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Increasing Speech Intelligibility in Children with Autism

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Accumulating studies are documenting specific motivational variables that, when combined into a naturalistic teaching paradigm, reliably influence the effectiveness of language teaching interactions for children with autism. However, the effectiveness of this approach has not yet been assessed with respect to improving speech intelligibility. The purpose of this study was to systematically compare two intervention conditions, a Naturalistic approach (which incorporated motivational variables) vs. an Analog (more traditional, structured) approach, with developmentally similar speech sounds equated within and across conditions for each child. Data indicate that although both methods effectively increased correct production of the target sounds under some conditions, functional use of the target sounds in conversation occurred only when the naturalistic procedures were used during intervention. Results are discussed in terms of pivotal variables that may produce improvements in speech sounds during conversational speech.

KEY WORDS: Speech intelligibility; naturalistic approach; analog approach; autism; pivotal response.

INTRODUCTION

Communication difficulties are common in children with autism, and intervention attempts have been difficult. Early approaches to intervention for teaching speech often required massive numbers of trials presented repeatedly in an analog teaching paradigm. Three major difficulties encountered were that: (a) gains were extremely slow (often requiring many thousands of trials to teach a single word); (b) when speech gains occurred they were often minimal; and (c) the children typically were unmotivated to be involved in the teaching sessions, frequently exhibiting severe disruptive behaviors (L. K. Koegel & Koegel, 1995; Lovaas, 1977). As a result, more recent research has focused on variables that increase the child's responsivity to the communication task.

Accumulating studies are documenting specific motivational variables that reliably influence the effectiveness of language teaching interactions. For example, incorporating the child's choice, lead, and interest in the selection of target stimuli during language intervention have been shown to increase learning in children with autism and other types of disabilities with expressive language delays (Camarata, Nelson, & Camarata, 1994; Hart & Risley, 1992; L. K. Koegel & Koegel, 1995; Warren & Kaiser, 1986; Yoder, 1987). Task variation and variation of the stimulus materials (Dunlap, 1984; Dunlap & Koegel, 1980), and using natural reinforcers (R. L. Koegel & Williams, 1980; Saunders & Sailor, 1979; Skinner, 1979) also seem to be important variables that positively influence the effectiveness of interventions. Additionally, reinforcing a child's communicative attempts, rather than only reinforcing correct motor speech responses in a narrowly defined shaping procedure, has been shown to enhance learning (R. L. Koegel, O'Dell, & Dunlap, 1988; O'Dell, Dunlap, & Koegel, 1983; O'Dell & Koegel, 1981). A number of researchers have reported an especially effective intervention outcome in terms of efficiency of language learning across communicative environments, when the above procedures are combined

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(Camarata, 1996; Camarata & Nelson, 1992; Camarata *et al.*, 1994; Halle, Marshall, Spradlin, 1979; Kaiser, 1993; R. L. Koegel, O'Dell, & Koegel, 1987; McGee, Krantz, & McClannahan, 1985; Warren & Gazdag, 1990). These procedures closely parallel the learning parameters available in the ambient naturalistic linguistic environment, and therefore, many have referred to the general approach as "naturalistic."

Another potentially important application of this naturalistic intervention methodology relates to children whose speech is largely unintelligible (Camarata, 1993; R. L. Koegel *et al.*, 1988; Moerk, 1992). For example, R. L. Koegel *et al.* (1988) suggested that reinforcing verbal attempts improved speech sound production in children with autism. Further, the children who participated in that study were rated as happier, more enthusiastic, more interested, and better behaved during sessions when their verbal attempts to speak were reinforced. This literature suggests that embedding motivational variables such as those described within the naturalistic interventions may also be effective for improving intelligibility of children with numerous speech sound production errors. Therefore, the purpose of this study was to systematically compare two intervention conditions, a naturalistic versus an analog teaching paradigm, with speech sounds equated within and across conditions for each child.

