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Speech Following Sign Language Training in Autistic Children with Minimal Verbal Language[1]

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This study was carried out to test the main and interaction effects of training condition and pretreatment-elicited verbal imitation ability when predicting spoken language use during language training of 60 minimally verbal autistic children. Subjects were randomly assigned to Speech Alone, Sign Alone, Simultaneous Presentation of Sign and Speech, and Alternating Presentation of Sign and Speech training conditions. Speech Alone, Simultaneous Presentation, and Alternating Presentation condition facilitated more child-initiated speech during treatment than did the Sign Alone condition. Regardless of training condition, pretreatment verbal imitation ability positively predicted the size of child-initiated spoken vocabulary observed during training. Exploratory analyses indicated that, in addition to verbal imitation, pretreatment age and IQ may also predict spoken language developed during training.

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A central problem of autism is the failure to develop communicative skills (Rutter, 1968). Spoken language is a frequent target of many intervention programs with autistic children. Many professionals have searched for alternatives to the frequently used verbal imitation procedures of the 1970s (Lovaas, 1977) because thorough implementation requires a great deal of control over the environment (Hingtgen & Churchill, 1969) and often fails to facilitate generalized spoken language (Carr, 1982).

An alternative or supplemental procedure that may facilitate speech development is simultaneous communication, that is, the simultaneous use of spoken language and signing of key words. Many autistic children in such treatment programs have demonstrated increases in spoken language development (Fulwiler & Fouts, 1976; Layton & Baker, 1981; Salvin, Routh, Foster, & Lovejoy, 1977; Schaeffer, 1980; Webster, McPherson, Sloman, Evans, & Kuchar, 1973).

It remains unclear whether simultaneous communication is facilitative of spoken language acquisition because of sign training, speech stimulation, or a combined effect of speech and sign. To investigate these three possibilities, the present study compared the effectiveness of four training conditions: (a) sign training alone, (b) verbal imitation alone, (c) simultaneous presentation of sign and speech, and (d) alternating presentation between sign and speech. The fourth condition was included to determine the relative effectiveness of simultaneous versus sequential presentation fo sign and speech in facilitating oral language development.

The most clinically relevant question is not which condition is most effective but which condition is superior for which children (Friedman & Friedman, 1980). We sought to test Carr's (1979) hypothesis that pretreatment verbal limitation ability positively predicts the level of speech acquisition subsequent to sign training.

We reviewed nine studies that reported (a) teaching autistic children to use manual communication, (b) subject verbal imitation skills, and (c) a dependent measure of oral language development. Eight of the nine articles supported Carr's hypothesis (Bonvillian & Nelson, 1976; Carr, Binkoff, Kologinsky, & Eddy, 1978; Casey, 1978; Cohen, 1981; Konstantareas, Webster, & Oxman, 1979, 1980; Salvin et al., 1977; Schaeffer, Kollinzas, Musil, & McDowell, 1977). Layton and Baker's (1981) study provided an exception to the hypothesis when their mute autistic subject eventually developed some oral language.

There are at least four, not necessarily mutually exclusive explanations for why pretreatment verbal imitation ability may predict oral language development after sign treatment. First, there is evidence that autistic children with low verbal imitation skills selectively process sign over speech when signs and speech are presented simultaneously (Carr et al., 1978; Carr & Dores,

1981). Under this sign overselectivity explanation, children with low verbal imitation skill should acquire more oral language when training stimuli are presented only verbally or by alternating the presentation between sign and speech. In these two training conditions, there is no simultaneous visual input from the sign language to compete with the oral input.

Second, autistic children with low verbal imitation skills may simply have less language to use than do high verbal imitators (Prizant, 1983). Under the initial expressive language level explanation, those with low verbal imitation skills should use less spontaneous oral language than children with high verbal imitation skills regardless of training condition. Additionally, the relation between verbal imitation and spontaneous language should be nonsignificant after initial expressive language level is statistically controlled.

Third, low verbal imitators may be more severely mentally retarded than are high verbal imitators. If high verbal imitators are more intelligent, then they are likely to learn more oral language during the same number of training sessions regardless of training condition. Under this severity of mental retardation explanation, verbal imitation should be related to spontaneous oral language after controlling for initial expressive language level, but not after controlling for nonverbal IQ.

