
The Relationship Between Prelinguistic Vocalization and Later Expressive Vocabulary in Young Children With Developmental Delay

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This study tested the relationship between prelinguistic vocalization and expressive vocabulary 1 year later in young children with mild to moderate developmental delays. Three vocalization variables were tested: rate of all vocalization, rate of vocalizations with consonants, and rate of vocalizations used interactively. The 58 toddlers in the study were 17–34 months old, not sensory impaired, and had Bayley Mental Development Indices (Bayley, 1969; Bayley, 1993) from 35–85. In addition, the children had fewer than 3 words in their expressive vocabularies and during classroom observation each showed at least one instance of intentional prelinguistic communication before testing. Selected sections of the Communication and Symbolic Behavior Scales procedures (CSBS; Wetherby & Prizant, 1993) were administered at the beginning and at the end of the study. The vocal measures were obtained in the initial CSBS session. One measure of expressive vocabulary was obtained in the CSBS session at the end of the study. In addition, expressive vocabulary was measured in a nonstructured play session at the end of the study. We predicted that rate of vocalization, rate of vocalizations with consonants, and rate of vocalizations used interactively would all be positively related to later expressive vocabulary. The results confirmed the predictions.

KEY WORDS: prelinguistic communication, vocalization, communication development, developmental delay

One of the more extensively studied areas of prelinguistic behavior is vocal development. More than 50 years ago researchers were investigating the relationship between babbling and spoken language (Jakobson, 1941; Lewis, 1936). Researchers have continued to investigate vocalization in infants to determine the continuities between vocalization and later speech and to see if spoken language development can be predicted from aspects of prelinguistic vocalization (Kagan, 1971; Locke, 1989; Roe, 1977; Stoel-Gammon, 1989, 1992).

Relationship Between Babbling and Spoken Language

A number of hypotheses have been formulated to explain the continuities between prelinguistic vocalization and later spoken language.

Most of the empirical literature has focused only on child characteristics. However, many of the hypotheses are transactional, in that both characteristics of the child and the mediating effects of the environment, usually in the form of maternal responsiveness, are used to explain child outcome.

One of the transactional hypotheses is that vocalization is related to later spoken language because it is one of the early behaviors typically responded to and labeled as communicative by adults. In a study of the communication development of 12 typically developing infants, Harding (1983) reported that all mothers in her study consistently responded to vocalizations as communicative. Adult responsiveness may mediate the relationship between prelinguistic consonant use and later spoken language. McCune (1992) has suggested that adults may be more apt to attribute meaning to canonical babbling than to other types of vocalizations and thus may respond to canonical babbling as if the infant had spoken real words. This feedback may make it easier for the child to make the connection between the adult word and the object or event about which the child is communicating. Another possible transactional explanation for the correlation between CV syllables and onset of speech is the co-occurrence between canonical syllables and word models by parents (Papousek, 1993). The word models in turn may facilitate language development.

Most of the research literature has examined the relationship between vocalization and later spoken language without considering the possibly mediating influence of the environment. These child-driven models are also posited as explanations for the relationship between vocalization and later spoken language. Locke (1989) suggested a direct relationship between babbling and later spoken language. Locke (1983) examined the similarity in the form of babbling and early speech. He reported that the sounds and the structure typical of canonical babbling were similar to those of early speech. He also identified the 12 consonants that account for 92–95% of consonant production for infants 11–12 months old. This same set of consonants was also the most frequently used in early word production. Locke found the CV syllable type, which is characteristic of canonical babbling, typified early speech. Early speech and babbling were similar in that they share the common features of sounds used and syllable structure.

Another child-driven explanation may be that an infant who is a good vocalizer may have a larger number of sounds on which to map meaning (Stoel-Gammon, 1989). Finally, it may be that infants who are good babblers have better developed motoric skills and neurological development than infants with less developed babbling (Locke, 1989). The empirical research on the

correlation between early babbling and later spoken language has used two measures of babbling: amount of vocalizations and consonant use in vocalizations.