METHOD

Participants

Five children, four boys and one girl, participated in this study. Four of the children were of European American descent, one was of Asian American descent, and all were monolingual English speakers. All five of the children were diagnosed with autism in accordance with the diagnostic criteria for autism as defined in the DSM-IV (American Psychiatric Association [APA], 1994) by outside agencies and referred to our clinic for treatment due to poor speech intelligibility. All children were enrolled in speech/language services through the public schools, however, services were coordinated so that the children did not receive any speech sound intervention during the course of this study. In addition, the children met the following criteria for inclusion in this study: (a) estimated hearing acuity within the normal range; (b) documented evidence of a minimum of a 12-month expressive speech and language delay, as measured by a battery of standardized language tests and by language samples; and (c) speech intelligibility often unintelligible to conversational partners and functioning below expected levels for same age peers, as measured by both the Arizona Articulation Proficiency Scale (AAPS; Fudala & Reynolds, 1986) and by language samples collected across a number of settings and contexts.

Child 1 was 5 years 6 months old at the start of the study and was enrolled in a regular education classroom at a private school with special education support services. On the battery of standardized tests, including the Peabody Picture Vocabulary Test—Revised (PPVT-R; Dunn & Dunn, 1981), the Expressive One Word Picture Vocabulary Test—Revised (EOWPVT-R; Gardner, 1990), and the Clinical Evaluation of Language Fundamentals—Revised (CELF; Semel, Wiig, & Secord, 1980), his language was estimated to be at the 4 year 3 month level, slightly over a year below his chronological age level. His AAPS total score was 89.5 (18th percentile), with 13 phonological errors, beginning at the 3-year-old level. Additionally, he produced numerous speech production errors when speaking in multiword utterances, and was frequently unintelligible during conversation.

Child 2 was 6 years 0 months old at the start of the study, and attended a regular education classroom with special education support services in a public school. His parents requested additional services due to his delay in language skills and lack of intelligibility in speech production. On a battery of standardized tests (PPVT-R, EOWPVT-R, Assessment of Children's Language Comprehension (ACLC; Foster, Giddan, & Stark, 1983), and the Communication Domain of the Vineland Adaptive Behavior Scales (VABS; Sparrow, Balla, & Cicchetti, 1984); he functioned from $1\frac{1}{2}$ to 3 years below his chronological age level. On the AAPS his total score was 82.5 (below the 3rd percentile), with 20 phonological errors, beginning at the 3-year-old level.

Child 3 was 7 years 6 months old at the start of the study, and was referred to our clinic due to behavior and communication concerns. He attended both a regular education class with special education support services and a special day class for children with severe disabilities. A functional analysis indicated that his poor articulation skills and the inability of others to understand his speech attempts led to

many inappropriate behaviors. On a battery of standardized tests, including the PPVT-R, the EOWPVT-R, the Test of Early Language Development (TELD; Hresko, Reid, & Hammill, 1981), and the VABS, he typically functioned 2 3/4 years below age level. On the AAPS his total score was 72 (below the 1st percentile), with 25 phonological errors, beginning at the 2 year 6 month age level.

Child 4 was 3 years 8 months old at the start of the study, and was having difficulty communicating with others in his regular education preschool classroom due to poor speech intelligibility. On a battery of standardized tests, including the PPVT-R, the EOWPVT-R, and the VABS, he functioned from 7 months to 1 year below age level. His total AAPS score was 78 (6th percentile), with 25 phonological errors, beginning at the 2-year-old age level.

Child 5 was 5 years 0 months old at the start of the study, and was referred to our clinic by her parents, who reported an inability to understand their daughter's speech. She attended both a regular education class with special education support services and a special day class for children with communicative disabilities. On a battery of standardized tests, including the PPVT-R, the EOWPVT-R, the TELD, the ACLC, and the VABS, she functioned at about the 2 year 6 month age level, approximately $2^1/_2$ years below her chronological age level. Her AAPS total score was 73.5 (4th percentile), with 23 phonological errors, beginning at the $1^1/_2$-year-old level. Additionally, when she attempted to speak in multiword utterances, almost all of her speech was unintelligible.