Finally, low verbal imitators may fail to process speech when it co-occurs with sign and nonsign visual stimuli, as it does in the natural environment (Lovaas & Schreibman, 1971; Pronovost, Wakstein, & Wakstein, 1966; Rincover & Koegel, 1975). Under the general visual overselectivity explanation, those autistic children with low verbal imitation skills should learn less oral language than children with more verbal imitation skills regardless of training condition. This explanation differs from the sign overselectivity explanation in that the absence of sign input is not predicted to differentially facilitate speech processing. Here, the nonsign visual stimuli that is present during all training conditions may compete with speech processing. Additionally, this explanation predicts that there should be a relation between pretreatment verbal imitation level and oral language even after controlling for initial expressive language level and nonverbal IQ.

The present investigation addressed the above issues using a five-step procedure. First, we tested whether the relation between verbal imitation and spoke vocabulary use differed across the four training conditions. That is, we were interested in a possible statistical interaction between verbal imitation and training condition when predicting spontaneous oral language. Given an interaction, we predicted that children with low verbal imitation skills would acquire more spontaneous spoken language in either alternating sign and speech condition or the verbal imitation alone condition than in the other two conditions. Second, in the absence of an interaction, we tested the relative effectiveness of the four training conditions in facilitating the amount

of acquired spontaneous oral language. Third, provided there is no interaction, we predicted that children with high verbal imitation skills would use a greater number of different spontaneous spoken words than would low verbal imitators. Fourth, as part of our effort to explain the relation between verbal imitation and spontaneous oral language, we statistically controlled initial expressive language level and nonverbal IQ while regressing spontaneous oral language use into verbal imitation level. Fifth and finally, we executed an exploratory search for other subject characteristics that may predict the amount of oral communication observed during training.

METHOD

Design

In this "true experiment," subjects were randomly assigned to treatment groups. Given random assignment, it is reasonable to assume that groups were approximately equivalent on all variables at the pretreatment period. To control for the possible effect of specific language trainers, each of the six language clinicians taught at least one subject in each of the four training conditions. Trainers were blind to the subjects' pretreatment scores and the prediction that verbal imitation would predict oral language development.

Because we were looking for an Aptitude × Treatment interaction in which the aptitude (i.e., verbal imitation) was measured as a continuous variable, a correlational, not a factorial, design was used. Measuring verbal imitation ability along a continuum allowed a more powerful test of the treatment by aptitude interaction hypothesis than does dividing the subjects into high versus low verbal imitators (Friedman & Friedman, 1980).

Subjects

Sixty autistic children were the subjects for this study. To be included in the study, each subject had to meet the following criteria: (a) be less than 9 years old; (b) have hearing and vision within normal limits; (c) fall within the moderate to severe range in autistic behavior on the Childhood Autism Rating Scale (Schopler, Reichler, DeVellis, & Daly, 1980); (d) have expressive and receptive ages of less than 28 months on the Sequenced Inventory of Communication Development (SICD; Hedrick, Prather, & Tobin, 1975; and (e) demonstrate pretreatment expressive vocabulary of 25 words or less as assessed by a parent questionnaire.

Table I. Means and Standard Deviations of Subject Description Variables by Treatment Groups

	Groups[a]							
	Alternating sign and speech		Sign alone		Speech alone		Simultaneous sign and speech	
Subject variables	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age	5.4	1.7	5.6	2.0	5.0	1.2	5.4	2.1
Nonverbal IQ	42.9	17.8	40.5	33.1	41.0	23.8	44.4	24.4
SICD expressive	15.2	12.6	9.9	6.9	12.3	6.5	11.7	8.8
SICD receptive	17.3	6.7	14.1	4.2	14.9	5.9	16.2	4.1
Initial vocabulary	6.8	7.3	4.8	7.1	6.5	7.6	3.9	7.9
Elicited verbal imitation	298.1	342.2	281.5	321.0	258.6	348.1	287.7	360.7
Number echolalic[b]	3		5		4		5	

[a]Each group has 15 subjects.
[b]Absolute number of echolalic subjects in each group.

Table I describes the treatment groups by age, nonverbal IQ (Leiter, Bayley MDI & Merrill-Palmer), SICD expressive scale, SICD receptive scale, initial expressive vocabulary (parent questionnaire), elicited verbal imitation (experimenter-designed instrument) and presence or absence of echolalia (clinical judgment).

Procedure

Pretreatment Testing and Training of Instructional Prerequisites. Prior to assignment to treatment groups, all subjects were tested on the above subject description variables and trained on certain skills assumed to be facilitative of establishing instructional control. These skills were compliance to simple directive (e.g., "Hands down; Come here"), remaining in one's seat for 1 minute during an instructional activity, and gross motor imitation.

