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An Exploratory Study of the Interaction Between Language Teaching Methods and Child Characteristics

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The present study examined whether the relative efficacy of two language teaching methods was predicted by pretreatment subject characteristics. Forty handicapped preschoolers were randomly assigned to two language teaching methods (i.e., Milieu Teaching and the Communication Training Program). No main effects of treatment were found. However, seven statistical interactions between pretreatment subject characteristics and language teaching method indicated that lower-functioning children benefitted more from the Milieu method and higher-functioning children benefitted more from the Communication Training Program. The results were discussed in relation to the extant literature reporting subject-by-language-teaching-method interactions. The importance of replicating the present results and specific suggestions for subject selection criteria and pretreatment subject characteristics likely to interact with language teaching methods similar to those used in this study are discussed.

KEY WORDS: language disorders in children, intervention, subject by treatment interactions, didactic intervention, interactive interventions

Language intervention is a costly, time-consuming, and important aspect of educational programs for children with developmental disabilities. In order to maximize the outcomes of the intervention process, clinicians must choose one of several possible language teaching methods to address the goals of individual children.

Theoretical Approaches to Language Intervention

Contemporary language teaching methods may be characterized along a continuum from highly structured didactic teaching to naturalistic child-oriented interventions closely resembling normal mother-child interaction (Carrow-Woolfolk, 1988; Fey, 1986). At the structured end of the continuum are behavioral-didactic interventions designed to teach the formal aspects of language using behaviorally based teaching procedures such as modeling, stimulus control, and reinforcement. At the other end of the continuum are responsive interaction interventions that facilitate the development of social communication while providing nondemanding models of appropriate language during interaction with adults. In the middle of the continuum are hybrid models of intervention that incorporate some aspects of behavioral language teaching methods but apply them in conversational contexts. Hybrid interventions, such as milieu or incidental teaching, emphasize the functional use of language in interactions while teaching new forms through modeling and reinforcement procedures (Hart, 1985).

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Although some have suggested that conversationally embedded approaches are superior to didactic ones (e.g., Nelson, 1989), an alternative hypothesis is that the most appropriate language teaching method varies depending on the developmental level of the child, type and degree of handicapping condition, and language goal (Carrow-Woolfolk, 1988). However, very few studies have examined the child characteristics that are associated with differential effectiveness of intervention methods. Thus, the current study was designed to explore whether the relative effects of two theoretically diverse intervention approaches depended on the characteristics of the children before they began the intervention.

Interactions Between Child Characteristics and Intervention Approaches

Research examining treatment-by-aptitude interactions is limited. Two studies have found that the relative effectiveness of different teaching methods is dependent on child characteristics. Connell (1987) found that language-impaired children learned a nonsense morpheme more efficiently when taught to imitate the language models; normally developing children learned the morpheme faster when they just listened to correct uses of the morpheme. Connell interpreted his results to suggest that as children depart from typical language learning, intervention methods that elicit atypical learning strategies (e.g., imitation) may be particularly useful. Friedman and Friedman (1980) found that language-impaired children with relatively high IQs had larger syntactic gain scores when taught by a hybrid teaching method in comparison with those taught by a didactic language teaching method. In contrast, Friedman and Friedman (1980) found that language-impaired children who had relatively low syntactic levels before therapy had larger syntactic gain scores when taught by a didactic language teaching method in comparison with those taught by a hybrid language teaching method.

Although others have used Friedman and Friedman's (1980) results to suggest that didactic methods are most appropriate for lower functioning children (Carrow-Woolfolk, 1988; Cole & Dale, 1986; Fey, 1986), Friedman and Friedman discounted the one finding that could be interpreted to support this interpretation. When discussing the interaction between teaching method and initial Developmental Sentence Scores (DSS) in predicting raw gain scores on the DSS, they interpreted this finding as a probable result of regression to the mean (i.e., low-scoring subjects tend to score better by chance when tested a second time). When raw gain scores (i.e., difference between post- and prescores on same variable) are used as dependent measures, regression to the mean can cause the interaction only if there are more lower functioning subjects at the pretreatment period in the group that was found to have higher gain scores for lower functioning subjects. In fact, the group with the higher gain scores for lower functioning subjects (i.e., the didactic group) did have about twice the variance as the other group on pretreatment DSS scores. Assuming that the pretest DSS scores were normally distributed, the didactic group may very well have had proportionally more lower-scoring subjects on the DSS at the pretreatment period than did the interactive group. Thus it is possible that Friedman and Friedman's results were the result of regression to the mean.

Although the results of Friedman and Friedman (1980) have also been used to argue that higher functioning developmentally delayed children will benefit more from an interactive approach (Carrow-Woolfolk, 1988; Cole & Dale, 1986), in fact, this study did not include cognitively handicapped children in its sample. Friedman and Friedman's (1980) results indicated that children with IQs above 112 benefitted more from the interactive method.

It can also be argued that a didactic approach may be more appropriate than a hybrid approach for developmentally older handicapped children. The controlled presentation of materials, elicited child response, and the closely spaced trials in the didactic approach may heighten the salience of the rules underlying many higher level syntactic language structures for handicapped children. Soraci, Deckner, & Baumeister (in press) present several studies that demonstrate that method of presentation of the stimuli is crucial to retarded children's (MA $<$ 5 years) attention to and learning of relational information. Specifically, they found that a nine-stimulus array facilitated young retarded children's acquisition of the oddity rule (i.e., find the odd one); whereas, the standard three-stimulus array did not, regardless of the number of training trials used.

A hybrid approach may be more appropriate than a didactic approach for developmentally young handicapped children. The content and timing of the teaching episodes in the hybrid intervention models are determined by the child's attentional focus, whereas the target language structure and timing of the teaching episodes in the didactic approach are determined by teacher agenda. Developmentally young children have been found to learn object nouns better when the adult language model is about objects the child selects and when the model is presented at the time the child is attending to the object (Tomasello & Farrar, 1986).