Amount of Vocalization

Researchers have measured amount of vocalization in the prelinguistic period to see if it is predictive of later speech (Camp, Burgess, Morgan, & Zerbe, 1987; Kagan, 1971; Roe, 1977). Kagan reported that for typically developing girls, high vocalization rates were positively correlated with higher vocabulary development at 27 months. Similarly, Roe, in a study of 14 typically developing male infants, found a positive correlation between the amount of vocalization at 3 months and the amount of talking at 3 years, as well as vocabulary development and performance on a reading task at 5 years. In a third study of 141 typically developing infants, Camp, Burgess, Morgan, and Zerbe reported that amount of vocalization at 4–6 months was related to word use at 1 year, but not to more global levels of development. All three of these studies suggest the predictive validity of amount of prelinguistic vocalization measures in typically developing children.

Consonant Use in Vocalizations

Consonant use in the prelinguistic communication period has been found to be positively correlated with onset of speech, accuracy of speech production, and development of expressive vocabulary (Menyuk, Liebergott, & Schultz, 1986; Murphy, Menyuk, Liebergott, & Schultz, 1983; Stoel-Gammon, 1989; Whitehurst, Smith, Fischel, Arnold, & Lonigan, 1991). Stoel-Gammon assigned a Mean Babbling Level (MBL) to 34 typically developing infants based on the extent to which vocalizations were reduplicated and variegated. She reported that infants with a higher MBL enter the stage of meaningful speech before children with lower MBL.

Murphy et al. (1983) found that, for typically developing infants, the proportion of vocal syllables that contained a consonant at 12 months was predictive of earlier attainment of a 50-word expressive vocabulary. There was also a positive correlation between the proportion of vocal syllables that contained a consonant and accuracy of production of final consonants in words at 29 months. Vihman and Greenlee (1987) reported a high proportion of syllables with true consonants in the prelinguistic period positively correlated with advanced phonological development at 3 years.

In a 5-month longitudinal correlational study of thirty-seven 2-year-olds with expressive language delay (ELD), Whitehurst and associates (1991) reported that the rate of vowel babbling, which is the use of syllables that have no consonants, was negatively correlated with expressive language. Whitehurst et al. also reported that the

ratio of consonantal babbling to total babbling was positively correlated with expressive language.

Vocalizations Used Interactively

A relationship may exist between vocalizations used interactively and the development of spoken language (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Halliday, 1975; Whitehurst et al., 1991). This may be because children who use vocalizations to make requests, to engage in social interaction, or to establish joint attention with a communicative partner are demonstrating their ability and desire to communicate. This understanding of prelinguistic communication is thought to provide the conceptual and social foundation for later expressive language (Mundy & Hogan, 1994; Mundy, Kasari, Sigman, & Ruskin, 1995).

In summary, the research measuring both amount of vocalization and use of consonants in the prelinguistic communication period shows that both are predictive of spoken language. In addition there is theoretical support for a positive relationship between vocalizations used interactively and later spoken language (Mundy & Hogan, 1994; Mundy et al., 1995).

The research described above supports the use of prelinguistic babbling as a predictor of later spoken language. However, with the exception of Whitehurst et al. (1991), all the research cited above was done with typically developing children. A better understanding of the relationship between prelinguistic vocal behavior and later expressive language could be important clinically for young children with developmental delay. If there are characteristics of vocal development that are correlated with later expressive language, then the rationale for targeting more frequent, more complex, or more social vocalizations in an intervention would be strengthened. Once effective vocal interventions had been designed, the stage would be set for future research that tests whether facilitating prelinguistic vocal development affects later spoken language development.

Even if teaching children to use prelinguistic vocalizations more frequently and with more complexity does not help them learn to talk, determining whether they predict later spoken language establishes “predictive validity” for these variables. Predictive validity is important to establish when selecting which aspects of early development to examine when trying to identify children who are at risk for language delays. Conducting the study in a sample of children with identified disabilities is important because diagnosticians need to know whether the variables they are assessing are valid predictively in the type of children who are likely to be referred for language intervention.

The purpose of this study was to determine if

prelinguistic vocalization for young children with developmental delays predicted later expressive vocabulary. Based on the literature cited above, we would expect that children who vocalized frequently, with greater complexity, and used their vocalizations interactively would have a larger expressive vocabulary 1 year later than children who engaged in less of these behaviors. Four specific hypotheses were tested. We predicted that rate of vocalization, rate of vocalizations with consonants, proportion of vocalizations with consonants, and rate of vocalizations used interactively would all be positively related to later expressive vocabulary.