Design

An ABA design (Barlow & Hersen, 1984) was employed with order of conditions counterbalanced to control for order effects. Target sounds were equated across conditions for each child by selecting a pool of sounds for treatment that were produced incorrectly and that were developmentally similar. Developmentally similar was defined as appearing within a similar chronological age within the developmental literature (i.e., Goldman & Fristoe, 1986; Prather, Hedrick, & Kern, 1975; Sander, 1972; Templin, 1957). For example, /b/, /d/, /n/, /m/, /p/, /t/, and /h/ would be considered as developmentally similar because all are mastered (90% correct criterion) by 36 months of age. Similarly, /r/, /l/, /v/, /s/, /z/, /θ/, /dʒ/, /t/, and voiced "th" would be considered later developing sounds (i.e., beyond 48 months). While some authors place /t/ at a lower developmental level, others include it with later developing sounds (i.e., Sander, 1972). Therefore, in the present study, /t/ was assigned to both treatments to ensure counterbalancing. Target sounds were then arbitrarily assigned to one of the two experimental treatment conditions. This resulted in the target sounds being approximately equal and unsystematically assigned to conditions, and some identical sounds being assigned to both treatment conditions within and across children. The specific sounds assigned to each child were as follow. For Child 1 sounds were "v" (as in van) in initial position in words; "th" (as in throw) in initial position in words; "th" (as in bath) in final position in words. For Child 2 sounds were "l" (as in like) in initial word position; "r" (as in rock) in initial word position, and "th" (as in thumb) in initial word position. For Child 3 sounds were "s" (as in sand) in initial word position; "ch" (as in chew) in initial word position; and "l" (as in like) in initial word position. For Child 4 sounds were "t" (as in bat in final word position, "g" (as in bag) in final word position, and "th" (as in bath) in final word position. For Child 5, sounds were "j"/dʒ/ (as in juice) in initial word position, "t" as in bat) in final word position, and "th" (as in that) in initial word position.

Procedure

Within each condition in the ABA design, a baseline phase preceded the assigned experimental (Naturalistic vs. Analog) treatment condition. Children typically participated in each intervention condition (Analog or Naturalistic) for a minimum of 20 sessions. However, conditions were considered complete if the child was responding in a stable manner at above 80% correct productions of the target sound during conversation for approximately four consecutive sessions. In addition, consistent with the Human Subjects Protocol, conditions were discontinued following four consecutive sessions of repeated verbal and nonverbal expressions of discomfort with the task during a session.

Baseline

Prior to the implementation of each of the experimental treatment conditions, baseline measures were obtained for each of the targeted sounds during

language samples (as described below in the Dependent Measures section). Throughout the experiment, measures were obtained in three settings: (a) a separate room in the clinic building with a person other than the clinician; (b) at home with family members; and (c) at school with peers. These sessions were videotaped for later analysis so as not to interfere with the natural conversational flow. Conversational partners in the clinic and the home settings were instructed to simply engage in con- versation with the child while playing or participating in an activity together. Language samples in the school setting were obtained while the children were interacting with peers, such as free time, recess, and lunch time. No guidelines or instructions were provided.

Treatment

Following each baseline assessment, one of the experimental treatment conditions (Analog vs. Naturalistic) was implemented in accordance with its assigned (counterbalanced) order within the ABA design. In both conditions, treatment sessions were conducted twice a week for 45 min per session by a clinician with graduate level training in each of the treatment procedures employed in the study. Treatment sessions were observed for fidelity of implementation for each clinician in each condition by two licensed speech pathologists, with both observers independently agreeing that the steps and intervention procedures in Table I were implemented as described in all instances.