Specific Language Programs Compared

The current study was the first in a series of comparative analyses examining the outcomes of various language intervention approaches. In this study, we compared the effectiveness of the Milieu Language Teaching program (Kaiser, Hendrickson, & Alpert, in press) with the Communication Training Program (Waryas & Stremel-Campbell, 1983), a behavioral didactic approach. These programs were selected because they have well-specified, written manuals, and represent what we judge to be state-of-the-art application of their representative approaches. We compared intervention packages instead of individual components of programs because clinicians most frequently must decide between program packages, rather than isolated components.

Purpose

In summary, the purpose of this study was to determine whether the relative efficacy of Milieu Language Teaching

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and the Communication Training Program was related to pretreatment differences in handicapped preschool children. Because current literature provides conflicting theoretical directions and a large number of analyses were conducted in the current study, the results should be considered exploratory.

Methods

Subjects

Forty handicapped preschoolers participated in the study. Children were recruited through a public and a university-based school that served handicapped preschoolers. To be enrolled in the programs, the children had to meet the following criteria. For the university-based school, children had to have a delay of at least 20% of their chronological age in at least one area of development as tested on the Denver Developmental Screening Test (Frankenburg, 1981). For the public school, children had to have scores more than 1.5 *SD* below the normal population mean in four of seven developmental areas. Parents of possible candidates for the study were sent consent letters. Of the children whose parents consented, we excluded those children with significant hearing or visual impairments (as indicated by school records). Of the remaining children, we selected those that (a) could verbally imitate 8 out of 12 words (which were obtained from the curriculum-based pretest and the Sequenced Inventory of Communication Development-Expressive Scale; Hedrick, Prather, & Tobin, 1984) as indicated by teacher report or direct observation, or (b) spontaneously used one-word utterances to communicate as indicated by teacher report or direct observation. The children who participated in the study were between the ages of 2 to 7 years, but functioned like 1–4-year-olds in the cognitive and language domains. They ranged in degree of handicap from near normal to severely delayed in the cognitive and language domains. The average cognitive developmental quotient was .69 (*SD* = .17) as measured by the Bayley Scales of Infant Development (Bayley, 1969), the Merrill-Palmer Scale of Mental Tests (Stutsman, 1948), or the Kaufman Assessment Battery for Children (Kaufman & Kaufman, 1983). Their mental ages ranged from 15 to 52 months. Table 1 contains descriptive statistics on the subjects.

TABLE 1. Means, standard deviations, and ranges of subject variables before language intervention.

Variables	Mean	*SD*	Range
Chronological age	52 mos	16.2 mos	26–81 mos
Mental age	35 mos	9 mos	15–52 mos
SICD-E	27 mos	8 mos	12–48 mos
Mean length of utterance	2.19	0.93	1.00–4.72
SICD-R	29 mos	6.5 mos	16–44 mos
MA/CA	0.69	0.17	0.43–1.00
SICD-E age/CA	0.52	0.16	0.27–0.88
SICD-R age/CA	0.57	0.14	0.38–0.97

Note: *N* = 40. SICD = Sequenced Inventory of Communication Development. R = Receptive. E = Expressive. CA = Chronological age at time of testing.

Pretreatment Variables

The children were pretested using a curriculum-based test (i.e., a modified version of the Communication Training Program's Level II pretest), two standardized tests [i.e., Sequenced Inventory of Communication Development, and one of either the Bayley Scales of Infant Development (Bayley, 1969), the Merrill-Palmer Scale of Mental Tests (Stutsman, 1948), or the Kaufman Assessment Battery for Children (ABC test, Kaufman & Kaufman, 1983)], and a 60-min speech sample (i.e., two 30-min samples). No one intelligence test assessed the entire range of our sample. Therefore, the most appropriate test was selected to test a specific child. Although it can be argued that the tests assess different specific skills, only general mental age index was used for the analyses and subject description. Pretests were used to select developmentally appropriate goals, to describe the subjects, and as a basis for deriving 16 pretreatment variables that would be used to test statistical interactions between treatment and pretreatment characteristic. Our intent was to select variables that indexed language (12 variables) and cognitive (1 variable) developmental level and degree of delay with respect to chronological age in the language (2 variables) and cognitive (1 variable) domains.

Three general measures were taken to assess the child's initial mastery of the skills to be taught in the Communication Training Program curriculum. Child responses to receptive and expressive items in Level II of the curriculum were elicited via a modified form of the standard protocol indicated for the Level II pretest (i.e., CTP Level II test)[1]. Two variables were derived: (a) the number of receptive and (b) the number of expressive goals mastered. The third curriculum-based variable (i.e., number of Level III goals used twice divided by exact length of session in minutes) was derived from the 60-min speech sample. We used a rate variable because 2 children had shorter sessions than we intended.

We derived seven other variables from the speech sample using the Systematic Analysis of Language Transcripts (SALT, Miller & Chapman, 1983). Two variables were selected to index vocabulary level: (a) rate of different words from total child utterances in the entire session and (b) type token ratio (TTR) from the first 50 intelligible and complete utterances. Mean length of utterance in morphemes (MLU) was selected to index syntactic level. Two additional variables were selected to index rate of talking: (a) rate of total child utterances and (b) rate of intelligible child utterances. Percentage of total child utterances that were partially or completely intelligible was selected to index intelligibility. Finally, one variable was selected to index the extent to which the handicapped children used their language in a spontaneous fashion: percentage of child intelligible utterances that were self-initiated (i.e., unprompted and not imitated).

The remaining six variables were derived from results of the standardized assessments. The Sequenced Inventory of Communication Development yielded indices of general expressive and receptive language levels: the age equivalency

[1]A copy of the modified test manual is available from the first author.

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on the expressive (SICD-E age) and receptive (SICD-R age) scales. The most appropriate of three intelligence tests (i.e., Merrill-Palmer, Bayley Scales of Infant Development—mental scales, or the Kaufman ABC Test) was used to index mental age. Additionally, developmental quotients (i.e., age equivalency divided by chronological age at time of assessment) were also derived from the standardized tests to index degree of expressive, receptive, and cognitive delay.

Design

A randomized group experiment was used to test group differences in means and the interaction between group and pretreatment variables. Children were assigned randomly to the two treatment methods. Limited resources for testing and language sampling prohibited the use of a no-treatment control group. However, a no-treatment control group was not necessary to infer differences between the two treatments. Any such differences could be interpreted as occurring above that expected by maturation alone because there is no reason to expect that either treatment should cause delays in maturation.