Method

Participants

The participants were 58 children, 34 boys, and 24 girls, 17–34 months old, who were enrolled in community-based early intervention programs. The ethnic makeup of the group was as follows: 31 Caucasian, 24 African American, and 3 “other.” Using the parents’ occupational title as indicated in Stevens and Cho (1985) and guided by the *International Standard Classification of Occupations* (1986), we found that most of our sample had occupational status scores that were below the national average. Schooling of the head of household was as follows: 6 had a 7th–9th-grade education, 30 had a 10th–12th-grade education, 20 attended some college, and 2 attended graduate school.

The children had Bayley Mental Development Indices (MDI; Bayley, 1993) ranging from 35–85 ($M = 54.33$, $SD = 13.47$). The Bayley does not provide MDIs below 50. Therefore, for children who scored below 50, an estimated MDI was calculated by finding the regression equation at each age for the data provided in the Bayley manual and then extending the regression line (see Naglieri, 1981 or Robinson and Mervis, 1996 for similar applications). Children with estimated MDIs below 35 were not included in the study because it was likely that they would develop too slowly to show the effects we were interested in. In addition, the children had to demonstrate at least one instance of intentional communication during classroom observation prior to testing to demonstrate their readiness to develop the prelinguistic communication skills.

The children gave no evidence of autism or sensory impairments and had the motoric ability to sit independently and shift their gaze from the toy to an adult who might be sitting beside them while playing with toys. The motor goal was included because of the need for children to learn to use gaze shift as a communicative behavior as part of the intervention. Of the 58 children in the study, 4 had Down syndrome, 4 were premature births with medical complications, 3 were “failure to

thrive," 2 had "pervasive developmental delay," 1 had macrocephaly, 1 had microcephaly, 1 had Duane's syndrome, 1 had neonatal meningitis, 1 had fetal alcohol syndrome, and one had tuberous sclerosis. The remaining 39 had no identifiable etiology or diagnosis other than developmental delay.

At the beginning of the study, the children were observed to have fewer than 3 productive, nonimitative words in their vocabulary. Each child's expressive vocabulary was estimated using teacher report and data from the initial Communication and Symbolic Behavior Scales (CSBS; Wetherby & Prizant, 1993) testing session. Seven out of the 58 children used words during the initial CSBS testing. The children used a total of five different words: mama, bye-bye, no, baby, and uh-oh. Two of the children spoke two words, and the other 5 children each spoke just one word. The number of words and rate of words at the beginning of the study were skewed, making the median a better statistic for central tendency than the mean and standard deviation. The median number of different nonimitative words was 0 (range 0–2).

The children in this study were part of a longitudinal intervention study being conducted by the second and third authors. In this larger study, children were randomly assigned to one of two staff-implemented prelinguistic interventions. The larger study is an experiment that compares the effects of two models of prelinguistic communication intervention. Each child in the study participated in either a one-to-one or group intervention. Both treatments involved working with the child 20 minutes a day, 4 days a week, in a room in the child's school. Children participated in the intervention for 6 months. Follow-up testing was done 6 months after the end of intervention or 12 months after the initial testing.

In the first treatment, the trainer worked one-to-one with a child utilizing milieu language teaching strategies to teach clear prelinguistic communication skills (Warren, Yoder, Gazdag, Kim, & Jones, 1993). The strategies included following the child's lead, imitating and expanding vocalizations and play, and modeling and prompting the desired behaviors (i.e., conventional gestures, coordinated attention, vocalizations to the adult).

The one-to-one treatment was contrasted with a play group condition with one adult and three children. In the play group, the adult was responsive to the children's communication and behavior, followed the children's leads, and commented on the children's play, but did not imitate vocalizations or actions or specifically prompt prelinguistic communication behaviors.

Because the results of the present investigation could have been influenced by the different treatments the children experienced in the larger experiment, we

tested the interactions between group assignment and predictor variables used in the present study. To do this we conducted two preliminary analyses. First, we tested whether the relationship between any of the vocal measures and later expressive language was different between groups (i.e., we tested the interaction between treatment group and the Time 1 vocal measures predicting later spoken language.) Second, we tested to see if there were group differences on the vocalization measures or rate of expressive vocabulary. The results indicated that there were no differences between the groups on the variables of interest and that the relationships of interest are nonsignificantly different between groups. Therefore, the remainder of the paper and the analyses will treat the children as one group.