Analog Condition. Intervention was implemented as follows. The clinician first worked on production of the target sound in isolation until an 80% correct production criterion on 20 trials was achieved. To do this, the clinician modeled the target sound and asked the child to repeat it. If the child responded correctly, the clinician gave the child social praise and a desired object or edible reward. If the child's response was incorrect, the clinician provided the child with visual and motor placement cues (e.g., "Put your tongue between your teeth like this." [to make the "th" sound]). In this step and all subsequent steps the child was rewarded as described above on both prompted and other correct responses using a shaping paradigm. That is, each sound production had to be as good or better than the previous sound production in order to be reinforced. After the child was able to imitate the sound correctly at an 80% level, the clinician then asked the child to produce the target sound spontaneously without a model ("Say it by yourself."). When the child was able to produce the target sound spontaneously at the 80% criterion level, production of the target sound was taught in a word. To do this, one pool of stimulus items consisting of 20 pictures and photographs of

Table I. Differences Between the Analog and the Naturalistic Conditions

	Analog	Naturalistic
Stimulus items	Chosen by clinician Pictures/photographs containing target sounds	Chosen by child Objects and toys containing target sounds Selection of items of high interest to child
Steps	Begin with sounds in isolation; drill until mastered Sounds presented sequentially in words, phrases, and sentences; drill until mastered at each level	Begin with word production of item Productions are immediately imbedded in words, phases, and sentences in naturalistic conversational play interactions until mastered
Interaction	Clinician models sound production Direct feedback (e.g., motor placement cues)	Clinician models word following child attempts Clinician and child naturally (play) interact with stimulus items
Response-reinforcer contingency	Child verbally reinforced for production of correct responses in a shaping paradigm, with successive approximations reinforced, and feedback provided for motor placement	A broad shaping contingency was employed so that both correct responses and verbal attempts were reinforced, and included a correct model of the target sound
Consequences	Social reinforcers, desired objects, and edible reinforcers	Social reinforcers, and natural reinforcers (e.g., opportunity to play with stimulus item)

objects containing the target sound was chosen by the clinician. The clinician held up the picture and modeled the sound production and gave prompts as described above (if the child responded incorrectly). Again, the child received social reinforcers, token reinforcers, and edible reinforcers as described above. When the child reached an 80% criterion, the child was asked to produce the sound in a word spontaneously, using the pictures as stimuli to evoke the word. This same procedure was then repeated with the target sound contained in phrases, a sentence, and then in gradually increasing numbers of sentences. Table I itemizes the steps and procedures employed in the Analog condition, and compares them directly with the Naturalistic treatment condition described below.

Naturalistic Condition. Intervention was implemented as follows. The clinician began working on production of the target sound in words occurring during natural interactions, without working on the sound in isolation. To do this, of a pool of 20 stimulus items was selected for each sound. In contrast to the analog condition where stimulus items were selected only with respect to their containing the targeted sound, regardless of the child's interest in the item, three criteria were used for selection of stimulus items in the naturalistic condition: (a) the label of the stimulus item contained the target sound (e.g., "v" in the word van) or a verb directly related to the use of the stimulus item contained the target sound (e.g., "r" for roll the ball); (b) the stimulus items were selected for use during each session only if they had high interest value for each particular child; and (c) objects and toys were selected that would provide naturally reinforcing consequences when the item was accessed by the child. Further, to increase motivation, opportunities for child choice of activity with the stimulus items were made available within the session (catch the football, throw the football, etc.) using the pool of high interest toys and objects. During each session, the clinician modeled the target sound in words, phrases, and sentences as they naturally came up in the play interactions. A broad shaping contingency was employed, so that following the child's correct productions of the target sound or attempts to produce the target sound in words, phrases or sentences, the child was naturally reinforced with the opportunity to play with the stimulus items, paired with social reinforcers. When the child did not attempt to produce the target sound, the clinician modeled the correct production of the sound in the word, and waited for the child to make a correct response or attempt before giving the child the reinforcing item.