Selection of Language Goals

Language goals for all children were selected from lists of goals from the Communication Training Program. Language goals were selected from a list of 41 language goals for children who had not mastered all of Level II goals and from a list of 15 language goals in Level III for children who had mastered all of Level II. Table 2 summarizes the goals for Levels II and III.

Receptive and expressive goals were selected for the children in the Communication Training Program group. Only expressive goals were selected for the children in the Milieu group. Developmentally appropriate goals were selected for each child based on his or her performance on the curriculum-based measures and the speech sample. Receptive Level II goals for Communication Training Program children were selected on the basis of elicited child performance on the developmentally sequenced Level II pretest. Expressive Level II goals for both treatment groups were selected on the basis of elicited performance mastery (i.e., 2/3 correct) or two unique instances of the target language structure in the language samples. Expressive Level III goals for both treatment groups were selected on the basis of whether the children used the target language structures twice during the

TABLE 2. Language curriculum.

Level II

1. Nouns
2. Proper nouns
3. Greetings
4. Yes, no
5. Action verbs
6. Adjectives
7. Adjective + noun
8. Possessive pronouns
9. Pronouns it, this, that
10. Possessor + object
11. Personal pronouns
12. Agent + action
13. Pronoun + verb
14. Action + object
15. Verb + it, this, that
16. Vocatives + action + object
17. Verb + pronoun
18. Action + location
19. Object + location
20. Noun + adjective
21. State + object
22. Agent + action + object
23. Agent + action + location
24. Agent + object + location
25. Person + state + object
26. Prepositions in, on
27. Action + adverbial
28. Two-word WH-questions
29. Three-word WH-questions
30. Object + preposition + location
31. State + attribution/recurrence + object
32. Negative constructions with negative in initial position
33. Contracted negative
34. Agent/person + action
35. Adjective + object
36. Agent + action + preposition + location
37. Agent + action + object + location
38. State/action + infinitive verb + object
39. Agent + state + infinitive verb + object
40. Action/state + (object = agent + action)
41. Agent + action/state + (object = agent + action)

Level III

1. Present progressive
2. Articles
3. Object pronouns
4. Subject pronouns
5. Possessive pronouns
6. Regular plural suffixes
7. Irregular plural
8. Irregular past tense
9. Possessive "s"
10. Regular past tense
11. Future tense
12. Singular copula
13. Plural copula
14. Singular auxiliary
15. Plural auxiliary

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language samples. Receptive Level III goals for the children in the Communication Training Program were the receptive goal counterparts to their expressive goals. These performance criteria were selected to allow efficient selection of goals while reducing the probability of incorrectly judging that the child has knowledge of the lexical term or linguistic rule in question due to child use of unanalyzed phrases in speech samples or chance responding on the comprehension tests.

Language Teaching Methods

As indicated in the introduction, the Milieu Teaching Method and the Communication Training Program were used to facilitate the children's acquisition and generalization of their language goals. The two programs differ in the timing of teaching episodes relative to the child's focus of attention and in the method of selection of the word or phrase to be elicited. The Milieu Teaching method follows the child's lead to determine when to teach and what language form to elicit. The Communication Training Program uses a predetermined protocol to determine the number of trials and exact language targets. The differences in who controls the timing and content of teaching episodes result in fewer, more dispersed teaching trials in the Milieu method and more frequent and massed trials in the Communication Training Program. Consequently, the Milieu session resembles a conversation, whereas the Communication Training sessions are drill and practice in nature. In Milieu teaching, the environment is arranged to include objects and activities that interest the child so there will be occasions for teaching functional language and so that teaching will follow the child's interests and conversational lead.

The second major difference in the programs is the degree to which comprehension of language is explicitly targeted. In the Communication Training Program, comprehension of language targets is taught explicitly. If both comprehension and production of the language structure are to be taught, comprehension is taught prior to production of the goal. In the Milieu method, comprehension is taught implicitly. The Milieu model assumes that children will learn to comprehend language structures when adults use the language model or elicit child production of the structure when the child is attending to and/or communicating about the nonlinguistic referent and that no planned teaching of comprehension is necessary (Carrow-Woolfolk, 1988).

The third major difference in the programs is in the nature of the consequences of child production of the target response. The Communication Training Program uses both verbal feedback (praise and expansions or corrections) and other tangible rewards that may increase the probability of child production of the response. With lower functioning children, there may be frequent use of rewards that are not semantically related to the child's utterance (e.g., food, stickers, tokens). Milieu Teaching consequents child production of language targets with delivery of requested objects, events, or actions and social attention implicit in expansion and extension of the child's topic. Ideally, the consequences in Milieu Teaching are always closely related to the intent and content of the child's utterance. Although the Milieu program is built around child-specified functional reinforcement for communication, expansions and extensions of the child's communicative message are also presumed to have facilitative effects on child language because they may provide the child with particularly salient examples of more complex language forms that convey the child's message.

There are two main similarities of the two intervention programs. Both explicitly elicit child production of language targets and provide systematic consequences of child productions.

Other potential differences in the two treatment methods were controlled in the study. We implemented the intervention sessions so that number of children in the instructional group and amount of time in instructional sessions would not vary across programs. Two or three children were in each instructional group, regardless of their assigned teaching method. The sessions lasted 10 min per child (i.e., either 20 or 30 min per session depending on the number of children), regardless of the assigned teaching method. All instructional groups were conducted for 60 sessions, regardless of assigned teaching method. Lexical and syntactic-semantic language targets appropriate to the child's pretreatment language level were taught in both programs.

Language Teachers

The language sessions were conducted by five staff members. Two staff members taught groups of children assigned to both treatment methods. One taught only children assigned to the Milieu treatment method. Two taught only children assigned to the Communication Training Program method. Because several trainers executed each treatment approach, the likelihood of group differences resulting from one particularly dynamic trainer was low. However, low numbers of subjects/trainer did not allow statistical testing of trainer effects.

Training of Language Teachers

All trainers received 12 hours of training in a group setting. Individual staff received varying amounts of subsequent individual and small group training dependent on their entry skills, their skill in execution of their assigned approach, and the children's specific needs. Three trainers received an additional 2 hr of training. The remaining two trainers each received an additional 10 hr of training.