Procedures

Vocalizations were measured at the beginning of the study, and expressive vocabulary was measured 12 months later in two sets of interactions, one structured and one unstructured, with a research staff member who was familiar to the child. Training for these procedures was conducted at the research center and consisted of watching videotapes of the procedures and then practicing the procedures using children who were not included in the study. Staff members implemented the procedures with children in the study only after demonstrating adequate skill. Testing was done in a separate room in each child's school. Prior to testing, research staff spent time in the classroom interacting and playing with the children who would be tested. The child to be tested willingly accompanied the adult to the testing room. For the few children who remained hesitant, the teacher also accompanied the child and only left the testing session if the child was comfortable.

The structured interactions consisted of the activities and adult interaction style described in the Communication Composite of the CSBS. The Communication Composite consists of "Communicative Temptations" and "Sharing Books." The Communication Temptations are seven situations that are designed to elicit comments and requests from young children. For example, in the first Communicative Temptation, the adult winds up a small walking toy and puts it on the table within the child's reach. When it stops walking the adult waits for the child to request to have the toy walk again. The adult will comply with the request. The adult repeats this sequence. The third time, the adult activates the toy and waits for the response but this time does not comply and puts the toy back on the table. When the child requests again the adult comments or labels the toy and sets it down, again without reactivating it. When the child communicates again, the adult activates the toy and then puts it away when it winds down. The

materials used for the other temptations are balloons, bubbles, blanket for peek-a-boo, the adult's hand for a tickling game, blocks and a box, and a jar with cereal.

During the Sharing Books portion of the test, the child is offered four books. The child chooses one and looks at it and then may choose another book when the first book is finished. The adult is to respond to the child's communications without directing or questioning the child.

It is important to note that we did not use the CSBS coding or scoring. Furthermore, we used a staff member who was familiar with the child, instead of the child's parent. There is strong evidence that adult-child interaction style influences children's immediate performance on many prelinguistic and linguistic measures (Lewy & Dawson, 1992). We chose to exclude the parent from the procedures because we wanted to reduce between-child differences in the extent to which the parent interacted with the child during the testing sessions. We also chose to use the structured protocol in addition to an unstructured communication sample because a more structured protocol reduces variability in the adult-child interactions more than the typical language sample. Also, the activities in the CSBS were selected to elicit communication from young children through engagement with interesting objects. The child sat in a child safety seat at the end of the table facing the video camera. The adult interacting with the child sat either across from the child or on the child's left, so both the adult's and child's faces were clearly in view. The interaction sessions were videotaped for later coding.

The children's expressive vocabulary was also measured at the end of the study in a 15-minute, one-to-one play session with a staff member who was familiar to the child. The toys in this session were those typically found in preschool settings and included a baby doll, two baby bottles, a baby spoon, doll hairbrush, rattle, blanket, teapot and two cups and saucers, four colored cylindrical sticks, a large pink car, and a toy telephone. The adult in the play session was instructed to imitate what the child was doing, comment on the play, and avoid modeling higher levels of play. For example, if the child picked up the sticks and started banging on the table the adult would bang on the table with the other sticks and say, "We're banging on the table." Or, if the child put the bottle in the doll's mouth, the adult might say, "The baby is hungry. She likes that bottle." The play sessions were videotaped for later coding. The child sat in a safety seat across from the adult or on the adult's right, so both the child's and adult's faces were visible. The adult behaviors used in the play session included interaction strategies from both interventions. For example, in the one-to-one intervention, adults frequently imitate the child's behavior. In the group intervention

adults frequently comment on the child's play. However, the reader is reminded that we tested for interactions between group assignment and the relationship between pretreatment variables and the outcome measures and found none. Therefore, the use of strategies that were part of one treatment or the other did not significantly affect our results.

Coding Vocalizations

The interaction sessions were coded using the CSBS list of consonants and Whitehurst et al.'s (1991) measurement strategies. All vocalizations were dichotomized into those that contained at least one consonant and those that consisted only of vowels. Because of low rates of vocalization for some of the participants, we used rate of consonant use in addition to proportion of vocalizations with consonants as the measure of consonant use. Vocalizations were segmented using the Whitehurst et al. method of recording a new vocalization if the child either took a breath or paused long enough to take a breath. The rate of vocalizations with consonants was calculated by dividing the number of vocalizations that contained consonants by the total number of minutes of the interaction session. The rate of vocalizations was calculated by dividing the total number of vocalizations by the number of minutes in the interaction session. The proportion of vocalizations with consonants was calculated by dividing the number of vocalizations with consonants by the total number of vocalizations. The CSBS testing at the beginning of the study took an average of 19 minutes per child with a range from 11.5 to 29.25 minutes.

