Determining Spoken Language Prognosis in Children With Developmental Disabilities

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The purpose of this study is to predict which of 58 children (mean age = 22 months) with developmental disabilities in the prelinguistic period of development would begin speaking 12 months after initial assessment. None of the children had severe or profound motor impairments. During the initial assessment period, children participated in a structured and unstructured communication sample with a project staff member. Also, at the time they entered the study, a mother-child interaction session was conducted to measure maternal responses to child communication acts, and mothers filled out a vocabulary checklist. Twelve months later, the structured and unstructured language samples were repeated. We labeled children with fewer than 5 different nonimitative spoken words in either communication samples as "prefunctional speakers" and those with 5 or more words in either sample as "functional speakers." The results indicate that functional speakers scored significantly higher than prefunctional speakers on 5 variables measured during the initial assessment period: (a) number of canonical vocal communication acts, (b) number of intentional communication acts, (c) rate of proto-declaratives, (d) ratio of words produced to those understood on the CDI (i.e., CDI discrepancy ratio), and (e) the number of maternal responses to child communication acts. After statistically controlling for the other significant predictors, only three of these variables continued to predict who would become functional speakers and who would not a year later: (a) number of canonical vocal communication acts, (b) rate of proto-declaratives, and (c) CDI discrepancy ratio. These three variables discriminated functional speakers from prefunctional speakers with 83% accuracy.

W hen a 1.5- or 2.5-year-old with an identified disability is not yet speaking, many parents and clinicians become concerned. Except in extreme cases, we will probably never be able to say with certainty that a particular child has no possibility of learning to talk. Our clinical experience is that almost all children with disabilities do eventually learn to talk. In the meantime, children need a way to communicate their needs.

Augmentative communication (e.g., sign language, communication boards) is among the treatment options for prelinguistic children with disabilities between the ages of 2 and 3 years (Goosens, Crain, & Elder, 1994). There is consensus that for individuals who hear, spoken language is the most efficient and widely understood modality of communication. However, for children who cannot yet speak, alternative means of communication may prove the more effective means of communicating in the short run (e.g., Goosens et al., 1994). Although it is still controversial

to use augmentative and alternative communication systems (AAC) with children under age 3, many have accepted AAC as a reasonable option for those children with a low prognosis for speech development in the near future (e.g., Beukelman & Mirenda, 1992). Knowledge of whether particular children are likely to begin to talk in a year is one factor that many proponents of AAC would use to decide whether to introduce a child to AAC (Musselwhite & St. Louis, 1988).

The present study was designed to test whether variables that are theoretically related to learning to talk are, in fact, useful in predicting which children with developmental disabilities would begin to use speech as a meaningful communication modality (i.e., become functional speakers) one year after the initial assessment period. These children were all enrolled in early intervention centers for the duration of the study and participated in daily prelinguistic communication intervention during the first 6 months of the study.

Given the importance of the topic, it is surprising that there is virtually no information that is directly relevant to discriminating which children with disabilities will become functional speakers from those who will not in the near future. Instead, most studies demonstrate associations that involve a continuous measure of later spoken language variables, such as size of productive vocabulary (many examples are in the review by McCathren, Warren, & Yoder, 1996). It is helpful to predict membership in functional groups such as those who use speech as a communication mode versus those who do not instead of predicting continuous measures of spoken language for two reasons. First, predicting membership in functional groups allows us to determine how many children are correctly classified, thus aiding our evaluation of whether the error rate is acceptable. Second, identifying membership in functional groups defined around children's conversational speech use matches what clinicians have to do when they decide whether to recommend an augmentative communication approach for a young child. It is easier to predict continuous variables than to predict group membership (Pedhazur, 1982), but our experience leads us to conclude that many clinicians find predictions of functional group membership more interpretable than correlations between continuous variables.