Throughout the intervention period, weekly observation of language teaching sessions occurred for each trainer. The amount of weekly observation per trainer varied according to the trainers' skill in executing the assigned approach (range = 1/2 hr–5 hr per trainer/week). Additionally, weekly group meetings were designed to support trainers and were used to solve individual training and behavior management problems.

Fidelity of Treatment

The staff rated the fidelity of each other's implementation of the intended procedures during at least three sessions per

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trainer. During Milieu sessions, a 19-item rating scale of various aspects of the procedure was completed. During the CTP sessions, the observer completed a 16-item scale on various aspects of the CTP teaching procedure and took interobserver agreement data on the correctness of the child's response to teaching trials. On a three-point scale (3 = high), the mean rating was 3.0 for Communication Training Program implementation and testing procedure and 2.82 for the Milieu Teaching Program. Interobserver agreement using these fidelity-of-treatment scales is reported in the Reliability section.

Language Sessions

The language sessions were located in the children's classrooms or a nearby therapy room. For the Milieu teaching sessions, one group activity (e.g., making collages, a simple game, a manipulative toy) was selected for the first half of the session. During the second half of the session, a variety of toys were available to the children and they were free to select the toys that were of interest to them. During the Communication Training Program, children were typically seated at a small table. Trainers worked with each child in turn. Children who were waiting their turn were provided books or other toys to play with while they waited. Sessions were conducted every school day until 60 sessions were completed. Child attendance to the sessions was measured and did not correlate with group, pretreatment, or posttreatment variables.

Posttreatment Variables

We measured language gains that were beyond simple stimulus response learning in training contexts in three ways. Materials used during posttesting were not used during training sessions. Posttest examiners were not the subjects' trainers. The interaction style during the speech samples was similar to that of the pretest speech samples and was different from either language teaching method in that specific language targets were not elicited. The posttreatment variables were 14 of the 16 variables that were assessed at the pretreatment period. Only mental age and mental age/chronological age at testing were not measured again at the posttreatment period.

Reliability

All transcripts were verified (i.e., transcripts were checked for accuracy by listening again to the audiotape) before analyses were conducted. Interobserver reliability on variables that were derived directly from the transcript (i.e., MLU, TTR, rate of different words, rate of child utterances, rate of intelligible utterances, intelligibility, rate of production of Level III skills) was estimated by comparing two independent transcriptions of 16 (i.e., 20% of the transcripts) randomly selected 60-min speech samples (i.e., 8 at each measurement period). Interobserver reliability of percentage of self-initiated utterances was estimated by comparing independent codings of 14 sessions (i.e., 6 at pretest, 8 at posttest). Intraclass correlations were used as estimates of interobserver reliability for speech sample variables because such coefficients are particularly useful with extremely variable scores and control for chance agreement due to limited variance in scores (Mitchell, 1979). Intraclass correlation coefficients on speech sample variables averaged .84 (SD = .10; range = .70–.97) for pretest variables and .90 (SD = .06; range = .83–.97) for posttest variables. Interobserver agreement on correct responding on the curriculum-based instrument, based on 20% of the assessments, was 100%. Interobserver agreement on the fidelity of treatment rating scales averaged 89% (79%–100%) on at least two training sessions for each trainer.

Results

Overview of Analyses

The results are presented in seven sections. First, we present analyses examining the intercorrelation of attendance to treatment with treatment group (i.e., Preliminary Analyses). Second, we present data describing the intercorrelation among pretreatment child characteristics (i.e., Principal Components Analysis of Pretreatment Variables). Third, we describe tests for preexisting differences between treatment groups and for evidence of language development during the treatment (i.e., Repeated Measures ANOVA). Fourth, we present an analysis of the children's rate of development during the treatment as compared to their rate of development before treatment (i.e., Results of Analyses on Proportional Change Scores). This set of analyses were conducted because the absence of a no-treatment control group prevents our concluding that changes in language scores were due to the treatments. Fifth, we present the results of the analysis of pretreatment child characteristics that interact with treatment type (i.e., Pretreatment Child Characteristics that Interacted with Teaching Method). Sixth, we present follow-up analyses designed to evaluate the probability that chance accounted for the interactions. Finally, we describe the children who fit the pattern represented in significant interactions.

Preliminary Analyses

Before testing the research questions, we determined whether attendance to language sessions and the type of school the children attended statistically interacted with group or with group and a pretreatment variable in predicting all possible outcome measures. No significant interactions were found, indicating that the randomization process was effective in distributing differences in these variables across groups. Therefore, subsequent analyses did not include attendance or school as a factor.

Principal Components Analysis of Pretreatment Variables

A principal components analysis on the pretreatment var-

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iables was conducted to summarize the intercorrelation of the variables for this sample (Table 3).

Three factors were formed, accounting for 76% of the variance in the scores. The first factor accounts for 50.8% of the variance and was composed of the 12 variables that conceptually measure developmental level. The second factor accounts for 17.8% of the variance and was composed of the three measures that conceptually measure degree of delay. The third factor accounts for 7.8% of the variance and was composed of a single variable, type token ratio (TTR). TTR was not significantly correlated with any other variable, thereby indicating that it is an individual difference variable that is independent of developmental level or degree of delay.

Repeated Measures ANOVA

A repeated measures ANOVA on each of the 14 variables that were measured at pre- and posttreatment periods was conducted. Each analysis had a within subject factor, time of measurement (i.e., pre- and posttreatment periods), and a between subject factor, teaching method (i.e., Milieu vs. Communication Training Program). Table 4 presents these data.

We found no group by time interactions. That is, no mean differences between teaching method group were found at either the pretreatment or the posttreatment period. Bartlett-Box *F* tests indicated there were also no differences in variances between groups on any of the 14 measures at either time period. However, 11 of the 14 variables increased after the language teaching, regardless of teaching method used during language training. One measure (i.e., TTR) reduced after treatment. Two measures did not change significantly (i.e., SICD-R age/chronological age and the C.T.P. Level II expressive scale).