Elicited Verbal Imitation Measure. A fourth skill, verbal imitation, was also trained and assessed before assigning subjects to training conditions. Six trained language clinicians asked each child to verbally imitate 11 sounds, words, and sentences. The items were *aah, woof-woof, quack-quack, ma, pa, hi, bye-bye, cookie, She wants more, Johnny bought a doll,* and *If you sit still you can have a book.* Contingent and noncontingent reinforcement were provided to attempt to teach the children to imitate and to maintain their attention to the task. The clinicians gave the children up to 44 trials per item or until the child gave a clear approximation of the model three out of five consecutive trials before testing the next item. The clinicians moved on after 44 trials to avoid training indefinitely.

The index of verbal imitation ability was the sum of the percentage of correct trials per item (number of correct trials/number of trials attempted)

over all 11 items. This procedure provided a possible range of scores from 0 to 1,100. Actual scores averaged 281 (*SD* = 106.5, see Table I).

Treatment Groups. Subsequent to pretreatment instruction and testing, subjects were randomly assigned to one of four language training conditions. The format and content of the language program was the same in all four conditions. However, the mode of communication or item presentation differed. Trainer compliance to prescribed treatment procedures was monitored through daily reports, phone conversations, and direct consultation.

The training conditions were Speech Alone, Sign Alone, Simultaneous Presentation of Sign and Speech, and Alternating Presentation of Sign and Speech. In the Speech Alone group, all training and behavioral management techniques were provided orally. In all conditions involving sign presentation of the training items, trainers used Signed English signs (Bornstein, Hamilton, Kannapell, Roy, & Saulnier, 1975). In the Sign alone group, signs were used during training and behavioral management without speaking. In the Simultaneous Presentation group, training and behavioral management were carried out using speech with simultaneous signing of key words. In the Alternating Presentation group, independent, sequential training of each training item occurred in both signs and speech. The order of presentation mode was laternated after every item. The Alternating treatment differed from Schaeffer's (1980) "signed speech" in that signs and speech were never presented simultaneously to subjects in this group. Behavior management was carried out using only sign one week and only speech the next week.

Language Training Program. The language training program common to all training conditions consisted of 90 individual sessions which were held daily for 40 minutes (Layton, 1983). Each session was divided into three periods. Initial comprehension and production of each vocabulary item was taught during the first 20 minutes of each session using a one-one, mass trial training format. The next 10 minutes were spent in a semistructured activity designed to facilitate generalization and child-initiated use of trained language items. Finally, the last 10 minutes were spent with the child in free play in the presence of a clinician to allow observation of the child's unstructured use of the trained items.

The words or signs selected for training met three criteria. First, they were not taught in the school or at home. Second, they could be used to obtain an object, action, or event that teacher and/or parent reported the child liked or needed. Third, they represented the general grammatic categories of normally developing children's early language development (i.e., labels for objects that can be acted on, action verbs, agents, locatives, and attributes).

Comprehension training of the vocabulary items consisted of training the child to point to a target referent from an array of three stimuli in response to "Show me (stimuli)." Placement of the target and two distractor referents was varied to prevent successful responding by location. Demonstrations and physical prompts were given as needed and later faded. All correct responses were reinforced using praise and other stimuli that had specific reinforcing value for the individual subjects. The criterion for mastery of an item was independent selection of the referent on six out of eight consecutive trials. Retention of the comprehended vocabulary item was tested and, if needed, trained to criterion during the next training session.

After demonstrating mastery of the vocabulary item on the comprehension probe during at least two training sessions, production training of the vocabulary item was begun. Production training consisted of shaping the child's use of the target items in response to the question "What?" or "What want?." Physical, sign, and verbal prompting of a child response was given as needed and later faded. Approximations of the adult form of the vocabulary item were reinforced until the child reached the mastery criteria of six correctly produced items out eight consecutive trials. Vocabulary items were trained until the child reached mastery criterion at least two consecutive days.

Generalized and child-initiated communicative use of the vocabulary items were elicited using the incidental teaching format during the semistructured 10-minute session (Alpert & Rogers-Warren, 1985). This procedure involved sabotaging the environment so that the child must request assistance in obtaining some referent of interest. For example, a cookie may be placed in a clear jar that has a tight lid. The child must request the cookie to receive the cookie.

Dependent Measure

The dependent measure in the present study was the total number of different child-initiated spoken words observed during the 40-minute training sessions. Words could be, but did not have to be, accompanied by signs to be counted in this measure. Only child-initiated spoken utterances were recorded to help insure that the child was using the words in an intentionally communicative fashion. This criterion excluded echolalic speech or response to teacher prompts or models.

The language clinicians used direct observation to orthographically record the utterances as they occurred. Reliability of the recording system was checked before language training started. Percentage agreement on the

occurrence of specific words averaged 93.5% before the study began. Reliability of the actual dependent scores was checked three times during the study. The clinicians maintained at least 85% agreement with an independent observer on the number of different words recorded during a session.