Coding Vocalizations Used Interactively

Coding of vocalizations used interactively consisted of identifying communication acts and then recording the presence or absence of a vocalization during the act. A communication act was defined as a vocalization or gesture that was directed toward the adult and served a communicative function (Wetherby & Prizant, 1993). For example, the child reached for the balloon and vocalized to make a request or looked at the adult's face and vocalized to establish joint attention when "reading" a book. Vocalizations outside communication acts were not coded for this variable.

Coding Expressive Vocabulary

Expressive vocabulary was measured in two types of interaction sessions 12 months after the initial vocalization assessment, one structured and one unstructured. Expressive vocabulary was measured in a set of structured interactions designed to elicit child-initiated communication. The procedure was similar to that described as the Communication Temptations in the CSBS.

The only adaptations we made to the CSBS protocol was to use our staff member instead of the parent to reduce possible measurement error resulting from different degrees of adult input and communication. Because the structured interactions took different amounts of time depending on the child, expressive vocabulary was quantified as the average rate per minute of different words spontaneously used in the interaction session. To calculate rate, the number of words was counted and divided by the length of time of the session. The CSBS testing at the end of the study took at average of 19 minutes per child, with a range from 12.5 to 28 minutes.

Expressive vocabulary was also measured in an unstructured play session with a familiar adult. Because each play session lasted 15 minutes, number of different words rather than rate was used as the outcome variable. Only words used nonimitatively were included. Nonimitatively was defined as any word spoken by the child that the adult had not used in the previous utterance. In addition, the word had to be included in the *American Heritage Dictionary* (1992). Words that were identical to the adult word and words that were approximations of the adult word were included in the calculations. Word approximations were defined as vocalizations having the same number of syllables and at least one morpheme in common with the adult word. In addition, there had to be nonlinguistic support for determining the child was saying a word (e.g., the child said "baby" while pointing to the baby). Also included were words that have an -ie or -y (e.g., doggy or horsie) and words that are commonly shortened by young children (e.g., "sketti" for spaghetti and "nana" for banana). If the child said both the adult form (e.g., horse) and the diminutive form (e.g., horsie) they were credited for only one word instead of two. Sound effects and animal sounds that are considered words (e.g., "uh-oh," "grr") by the MacArthur Developmental Inventory/Infants (CDI/I; Fenson et al., 1991) were also included.

Reliability

Reliability for all variables in the analyses were calculated for 20% of the data. Reliability was assessed by having coders independently code videotapes. Agreement was calculated on global counts rather than by establishing point-by-point agreement. For example, for the rate of vocalization measure, the total number of vocalizations were calculated by two coders for a particular videotape. We did not go through the tape to identify precisely what the agreements and disagreements were. Reliability samples were randomly selected. Reliability was reported using a generalizability or g-coefficient. G-coefficients, an index of reliability that includes information about between-subject variability, inform the investigator about the importance of the

degree of between-coder disagreement to the goal of discriminating between subjects (Cronbach, Gleser, Nanda, & Rajaratnam 1972). G-coefficients approach 1 as the variance accounted for by the subjects is large in comparison with the variance accounted for by coders (Kasari, Freeman, Mundy, & Sigman, 1995; see McWilliam & Ware, 1994, for discussion on the use of g-coefficients for observational data). Mitchell (1979) recommended g-coefficients in the .5–.7 range. The g-coefficients for the variables in this study are as follows: expressive vocabulary = .96, number of vocalizations = .98, number of vocalizations with consonants = .97, and number of communication acts with vocalizations = .95. Our g-coefficients are considered large and indicate that the variance among the children's vocal behavior was very large in comparison to the variance in the coders' identification and categorization of those behaviors. For example, the range in the number of children's vocalizations was 4–185.

Results

Preliminary analysis was done on the data using the steps recommended by Tabachnick and Fidell (1989). According to their procedures, standardized scatterplots of the residuals from the four hypothesized relationships were tested for normality. The distributions were not normal, indicating that the outcome variables needed to be transformed. After the square root transformation of the outcome variables was done, the distribution of the residuals was not significantly different from the normal distribution. The proposed analyses were then run.