Changes in the 11 variables that increased from pre- to posttreatment periods could be due partly to the language training and/or to development that would have occurred without language teaching. To compare the amount of change to expected rate of development without treatment, we calculated proportional change scores (the ratio of developmental rate during treatment/developmental rate before treatment; Wolery, 1983) for the one variable that was appropriate (the SICD-E). Theoretically, proportional change scores over the value of 1 indicate that the developmental rate during treatment was faster than the average rate before language teaching. Proportional change scores can only be calculated on standardized test scores and would only be expected to exceed 1.0 if the developmental quotient (age equivalent/chronological age at test) for the test significantly increased over time.

Change scores (i.e., a derivation of the difference between post- and premeasures) have often been criticized because (a) some have claimed them to be less reliable than their components and (b) they tend to correlate negatively with their pretest component (i.e., regression to the mean) (O'Connor, 1972). However, recent methodological research indicates that the reliability of difference scores is actually greater than the reliability of the component scores when interindividual differences in growth are large (Willet, 1989, for review). The differences in growth in the present study are quite large (range of proportional change score = −2.0–7.0). Regression to the mean could not account for interactions involving the proportional change score in the present study because there were no mean or variance differences in the measures at the pretreatment period.

Results of Analyses on Proportional Change Score

Figure 1 illustrates the distributions of the proportional change scores for each teaching method.

The children's responses to language teaching were more consistent when instructed by the Milieu method than when instructed by the Communication Training Program. That is, the variance of the SICD-E proportional change scores for children in the Communication Training Program (4.57) was

TABLE 3. Factor loadings from a principal components analysis of pretreatment variables.

Variable	Factor 1 (50.8% of variance)	Factor 2 (17.4% of variance)	Factor 3 (7.85% of variance)
Rate of different words	0.93510	−0.18409	−0.02927
Rate of intelligible utterances	0.90303	−0.22763	−0.08969
Rate of CTP Level III skills	0.89982	−0.21812	−0.03260
Mean length of utterance	0.87372	0.03267	−0.21377
CTP Level II; expressive	0.87352	0.15361	0.14792
SICD-expressive	0.87053	0.27331	0.05250
Rate of utterances	0.82287	−0.33823	−0.04429
SICD-receptive	0.80767	0.10718	0.21615
Intelligibility	0.78859	0.20639	−0.20410
CTP Level II; receptive	0.73309	0.13819	0.34567
Mental age	0.70637	0.08871	0.40828
Percent self-initiated utterances	0.61179	−0.08084	−0.53858
SICD-E/CA	0.29511	0.87082	−0.18549
MA/CA	−0.01667	0.86940	0.14207
SICD-R/CA	−0.04472	0.80704	−0.01551
Type token ratio	0.20739	−0.15449	0.63844

CTP = Communication Training Program. SICD = Sequenced Inventory of Communication Development. MA = Mental age. CA = Chronological age at time of testing.

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TABLE 4. Means, standard deviations, and *F* test for time effect on pre- and post-measures.

Variable	Milieu				CTP				Time main effect	
	Pre-X		Post-X		Pre-X		Post-X			
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*
Rate of utterances (per minute)	5.7	2.1	8.5	3.0	6.3	3.0	9.2	3.1	31.2	0.000
Rate of intelligibility utterances (per minute)	4.9	2.2	7.7	3.0	5.3	3.0	8.1	3.0	37.6	0.000
Intelligibility (% utterances intelligible)	0.8	0.2	0.9	0.1	0.8	0.1	0.9	0.1	30.5	0.000
Percent self-initiated utterances	0.4	0.2	0.6	0.1	0.4	0.2	0.4	0.1	61.6	0.000
Mean length of utterances	2.3	0.9	2.8	1.1	2.1	1.0	2.5	1.1	30.3	0.000
Rate of different words (per minute)	2.5	1.2	3.3	1.2	2.5	1.7	3.2	1.7	16.4	0.000
SICD-R age	29.2	6.8	31.6	5.2	29.6	6.4	31.6	5.0	8.9	0.005
SICD-E age	28.0	8.3	33.0	7.8	26.2	8.0	30.8	7.1	45.3	0.000
Type token ratio	0.5	0.1	0.4	0.1	0.5	0.1	0.4	0.1	10.1	0.003
SICD-E age/CA	0.55	0.16	0.58	0.16	0.5	0.15	0.53	0.14	4.3	0.05
CTP level II; receptive	20.2	6.6	23.8	6.6	18.6	6.7	23.1	5.4	37.2	0.000
Rate of CTP level III skills (per minute)	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	13.4	0.001
SICD-R age/CA	0.58	0.15	0.56	0.14	0.56	0.14	0.53	0.10	2.77	0.10
CTP level II; expressive	13.9	9.0	15.8	9.6	11.95	8.35	12.40	8.47	3.72	0.06

over three times that of the children in the Milieu group (1.50; $F = 3.05$; $p < .01$).

Assuming a linear average rate of development, the average proportional change score for the children in the Milieu group exceeded the average pretreatment developmental rate [i.e., obtained mean was above 1.00; obtained mean = 1.61; $SD = 1.22$; $t(19) = 2.24$; $p < .05$]. Because of the large variance in the CTP group, the average proportional change score for the CTP children was not significantly greater than expected from the pretreatment developmental rate [mean = 1.78; $SD = 2.14$; $t(19) = 1.59$; $p > .10$]. The mean proportional change scores were not significantly different between groups [$t(38) = -.31$; $p > .05$]. The highest scoring children were in the CTP group.

In summary, it appears that although the average developmental rate was accelerated and the child response to teaching was more consistent in children taught by the Milieu method, the highest-scoring children were in the CTP group. This pattern demonstrates the need to determine which children benefited most from each method.