RESULTS

As implied in the Design section, multiple regression analyses were used to test the hypotheses. When included as one of the predictors, training conditions were coded as "dummy variables" (Pedhazur, 1982).

Due to the violations in the assumptions of multiple regression, the original dependent scores were transformed. We used the log transformation method (i.e., $\log_{10}(x + 1)$ = new score) to transform the number of different child-initiated spoken words (Kirk, 1982). Using the transformed scale of dependent scores, no violations of the assumptions were found. Therefore, all subsequent analyses were performed using the transformed scale of the dependent measure.

Our first hypothesis, that there would be a training condition by verbal imitation level interaction when predicting the number of different child-initiated spoken words, was not supported ($F < 1$). Therefore, the interaction term was dropped from the subsequent regressions.

The regression model containing only verbal imitation and training condition did strongly predict the transformed number of different-initiated words ($R^2 = 0.63$, $F = 23.10$, $p < .0001$). Only three children's actual dependent scores were greater than 2 standard deviations from their predicted scores (standard residuals = 2.06, 2.07, 2.60) indicating that treatment group and pretreatment verbal imitation abilities were predictive of spontaneous oral language use by all but 3 of the 60 subjects.

As predicted, there was a significant treatment effect after controlling for verbal imitation level ($F = 2.95$, $p < .05$). Subjects in the Sign Alone group (transformed $M = 0.78$, $SD = 0.62$; original $M = 13$, $SD = 17$) used significantly fewer spontaneous words than subjects in the other three groups (Scheffé's $D = 0.39$, $p = .01$). The treatment effects of Speech Alone (transformed $M = 1.25$, $SD = 0.67$; original $M = 38$, $SD = 47$), Simultaneous Presentation of Sign and Speech (transformed $M = 1.01$, $SD = 0.78$; original $M = 31$, $SD = 40$), and Alternating Presentation of Sign and Speech (transformed $M = 0.97$, $SD = 0.64$; original $M = 24$, $SD = 44$) were not significantly different from each other.

As predicted, there was a significant main effect for verbal imitation after controlling for the treatment effect ($F = 84.80$, $p = .00001$). That is, the subjects with the higher verbal imitation scores tended to use more spontaneous words regardless of their treatment group.

Table II. Significant and Nonsignificant Predictors of the Transformed Number of Different Child Initiated Spoken Words Used During Treatment Sessions

Predictor model	R^2	F^a	p
Full model	.69	40.93	.0001
SICD expressive age		8.32	.006
IQ		6.60	.01
Elicited verbal imitation		9.52	.003
Full model	.65	52.9	.0001
SCID expressive age		13.62	.0005
Elicited verbal imitation		11.11	.0015
Full model	.64	50.72	.0001
IQ		11.73	.001
Elicited verbal imitation		41.51	.0001

[a] F values for individual variables' regression coefficients after controlling for other predictors.

To test the relative fit between the data and the explanations for the relation between verbal imitation and verbal vocabulary, the transformed dependent measure was regressed onto verbal imitation while controlling for the individual and combined effects of IQ and initial expressive language level. The SICD expressive scale (SICD-E) was the only measure of initial expressive language that was related to the dependent variable after controlling for verbal imitation level. Therefore, the SICD-E was used in analyses requiring a measure of initial expressive language level.

As indicated in Table II, verbal imitation level was positively related to the child-initiated spoken vocabulary during treatment even after controlling for both IQ and SICD-E ($F = 9.52, p < .01$). Smaller models with only verbal imitation and SICD-E ($F = 11.11, p < .01$) as well as verbal imitation and IQ ($F = 41.41, p < .0001$) also yielded significant relations between verbal imitation and the dependent measure.

Exploratory analyses of other subject characteristics that may predict the dependent variable were executed. To allow prediction within homogeneous groups with respect to the dependent variable, one analysis was carried out on subjects in the Sign Alone group ($n = 15$), and a second was carried out on subjects in Speech Alone, Simultaneous Presentation, and Alternating Presentation groups ($n = 45$). The predictor variables were the following pretreatment characteristics: size of reported initial vocabulary, age, SICD-receptive age, SICD-expressive age, IQ, and verbal imitation level. The following results report all variables that were significantly related to the dependent variable after controlling for all other predictors in the model.

The backwards stepwise regression on the Sign Alone group indicated that SICD-E ($F = 4.53, p < .05$) and verbal imitation level ($F = 10.39, p$

$< .0001$) predicted size of child-initiated spoken vocabulary ($R^2 = .85$, $p < .0001$). The regression on the remaining three conditions indicated that age ($F = 20.70$, $p < .0001$), IQ ($F = 8.90$, $p < .01$), and verbal imitation level ($F = 57.15$, $p < .0001$) predicted the dependent variable ($R^2 = .78$, $p < .0001$).