Dependent Measures

Data were recorded on the children's correct production of the target sounds under two language sampling conditions: (a) Prior to each treatment session, language samples were recorded for a minimum of 10 min, with the requirement that there be at least 6 productions of the target sound in each sample. During each sample, the child interacted with a familiar person other than the clinician. Conversational partners were instructed to simply engage in conversation with the child while playing or participating in an activity together. (b) In addition, periodic language samples were obtained within the child's home while the child interacted with family member(s) and within the child's school while the child interacted with classmates, with the requirement that there be at least 50 utterances, and at least 3 productions of the target sound in each sample. (c) Finally, to assess whether there were improvements in subjective ratings of the children's overall intelligibility during unstructured conversational interactions, as a function of improvements in speech production of the target sounds in the language samples, pre and post ratings were made by listeners who were unfamiliar with the children and naive to the experimental conditions and hypotheses. For each child, a 6-point Likert scale was utilized to rate four 5-min segments selected from the pre and post language samples while the children were engaging in conversational interactions. To eliminate order effects and experimenter drift, the observers viewed the tapes in a random order. Scores could range from 0 (*not intelligible, very difficult to understand*) to 5 (*very intelligible, easy to understand*). The Appendix presents the full rating scale.

Language samples were videotaped, using a small wireless microphone, in order to prevent data recording from interfering with the pace of the conversation. Words containing the target sound were transcribed by individuals who were familiar with each child. Correct and incorrect production of the target sound was then recorded from the transcripts. Correct productions were defined as target sounds produced without substitution or distortion. Incorrect speech productions were defined as the child omit-

ting or distorting the target phoneme, or substituting another phoneme in its place. Percentage correct production of the target sound was then computed for each session.

Reliability

Reliability measures were obtained by two independent data recorders (who were graduate or undergraduate students with previous training in the recording of speech production) for 68 (i.e., 20%) of the language samples, with reliability measures occurring in all conditions for all children. To control for experimenter bias, at least one of the observers was naive to the experimental condition in over 50% of the sessions. Reliability was calculated on a trial by trial basis according to the formula, agreements times 100 divided by agreements plus disagreements. Using one transcript as the master and one as the reliability measure, agreements were defined as the two observers recording identical speech production sounds on a given trial. Disagreements were defined as one observer recording the speech production as correct, and the other observer recording it as incorrect. Interrater reliability scores averaged 87%, with a range of 81–89% across children (kappa was .686, corresponding to a "very good" level of agreement for categorical data; Fleiss, 1981; Landes & Koch, 1977). On the speech intelligibility rating scales, reliability measures were obtained for 10 (i.e., 50%) of the sessions. Both observers recorded exactly the same score for 6 of the 10 ratings, a 1-point difference for 3 sessions, and a 2-point difference for 1 session.

RESULTS

The results from the language samples, showing functional use of the targeted speech sounds, are shown in Fig. 1. Baseline measures indicate that the target sounds were produced incorrectly prior to treatment in each condition for each target sound. Within the ABA design, treatment for Child 1 began with the naturalistic treatment condition for his first target sound. As indicated in the figure, his production of the target sound improved throughout this phase, reaching 100% correct production by the end of the condition in all three settings in which language samples were taken. These settings included a different room in the clinic building, the child's home, and the child's school setting.

Within the context of the ABA design, the treatment condition for a new target sound was then changed from the naturalistic condition to the analog condition for Child 1. Correct production of the target sound remained at or near zero in the language samples throughout the analog treatment condition. The results indicate little or no correct conversational use of the target sound occurred in any of the three language sample settings. Consistent with the ABA design, a target sound was then treated within the naturalistic treatment condition. Similar to the first naturalistic phase, the correct production of the sound within the language samples increased rapidly and reached an initially high level of over 80% correct production within four sessions.

These results are replicated with Children 2, 3, 4, and 5. That is, for all sounds, high levels of correct conversational use of the target sounds only occurred when treatment was conducted within the naturalistic condition. Treatment for Children 1 and 2 began with the naturalistic condition followed by the analog condition with a return to the naturalistic condition. For Children 3, 4, and 5, treatment began with the analog condition followed by the naturalistic condition with a return to the analog condition. Again, the pattern was consistent for all of the children. The language sample results indicate that these children exhibited low levels or no correct conversational use of the target sound during the language samples when treatment was conducted using the analog procedures. In contrast, all of the children showed high levels of correct conversational use of the targeted sounds in the language samples when treatment was conducted using the naturalistic procedures.