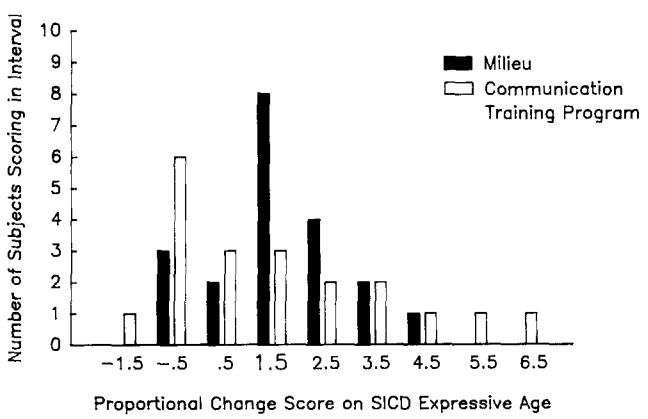

FIGURE 1. Histogram of proportional change score for the SICD-E by treatment group.

Pretreatment Child Characteristics That Interacted With Teaching Method

A significant interaction between pretreatment child characteristics and teaching method indicates pretreatment variables that describe children who benefit more from one treatment than from the other. We used simultaneous multiple regression analyses to test whether any of the 16 pretreatment variables interacted with teaching method. In the context of simultaneous regressions, significant interactions are significant beyond the main effects for treatment group and pretreatment variable. The outcomes for these multiple regressions were those 11 variables that increased from pre- to post-periods and the SICD-E proportional change score.

Table 5 presents the seven interactions between pretreatment variable and group that accounted for a significant portion of the variance in an outcome variable. The seven interactions were disordinal. Main effects for group and pretreatment characteristic should not be interpreted when significant interaction effects are present (Pedhazur, 1982).

All seven interactions indicated that children who scored low on the pretreatment variables tended to benefit most from the Milieu method. Children who scored high on the pretreatment variables tended to benefit most from the CTP method. These statistical interactions were significant even when analyses were repeated after eliminating extreme outliers that may have had disproportional influence on the slopes of the regression lines. The data fit the assumptions for multiple regression analyses in all cases.

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TABLE 5. Simultaneous multiple regression models with significant interaction terms.

Variables in model with group		Effects					
		Pretreatment x group		Group		Pretreatment measure	
Outcome measure	Pretreatment measure	*t*	*p*	*t*	*p*	*t*	*p*
*1. SICD-E/CA	Rate of utterances	2.07	0.05	−2.35	0.02		
2. Rate of different words	Rate of utterances	2.07	0.05	−2.06	0.05		
*3. Intelligibility	Type token ratio	2.25	0.03	−2.37	0.02	−2.14	0.04
*4. Mean length of utterance	Type token ratio	2.05	0.05	−2.17	0.04		
*5. Rate of CTP Level III skills	Intelligibility	2.06	0.05			3.58	0.001
6. Rate of CTP Level III skills	SICD-R age/CA	2.07	0.05	−2.02	0.05		
*7. Proportional change score for SICD-E	Percent self-initiated utterances	2.43	0.02	−2.26	0.03		

*At least one region of significance in range we measured.

We used the Johnson-Neyman technique to set confidence intervals around the regression lines, thereby allowing us to determine at which point on the pretreatment variable the regression lines were significantly different (Pedhazur, 1982). Those interactions with at least one such cut-off point or region of significance within the range we measured are indicated by asterisks in Table 5. Figure 2 presents one of the statistical interactions with the regions of significance marked.

The results of the Johnson-Neyman technique indicated that children who did not talk much (i.e., fewer than .45 utterances/minute), did not self-initiate often (i.e., less than 18% of their utterances were initiated), were not very intelligible (i.e., less than 45% of utterances were at least partially intelligible), and used a restricted vocabulary (i.e., type token ratio < .40) were likely to have benefited more from the Milieu Teaching method. In contrast, children who self-initiated frequently (i.e., greater than 65% of their utterances were initiated) and were highly intelligible (i.e., at least 95% of the their utterances were intelligible) were likely to have benefited more from the CTP program.

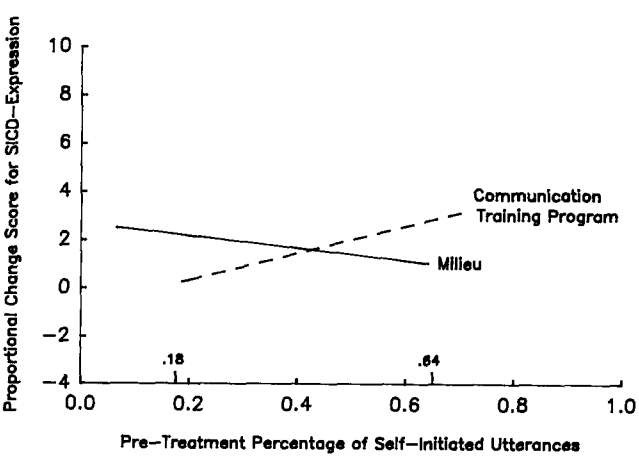

FIGURE 2. Disordinal interaction of pretreatment percentage of self-initiated utterances by group predicting proportional change score of the SICD-Expressive scale.

Exploring the Possibility That Chance Accounted for the Results

A consistent direction of regression slope differences for the pretreatment variables that measured the same construct as those pretreatment variables involved in significant interactions with treatment would support the hypothesis of subject-by-treatment interactions (Cole & Dale, 1986). To produce the data for this test a two-step procedure was conducted. For each of the five pretreatment variables involved in significant subject-by-treatment interactions, we first selected variables that conceptually measured the same construct as the target pretreatment variable and/or correlated with the target pretreatment variable at $r = .50$ or above. Using a correlation of .50 to select variables that empirically measure an overlapping construct with that measured by the target pretreatment variable may have resulted in overselection. We used this criterion because it represents a conservative test of whether chance findings accounted for our results. For each of the selected pretreatment variables, we then compared the within-treatment-group regression slopes of the selected pretreatment variable predicting the outcome involved in the significant subject-by-treatment interaction of interest. If differences in the slopes were the same sign as that of the significant interaction of interest, then we considered the pattern to support the hypothesis of subject-by-treatment interactions.

The results indicated that 13 variables fit the above criteria for "measuring overlapping constructs" as those measured by the five pretreatment variables involved in subject-by-treatment interactions. Twelve of the 13 differences in slopes matched the direction described by the significant subject-by-treatment interactions.