DISCUSSION

The present study investigated the possible interaction of pretreatment verbal imitation abilities and four language training conditions in predicting the number of different spontaneous spoken words observed during treatment. Having found no such interaction, main effects for training condition and pretreatment verbal imitation abilities were investigated. Several additional analyses were carried out to eliminate alternative explanations for the relation between verbal imitation and the number of spontaneous words used during treatment. Finally, exploratory analyses were executed to identify additional subject characteristics that predicted the number of spontaneous spoken words.

The results indicate that training conditions that included verbal input and the expectation for verbal output were superior to the Sign Along condition in facilitating child-initiated use of spoken words. The present use of random assignment to treatment groups provides strong evidence that spoken language is facilitated in autistic children with very little pretreatment language. It should be noted that the effect of these treatments on other modes of communication (e.g., sign language) was not evaluated in the present study.

Other studies have also found that autistic children have increased oral language skills after participating in simultaneous sign and speech training (Fulwiler & Fouts, 1976; Layton & Baker, 1981; Salvin et al., 1977; Schaeffer, 1980). Given the present nonsignificant differences between Speech Only, Simultaneous Presentation, and Alternating Presentation of speech and sign, it remains unknown whether it was the sign or the oral component of these training programs that facilitated spoken lexical development.

The first three explanations for the verbal imitation–oral language development relation discussed in the introduction are not supported by the results of this study. The explanation proposing that low verbal imitators selectively process signs over speech only when speech and sign are presented simultaneously (i.e., sign overselectivity) must be rejected because high verbal imitators used more spontaneous spoken words than did low verbal imitators regardless of whether sign and speech were presented simultaneously. The explanations proposing that low verbal imitators may have lower initial expressive language levels and/or more severe mental retardation are

rejected because verbal imitation level and the size of the spoken vocabulary were related even after controlling for initial expressive language and cognitive levels.

The present data are compatible with the general visual overselectivity explanation. That is, autistic low verbal imitators selectively fail to process speech in favor of sign and nonsign visual stimuli, at least when speech is presented in the natural environment where some visual stimuli is nearly always present. As predicted under this explanation, the present study found that low verbal imitators used fewer spoken vocabulary words than did high verbal imitators regardless of training condition. Additionally, even after controlling for different IQ and initial expressive language levels, autistic children with low verbal imitation abilities used fewer spoken words during training than did high verbal imitators.

Past research also supports the general visual overselectivity explanation. Several researchers have found that severely retarded and autistic children selectively attended to visual information when auditory and nonsign visual inputs were presented simultaneously (Lovaas & Schreibman, 1971; Lovaas et al., 1971; Pronovost et al., 1966; Rincover & Koegel, 1975). Additionally, Carr et al. (1978) and Carr and Dores (1981) have demonstrated that low imitating autistic children learn only sign when speech and sign are presented together. In contrast, their autistic children with high verbal imitation skills learned both speech and signs when presented simultaneously. Carr, Pridal, and Dores (1984) found that pretreatment verbal imitation abilities predicted autistic subjects' posttreatment comprehension of spoken language but not their comprehension of sign language.

Future research is needed to investigate a causal relationship between verbal imitation and oral language development in autistic children. For example, one could compare the spoken language skills that autistic children who have received pretreatment verbal imitation training have learned in language training with that of a control group of similar children who have not received such verbal imitation training.

The results of the exploratory analyses provide an additional basis for future research. Because a predictive model can be significant in one sample but not in another, replication of the following results is needed before generalizations can be assumed. The exploratory predictive models accounted for 78 and 85% of the variance in the dependent variable suggesting that they hold promise for predicting spontaneous verbal language in future studies. The finding that initial expressive language level is a significant predictor even after controlling for verbal imitation in the Sign Alone group, but not in the other groups, suggests that the Sign Alone treatment may have facilitated little spoken vocabulary beyond that expected by the pretreatment expressive language level.

In summary, the present study provides confirmatory evidence of the relation between pretreatment verbal imitation abilities and the number of spontaneous spoken words used during four language-training conditions. Those subjects in conditions using speech input used a greater number of different spoken words during training than did subjects in a Sign Alone condition. In addition to verbal imitation abilities, exploratory analyses suggest that when the training includes verbal input, pretreatment child characteristics of age and IQ may also predict spoken language output. Finally, the authors make a call for experimental research that examines a possible causal relationship between verbal limitation and posttreatment language development.

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