It is also noteworthy that Child 5 exhibited large increases in disruptive and avoidance behavior during the analog conditions (refusing to enter the room or sit in the chair, verbally expressing "No cards," etc.) so that those analog sessions were terminated to be in compliance with the Human Subjects Protocol (see Participants section). Such avoidance responding and expressions of discomfort by the children never occurred during the naturalistic sessions.

In summary, regardless of the order of conditions, the data indicate low levels or no correct conversational use of the targeted speech sounds during the language samples when treatment was conducted within the analog condition. However, large gains, usually to near 100% correct conversational use of

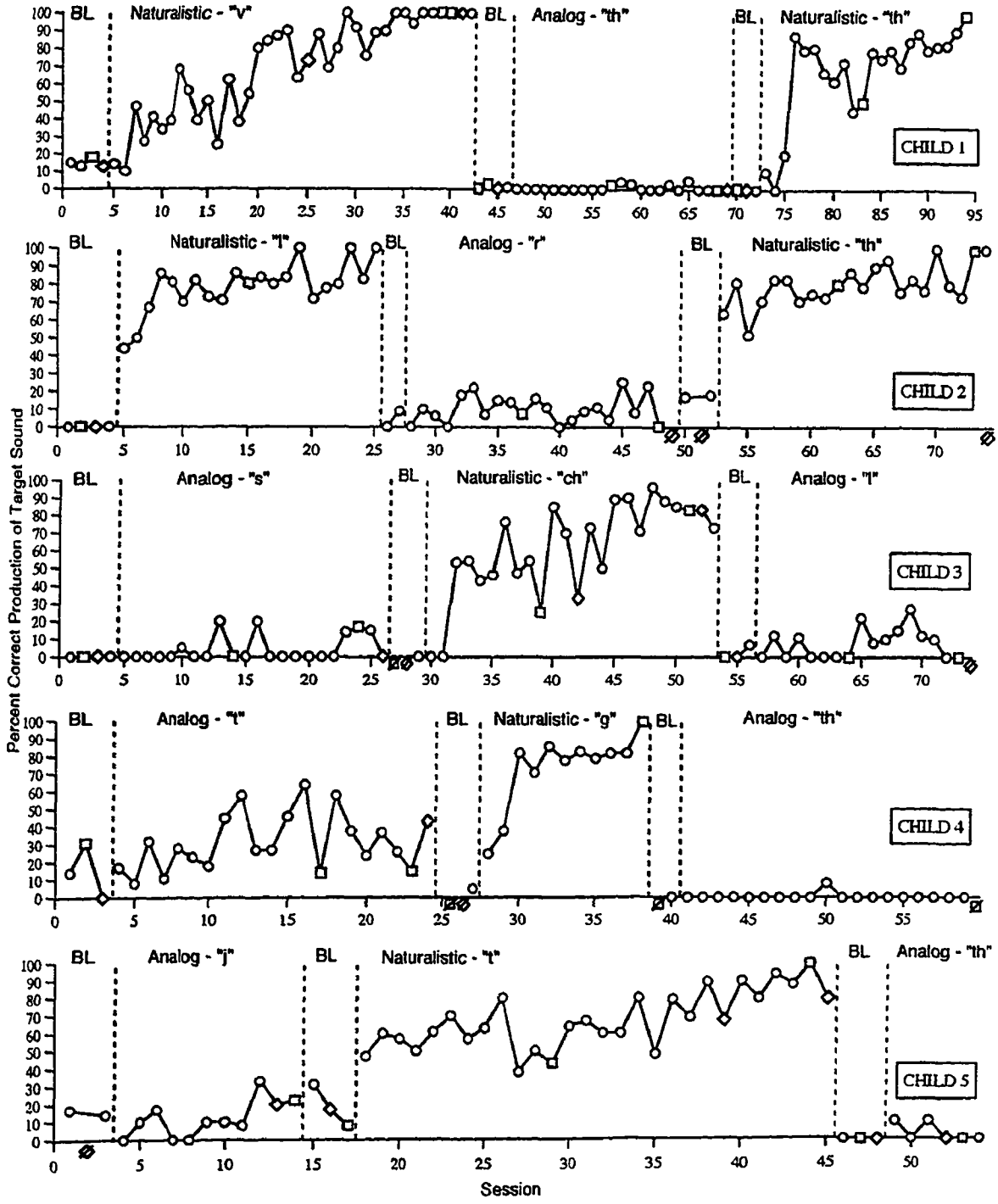

Fig. 1. Percentage correct production of target sounds within language samples measured during each treatment phase. Circles indicate language samples in a different room in the clinic building with a person other than the clinician while the squares and diamonds represent samples at home with family members and at school with peers, respectively. Symbols with hatch marks reflect that insufficient opportunity to use words containing the target sound occurred during the language sample.

the target sound, during the language samples occurred when treatment was conducted in the naturalistic condition. These results were consistent for all five children, regardless of the target sounds or of the order of experimental conditions. Thus, the naturalistic procedures repeatedly resulted in greater treatment gains in comparison to the analog procedures.

Treatment Gains in the Analog Condition

Because the analog condition required working on the target sound in systematically increasing difficulty of steps (sound in isolation, sound in words, etc.), it was necessary to keep data on the children's progress on these steps. The outcomes of these data are interesting given the above results showing that within the analog condition the children only responded correctly at low levels during the language samples plotted in Fig. 1. Table II shows the criterion level reached with the clinician present in the treatment sessions for each sound within the analog condition. The results of the target sound acquisition showed that in almost every instance the children learned to produce speech sounds at some level during the analog condition within the clinical treatment sessions. For example, Children 1 and 3 reached criterion at the sentence and multiple sentence levels, and Children 4 and 5 reached criterion for correct production at the word and/or phrase levels. Thus, 4 of the 5 children made substantial gains within the analog clinical intervention sessions. However, referring back to Fig. 1, in no case did this progress result in substantial functional use of the targeted sounds in their conversational interactions during the language sample sessions. Thus, both treatment conditions typically were effective in producing acquisition of the target sound at some level. However, as Fig. 1 shows, only the naturalistic condition resulted in functional use of the targeted sound during conversation.