The children vocalized an average of 3.95 times per minute ($SD = 2.95$). The rate of vocalizations per minute that included a consonant was 1.14 ($SD = 1.22$). The rate of communication acts with vocalizations per minute was 1.11 ($SD = .99$). The child's rate of expressive vocabulary was measured 12 months later. The means include children who did not produce words in the testing sessions. During the structured interactions at the end of the study, all but 7 children used words. The rate of expressive vocabulary was .66 words per minute ($SD = .8$). The average number of words used was 13 ($SD = 15.35$). The range was 0–79. In the unstructured play session, 12 children didn't talk. The average number of words used during the 15-minute session was 11.31 ($SD = 15.54$). The range was 0–87. (See Table 1 for a breakdown of word use in each session.)

Pearson's product moment correlations were calculated to estimate the strength of the relationship between the predictor variables and rate of expressive vocabulary during the structured interactions. Three of the four tested correlations were significant. Rate of

vocalization, rate of vocalization with consonants, and rate of vocalizations used interactively were positively correlated with later expressive vocabulary. Proportion of consonants was not. (See Table 2 for correlations and *p* values.)

Pearson's product moment correlations were calculated to estimate the strength of the relationship between the predictor variables and the number of different words used during the unstructured play session. Three of the four tested correlations were significant. Rate of vocalization, rate of vocalization with consonants, and rate of vocalizations used interactively were positively correlated with later expressive vocabulary. Proportion of consonants was not. (See Table 2 for correlations and *p* values.)

Because developmental delay and cognitive level are frequently related to communication and other behavioral skills, correlations were run to make sure that our results were not simply the by-products of degree of developmental delay and cognitive level. In our study, MDI represents the degree of developmental delay and mental age (MA) represents cognitive developmental level. Both of these scores are calculated from the

Table 1. Number of words used in each setting by number of children.

Number of words	Number of children in each setting	
	Structured interaction	Unstructured play
0 words	7	12
1–9 words	28	25
10–19 words	12	9
20–29 words	5	4
30–39 words	3	5
40–49 words	0	1
50 and above	3	2

Table 2. Correlations between predictors and rate of unique words produced in the two testing sessions.

	Correlation	<i>p</i> value
Structured interaction		
Rate of vocalization	<i>r</i> = .36	<i>p</i> = .002
Rate of vocalization with consonants	<i>r</i> = .43	<i>p</i> = .000
Proportion of consonants	<i>r</i> = .06	<i>p</i> = .334
Rate of vocalizations used interactively	<i>r</i> = .34	<i>p</i> = .004
Unstructured play session		
Rate of vocalization	<i>r</i> = .27	<i>p</i> = .019
Rate of vocalization with consonants	<i>r</i> = .40	<i>p</i> = .001
Proportion of consonants	<i>r</i> = .02	<i>p</i> = .449
Rate of vocalizations used interactively	<i>r</i> = .32	<i>p</i> = .007

Bayley. We ran Pearson's *r* correlations to determine the relationship between MDI and later expressive vocabulary and MA and later expressive vocabulary. Neither of these relationships was significant. The correlation between MDI and later expressive vocabulary was *r* = .20, *p* = .12. The correlation between MA and later expressive vocabulary was *r* = .07, *p* = .59.

Discussion

The purpose of this study was to explore the continuities between prelinguistic vocalization and later expressive vocabulary for young children with developmental delay. This study differs from earlier investigations of the relationship between prelinguistic vocalization and later expressive language in that our sample was composed of children with a range of etiologies. Earlier work has targeted typically developing children or children with expressive language delay (ELD). The range of etiologies in our sample more closely resembles a "typical" group of children that practitioners see for diagnostic and intervention services. Thus, the results of this study may be important to early interventionists working with young children.

The results of this study indicated that rate of vocalization, rate of vocalizations with consonants, and rate of vocalizations used interactively were all positively correlated with later expressive vocabulary. However, the intercorrelations among the three significant variables were high (ranging from .64 to .75), thus making it impossible to determine the relative importance of the three. It is likely that a cluster of interrelated variables rather than a single variable are involved in the development of expressive vocabulary. However, because prior research has examined variables one at a time, the predictor variables will be discussed individually.

