtained might be better described in terms of stimulus overselectivity in situations such as simultaneous communication training where visual and auditory stimuli are conjointly presented.

These results emphasize the difficulties of making prescriptive statements regarding the appropriate intervention technique for sign language training with autistic children. It is clear that simultaneous communication is not necessarily more efficient (cf. Barrera et al., 1980), or less efficient (Bonvillian & Nelson, 1978), than sign-alone training, which is itself sufficient to produce reliable signing. Similarly, simultaneous communication does not necessarily facilitate receptive language skills, although it has the capacity to achieve this with some children. What are now required are studies designed, first, to identify the circumstances under which simultaneous communication is more effective than sign-alone training, and, second, to establish the necessary and sufficient conditions under which simultaneous communications training facilitates the acquisition of productive and receptive speech. The information provided by such behavior analytic research can be directly applied to the design of satisfactory remediation programs.

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