Overall Intelligibility of the Children's Speech

Results for the children's overall speech intelligibility for the 2 pre and 2 postvideotaped language sample segments for each child are shown in Table III. Following the improvements in their speech sounds during conversational speech in the naturalistic intervention conditions, the children typically were rated as showing a 1- to 2-point improvement in speech intelligibility. Note that before the intervention was implemented, naive observers reported that the children were only "sometimes intelligible" or "mostly not intelligible," and that it typically required "some strain" or "much strain" to understand their speech. In contrast, following the intervention, 4 of the 5 children were reported to be in the "sometimes" to "mostly" intelligible range, requiring "minimal strain" or "usually does not require strain" to understand their speech. Child 5, who was the one exception, was noted by observers to speak primarily in one-word utterances during the pre measures, and mostly in multiword utterances during the post measures. These improvements are substantial, considering the numerous phonological errors each child demonstrated prior to implementation of the intervention.

DISCUSSION

The children who participated in this study clearly demonstrated greater gains in functional speech use when the naturalistic intervention procedures were employed as compared to the analog intervention procedures. This finding may be interpreted in a number of ways. First, previous research in the area of language intervention has demonstrated that learning is greater and disruptive behavior occurs at lower levels when naturalistic procedures focusing on motivation are incorporated (L. K. Koegel & Koegel, 1995; L. K. Koegel, Koegel, & Surratt, 1992; R. L. Koegel *et al.*, 1987; Lovaas, 1977). The results of this study are consistent with those findings, showing that the naturalistic procedures were also more effective in establishing accurate sound production. Thus, the motivational components of the naturalistic teaching paradigm may have resulted in the children being more actively

Table II. Criterion Level Reached During Treatment Sessions for Each Sound Within the Analog Condition

	Analog condition	
Child	First	Second
1	Sentence	Not in exp. design
2	No criterion level reached	Not in exp. design
3	Multiple sentence	Multiple sentence
4	Phrase	Words
5	Words	No criterion level reached