A positive correlation between rate of prelinguistic vocalization and later expressive language is consistent with other published research findings for typically developing infants (Camp et al., 1987; Kagan, 1971; Roe, 1977). This result is inconsistent with findings for 2-year-olds with ELD reported by Whitehurst et al. (1991). Whitehurst et al. found that rate of vocalization was not positively correlated with later expressive language. It is interesting to note that our findings resemble those for typically developing infants who were much younger than our sample but differ from those of children with ELD who were about the same age.

Rate of vocalizations with consonants as a predictor of later expressive language has support in the published literature for both typically developing children (Menyuk et al., 1986; Stoel-Gammon, 1989) and children with ELD (Whitehurst et al., 1991). The percentage of vocalizations with consonants was approximately the

same for the children with ELD (37%) and our sample of children with developmental delay (30%). When predicting rate of expressive vocabulary in the structured interaction session, rate of vocalizations with consonants accounted for 18% of the variance. It is important to note that proportion of consonants was not a predictor, lending credibility to the hypothesis that frequency of vocalization does play an important part in the development of spoken language.

Rate of vocalizations used interactively as a predictor of later expressive vocabulary is a new finding and contrary to what Whitehurst et al. (1991) reported for 2-year-olds with ELD. Vocal communication as a predictor may be explained using either transactional or child-driven theories. First, adults may attribute meaning to these vocalizations and respond as if the child had spoken (McCune, 1992). Such adult responding may in turn facilitate child vocabulary development (Yoder, Warren, McCathren, & Leew, 1998). In addition, children who engage frequently in communication with adults may engage in the kinds of interactions that are facilitative of language development more often than children who interact less frequently. Second, Bloom (1993) has suggested that children learn to talk to share the contents of their minds. Therefore, children who interact in a social manner with others may be more motivated to learn to talk than children who interact less or in nonsocial ways.

There are other factors that may impact children's spoken language beyond vocalization that were not addressed in this study. We did not look at some of the more transactional factors that may influence language development. First, we didn't measure either parent or teacher responsiveness in general or responsiveness to vocalization to determine what role that may play in expressive language development. We also didn't examine some hypotheses considered to be child driven. For example, oral-motor development, vocabulary comprehension, and the number of different consonants used were not examined. All of these may impact expressive language development but were beyond the scope of this study.

The results of this study are important as a step in identifying one of the relationships between prelinguistic and linguistic communication for young children with developmental disabilities. Our findings are especially important given that MA and MDI, two frequently used measures, did not predict expressive vocabulary for our sample of children. Wilcox and Shannon (1998) comment on the lack of an empirical database documenting the transition from prelinguistic to linguistic communication for children with developmental disabilities. Such data are important because they might help interventionists facilitate children's communication development

more effectively or efficiently. For example, if children demonstrate strong prelinguistic skills in communication and use complex vocal communication frequently, Wilcox and Shannon (1998) recommend teaching spoken words. However, if children have an extremely limited vocal repertoire, Wilcox and Shannon recommend teaching an augmentative or alternative means of communication (e.g., manual sign or communication boards).

In conclusion, prelinguistic vocalization was shown to be positively correlated with later expressive vocabulary. However, it is important to note the differences between our results for children with developmental disabilities and the children with ELD that Whitehurst et al. (1991) studied. These differences raise questions about the importance of specific etiologies in identifying predictors of language outcomes. The questions can only be resolved through further research.

Although prelinguistic vocalization was correlated with later expressive vocabulary, correlation is not causation. Research has shown that young typically developing children can be taught to vocalize more frequently (Pelaez-Noguras & Gewirtz, 1993). However, there is no research relative to the effects of such increases on later language development or on how much vocalization is enough. In addition, there are no published studies on increasing the complexity or "socialness" of children's vocalizations. More research is needed with young children who are at risk for later language delays and disorders. First, research is needed to determine whether we can teach children to be "better vocalizers" and, if so, whether this has any impact on the development of expressive language. Further study is also needed to determine which, if any, predictors are valid for all groups of children.

Acknowledgments

This research was supported in part by the National Institute of Child Health and Human Development Grants T32HDO7226 and RO1HD27549 and United States Department of Education Grant HO23C20152. The views expressed are solely those of the authors.

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Received February 2, 1998

Accepted December 22, 1998

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J Speech Lang Hear Res 1999;42;915-924

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