Individual Children That Fit the Group Pattern

To improve the probability that future confirmatory studies will replicate our results, we explored the characteristics of the individual children who fit the group results particularly well. These data may be used to supplement our sample description when selecting future samples. For each of the seven regression models with significant pretreatment char-

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acteristics-by-treatment-group interactions, we correlated the children's residuals (i.e., the actual score minus the score predicted by the entire regression model) with pretreatment indices of expressive language level (MLU and SICD-E), receptive language level (SICD-R), cognitive level (mental age), and degree of delay in the expressive language (SICD-E/CA), receptive language (SICD-R/CA), and cognitive (MA/CA) domains. Next, those pretreatment variables that significantly correlated with and accounted for at least 25% of the variance in the residuals were selected for further analyses. Finally, we computed the value of the pretreatment variables that identified subjects for whom the group analysis accurately predicted their actual scores.

Residuals that were less than +/− 1 standard deviation of the outcome variable were considered evidence of a good fit between the individual scores and those predicted by the group regression equations. For the seven regression models with significant interaction terms, the results indicated that an average of 81% (77%–90%) of the children's residuals were less than +/− 1 standard deviation of the outcome variable.

Reporting for the interactions in which at least one pretreatment variable accounted for at least 25% of the variance in the residuals, pretreatment degree of expressive language delay (SICD-E/CA) accounted for over 25% of the variance in the residuals for the first ($r = .73$; $p < .01$) and second ($r = .83$; $p < .01$) regression models in Table 5. Using the regression equation from these simple regressions, we found that children with developmental quotients between .73 and .31 tended to fit the group pattern for these two interactions well. Pretreatment expressive level (SICD-E) accounted for 36% of the variance in the residuals for regression model three in Table 5 ($p < .01$). Children with SICD-E age equivalency scores between 42 months and 15 months tended to fit the group pattern well. Pretreatment MLU accounted for over 25% of the variance in the residuals for the fourth ($r = .88$; $p < .01$) and sixth ($r = .70$; $p < .01$) regression models in Table 5. Children with MLU's between 3.67 and 1.00 tended to fit the group pattern well. No pretreatment variables accounted for over 25% of the variance in the residuals for regression models five and seven in Table 5.

Discussion

The results of the present study are contrary to three hypotheses others have made about language intervention. These hypotheses are as follows: (a) conversationally-based interventions are superior to all others for all children (Nelson, 1989); (b) conversationally-based interventions are best suited for higher functioning children (Friedman & Friedman, 1980; Snow, 1989); (c) didactic interventions are best suited for lower-functioning children (Friedman & Friedman, 1980; Snow, 1989). Because our study was exploratory, we believe the results should be interpreted with caution. Studies that conduct many tests of significance, particularly when very specific hypotheses cannot be posited before analyzing the data, may yield results that are statistically significant, but that do not describe what occurs in the general population. Therefore, two possible explanations exist for the conflict between these three hypotheses and our results: (a) our results are the product of chance findings; (b) the aforementioned hypotheses do not accurately describe what occurs in the diverse population of handicapped preschoolers served in early intervention programs.

Evaluating the Possibility of Chance Findings

The results do not support the suggestion that our findings were produced by chance. First, if chance accounted for our subject-by-treatment interactions, then one would expect the relative magnitude of the slopes to be random. Instead, all seven of the subject-by-treatment interactions in the present study indicated the same general pattern. Second, even though we used a very liberal definition of what defines pretreatment variables that measure the same construct as variables that interacted with treatment method, our post hoc analyses indicated 12 of 13 differences between regression slopes were very similar to those of the significant interactions. However, the absence of differences is always inconclusive in science. Therefore, replication remains necessary before confident clinical or theoretical application of our results is reasonable.

Reevaluating the Three Hypotheses About Language Intervention

If future confirmatory studies replicate our general findings, then reevaluation of the three hypotheses is in order. First, there is little support for the notion that conversationally embedded approaches such as Milieu Teaching are superior to other methods for all children (Nelson, 1989). Together with Friedman and Friedman (1980) and Connell (1987), the present results contradict the notion that one treatment is superior for all children learning all language goals.

Second, the hypothesis that didactic approaches are superior to conversationally embedded approaches for lower-functioning handicapped children may need further consideration (Carrow-Woolfolk, 1988; Cole & Dale, 1986; Snow, 1989). The results of the present study indicated that children who scored low on several pretreatment measures benefitted more from Milieu Teaching, a conversationally embedded teaching method. Unlike the CTP program (and most other didactic programs), in Milieu Teaching the timing and content of the teaching episode follow the child's focus of attention. Several investigators have found that developmentally young children are more readily affected by, and thus probably comprehend more readily, adult speech that follows the child's focus of attention than speech that does not follow the child's lead (Bloom, Rocissano, & Hood, 1976; Landry & Chapieski, 1989; Yoder & Davies, 1990). Children who scored lower on the pretreatment variables tended to have vocabulary goals in the current study. Tomasello and Farrar (1986) have shown that young children learn vocabulary faster when the linguistic model is presented while the child is attending to the nonlinguistic referent than when the model is presented according to an adult's agenda. Additionally or alternatively, developmentally young children may generalize

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their newly learned language more when taught by Milieu Teaching than by didactic methods because Milieu Teaching incorporates more of the instructional characteristics that typically facilitate generalization (i.e., loose teaching, multiple exemplars, similarity of training, and use environments; Warren & Kaiser, 1986a). Developmentally younger DD children may be more reliant on these characteristics that facilitate generalization than are developmentally older DD children. It should be noted that our outcome measures were all conducted with nontraining materials, using nontraining interaction styles, and examiners who were not the children's trainers.