Table III. Overall Intelligibility Ratings for Pre and Post Conversational Language Sample Segments for Each Child[a]

Child	Overall intelligibility rating	
	Preintervention	Postintervention
1	2 (1)	4 (4)
	2	3
2	2 (1)	4 (3)
	2	3
3	3 (3)	4 (4)
	3	3
4	1 (1)	4 (4)
	1	4
5	2 (0)[b]	2 (2)[c]
	2[b]	2[c]

[a]Parentheses contain the reliability observer's ratings.
[b]Observers noted that conversation consisted of many one word utterances.
[c]Observers noted that conversation consisted of mostly multiword utterances.

involved in the intervention and less likely to exhibit disruptive avoidance behaviors, increasing the effectiveness of teaching.

Second, it may be important to note that when the naturalistic procedures were implemented, the children with autism participating in the present study demonstrated improved speech in a variety of settings, including a separate room in the clinic, in their homes, and in their schools. It is possible that using the targeted speech sound within the context of natural interactions produced more widespread exposure to a natural reinforcer, rather than an arbitrary reinforcer that had no direct relationship to the target sound. This direct response-reinforcer relationship may have been emphasized by providing the child with access to a desired item that contained the targeted speech sound contingent upon a correct response or attempt at the speech sound. Thus, repeated exposure to a favorable response-reinforcer contingency would have been created, a condition which has been shown to improve motivation and most types of learning (L. K. Koegel & Koegel, 1995; Seligman, 1972).

Similarly, the use of stimulus items such as preferred toys rather than artificial stimuli such as picture cards used in the analog condition, and the presentation of the teaching within the context of natural (play) interactions during the naturalistic sessions, may have been variables that increased the likelihood of functional use of the speech sounds outside of the teaching setting. Also, Stokes and Baer (1977) have discussed variables such as programming common stimuli, using sufficient exemplars, and using commonly occurring stimuli as clinically important variables for producing widespread treatment gains. These themes were enhanced during the naturalistic procedures employed in this study.

Finally, reinforcing the children's attempts to produce the speech sounds in the target words during the naturalistic condition may also have influenced responding. Hovell, Schumaker, and Sherman (1978) have pointed out that parents of children without disabilities frequently reinforce their children's attempts to imitate parent models of speech, and that the resulting high rate of imitative behavior may facilitate speech acquisition (also see Moerk, 1972). It is interesting to note that these improvements were observed without any direct motor training on targets (as in Camarata, 1993). This finding calls into question the long-standing assumption that speech intervention uniformly requires analog application of motor training to be successful (Bernthal & Bankson, 1993; Camarata, 1995; Klein, 1996; Swift, 1918, Van Riper, 1938). At least for the children with autism who participated in this study, superior performance was evidenced during the naturalistic condition, which did not incorporate motor speech sound drills.

Given that the children demonstrated learning within naturalistic teaching procedures, one may wonder why such learning does not occur in the ambient environment. It may be necessary to present the teaching stimuli in a salient, focused manner that occurs relatively rarely in the ambient learning environment (Camarata, 1995, 1996; Nelson, 1989). Because the naturalistic intervention presented in this study included multiple models of correct speech, within the context of simple language structures, there was a high degree of salience for the speech targets. This increased salience, within meaningful motivational contexts may have been sufficient to generate improved speech in the absence of motor training. In summary, the present study suggests that a naturalistic intervention, implemented systematically, is an effective method for improving speech intelligibility in children with autism.

APPENDIX

Overall Speech Intelligibility Rating Scale Administered During the Children's Conversations

0 = Not intelligible, very difficult to understand

1 = Mostly not intelligible, requires much strain to understand
2 = Sometimes intelligible, requires some strain to understand
3 = Sometimes intelligible, requires minimal strain to understand
4 = Mostly intelligible, and usually does not require strain to understand
5 = Very intelligible, easy to understand

Please rate each 5-minute segment according to the described scale, and record in the appropriate place on the form.

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