Finally, the hypothesis that conversationally embedded approaches are superior to didactic ones for higher-functioning handicapped children (e.g., Cole & Dale, 1986; Friedman & Friedman, 1980) may also require reevaluation. In the present study, children who scored higher on several pretreatment variables benefitted more from the CTP method, a didactic approach. As in the clinic or classroom, child characteristics in the present study were confounded with the aspects of the language system the children were learning. Higher-functioning children tended to be have syntactic or morphological goals, whereas lower functioning children tended to have vocabulary goals. Higher-functioning children had, for the most part, already mastered the conversational skills and many of the vocabulary words that the Milieu method probably teaches best. The CTP method may be a better method for teaching the rule-based skills that these higher-functioning children were learning. The addition of the comprehension training may require the child to comprehend the underlying linguistic rule more thoroughly than does an exclusively production-oriented method such as Milieu Teaching. CTP materials are carefully selected to require close attention to relevant stimulus dimensions. Alternatively or additionally, the frequent, closely spaced production of the example phrases may help the child notice similarities across examples and deduce the underlying syntactic or morphological rule (Connell, 1987). If future studies confirm our hypotheses, developmentally older DD children may initially acquire new syntactic structures more quickly in didactic interventions than in conversationally embedded approaches such as Milieu Teaching. However, in light of retarded children's well-documented failure to generalize language structures from didactic to conversational settings (Costello, 1983; Warren & Rogers-Warren, 1983; Warren & Kaiser, 1986b), conversationally embedded approaches will probably still be necessary to facilitate the children's conversational use of syntactic skills that were initially learned in didactic instruction.

Integration of Present Findings With Extant Literature

At first glance, the general pattern of the present results appears to conflict with that of the two other studies in the language intervention literature that have found subject-by-language-teaching-method interactions (Connell, 1987; Friedman & Friedman, 1980). The apparent conflict may be due to intervention differences, subject differences, or design differences. We cannot determine exactly how the differences in the treatments that were compared may have produced discrepant findings because the current study and Friedman and Friedman (1980) compared treatment packages that differ on many dimensions.

Subject differences among studies offer a more fruitful explanation for the apparent discrepancy. The lowest-functioning children in the Friedman and Friedman (1980) and Connell (1987) studies had "normal intelligence"; in contrast, the average cognitive level in our sample was 31% below that expected for chronological age. Only two children in our sample scored at approximately age-level on the intelligence measure. Nonverbal intelligence may affect whether children with delayed language skills can comprehend and analyze adult language models presented in a didactic instructional context. For example, children with normal nonverbal intelligence may be better able to deploy their attention on command and still have sufficient information processing capacity to comprehend adult language models than are retarded children. Therefore, the apparent conflict is reduced when one realizes that the nonverbal intelligence of the low-functioning children in the Friedman and Friedman (1980) and Connell (1987) samples was similar to or higher than our highest-functioning children. Friedman and Friedman's (1980) and Connell's (1987) low-functioning samples and our highest-functioning children benefitted more from a didactic method than from an interactive one.

Additionally, Connell's (1987) language-impaired group had an average MLU of 4.0; only 3 of our children had pretreatment MLUs above 4.0. In other words, Connell's language-impaired group on the average was developmentally similar to or developmentally more advanced than our highest-functioning children. Connell's language-impaired group and our highest-functioning children benefitted most from a method that elicited child performance in a didactic format.

Although the language level of Friedman and Friedman's (1980) language impaired sample overlapped with ours, Friedman and Friedman (1980) did not use a random process to assign subjects to teaching method conditions as was done in the current study. Their results show large between-group differences in the variances of several pretreatment variables. Even in the absence of mean differences, variance differences between groups could result in quite different group composition at various levels of the pretreatment variables. Additionally, without random assignment to treatments, it is possible that the Friedman and Friedman groups were not equivalent on unmeasured variables before treatment.

In contrast to Dale and Cole's (1988) preliminary results, one of the final reports on a language delayed subsample of their total sample (Cole, Dale, & Mills, in press) of their longitudinal comparison of two educational treatments with handicapped preschoolers indicates a pattern of results that is similar to ours. Because the Cole et al. (in press) sample is very similar to ours and because their subjects were randomly assigned to treatments, their results are particularly interesting to us. Although Cole et al. (in press) compared two teaching methods that are different in several ways from those we compared, they also found that higher functioning

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handicapped preschoolers benefited more from a didactic, drill-and-practice teaching method (Direct Instruction). Lower functioning children in the Cole et al. (in press) study benefited more from a method that can accurately be described as a hybrid between teacher- and child-oriented teaching methods (i.e., mediated learning).

Designing a Future Confirmatory Study

The results of the present study can be used to design future confirmatory studies. The results suggest a general hypothesis, specific pretreatment variables that may interact with teaching methods similar to those used in this study, and subject characteristics that can be used as selection criteria.

We consider those pretreatment variables that interacted with teaching method and that included at least one region of significance within our measured range to be particularly promising for future study. These variables were: (a) rate of child talking, (b) intelligibility, (c) percentage of self-initiated utterances, and (d) type-token ratio. Because these variables covary with many other subject characteristics, some of which we did not measure, one cannot reasonably conclude that these variables cause the differential effectiveness of teaching methods. Instead, it is more reasonable to view these variables as ways to identify children who may benefit *more from one teaching method than another.*

Finally, the regions of significance and information regarding which individual children fit the group pattern help to identify the types of children who are likely to replicate the present results. In addition to the constraints defined by our subject description information, children who may be most likely to benefit from Milieu Teaching more than the CTP method are those who do the following: (a) speak less than 1 utterance every 2 min and have a SICD-E/CA between .73 and .31, (b) use intelligible speech less than 45% of their utterances, (c) use self-initiated speech less than 18% of their utterances, or (d) have type token ratios less than .40 and MLUs less than 3.67. Additional information about children who may be most likely to benefit more from the CTP method over Milieu Teaching are those who do the following: (a) use self-initiated speech more than 65% of their utterances, or (b) use intelligible speech more than 95% of the their utterances.

Future studies should control the type of language goal while investigating which treatment methods are most efficient for which children. Although the confound between language goal and child characteristics is among the most problematic aspects of the present study, the confound is a naturally occurring phenomenon (i.e., higher-functioning children are usually assigned more complex language goals). However, until this confound is unraveled, we will not confidently know whether it is child characteristics (e.g., the developmental level or degree of delay) or type of language goal that reliably predicts the treatment of choice.

In summary, the present exploratory study presents data that challenge us to examine the empirical basis for three common hypotheses about language intervention. If the present pattern of results is replicated, the present study may be one impetus for developing a comprehensive model of language intervention. This new model will ideally help clinicians and teachers select an intervention method that is best suited to children's developmental level and degree of handicap experienced before language intervention, as well as the language structures the children are learning during language intervention.

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