To select specific variables that predict who will meet our criteria for using speech as a functional communication modality 1 year after the initial assessment period, it is helpful to consider the transactional model of development (Sameroff & Chandler, 1975). A primary principle of the transactional model of development suggests that we attend to both maternal and child variables when attempting to predict later child developmental status (Sameroff & Chandler, 1975). One specification of this model for the prelinguistic period and for the purposes of predicting later language status suggests that children's prelinguistic intentional communication elicits maternal language-facilitating responses, which in turn facilitates language development (Yoder & Warren, 1993). However, there are several attributes of the child with developmental disabilities that may prevent him or her from taking full advantage of the responsive input the parent provides. Therefore, models that predict later developmental status in typically developing children must be enlarged to include such variables if they are to be applicable to children with disabilities.

The rest of the introduction provides a rationale for each of the seven variables that we have selected to predict which children with developmental disabilities would fit our criteria for conversational speech a year later. These seven variables are (a) maternal responses to children's communication, (b) children's intentional communication, (c) children's proto-imperatives, (d) children's proto-declaratives, (e) the parents' perception of the discrepancy in their children's expressive versus receptive vocabulary, (f) children's canonical vocal communication, and (g) children's object play level.

Maternal responses to children's pre-intentional and intentional communication are frequently posited to facilitate children's language development (Yoder, Warren, McCathren, & Leew, 1998). By "responses," we mean the extent to which mothers comply with or verbally model the meaning of the child's previous communication act. When considered as one category, the amount of responsive input has been found to predict later expressive language in children with developmental disabilities (Yoder & Warren, in press). Indeed, many interventions that teach parents to be more responsive to their children have resulted in substantial gains in children's language development (e.g., Girolametto, Pearce, & Weitzman, 1996).

Intentional communication may elicit maternal responses that facilitate language development (Yoder & Warren, 1993), thereby making intentional communication a probable predictor of which children will fit our criteria for functional speakers in the near future. In fact, it has been empirically demonstrated that maternal responses are partly responsible for the relationship between intentional communication and later language in children with developmental delays (Yoder & Warren, in press). This relationship may occur because mothers respond to intentional communication more than to preintentional communication (Yoder, Warren, Kim, & Gazdag, 1994). Additionally, children with intentional communication may be more fluent in the underlying abilities of later linguistic communication such as means-end, causality, or social agency (Golinkoff, 1981; Harding, 1983).

If intentional communication predicts later language because fluent intentional communicators have mastered one of the underlying abilities of linguistic communication (i.e., means-end relationships), then intentional communication acts used as requests for objects or action (i.e., proto-imperatives) may be more predictive of who will meet our criteria as a functional speaker than communication acts used for other purposes. Proto-imperatives more obviously reflect that the child is using the adult as a means to an end than do many other pragmatic functions (Gomez, Sarria, & Tamarit, 1993). Additionally, proto-imperatives may elicit a particularly facilitating type of maternal response (i.e., maternal compliance). Maternal compliance is doing what the mother presumes the child wants her to do. Proto-imperatives seem to lend themselves to this type of response because they explicitly request an action or object. Yoder and Warren (in press) found that maternal compliance predicted later spoken vocabulary in children with developmental delays. Several studies have found that the number of proto-imperatives predicts future expressive language in children with Down syndrome (Mundy, Kasari, Sigman, & Ruskin, 1995; Smith & von Tetzchner, 1986) and in typically developing toddlers (Mundy et al., 1995).

On the other hand, the number of communication acts that are proto-declaratives might also predict which children meet our criteria for functional speaking in the near future. Proto-declaratives are prelinguistic communication acts that are used to direct the adult's attention to an object or share the experience of an event with others (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Mundy, 1995). Proto-declaratives, which are sometimes called bids for joint attention (Mundy, 1995), are thought to be particularly related to language acquisition for several reasons. First, they may signal the child's desire for

maternal linguistic input (Locke, Young, Service, & Chandler, 1990). Second, they may tend to elicit maternal linguistic input (Franco, Fabia, & Butterworth, 1996; Kessler-Shaw, 1992). Additionally, children who use many proto-declaratives may be particularly interested in sharing their experience with adults (Mundy, 1995). Bloom (1993) hypothesized that the primary reason children learn to talk is to share the contents of their minds. Studies have found that the number of proto-declaratives predicts later spoken vocabulary or expressive language measures in children with Down syndrome (Mundy et al., 1995), with autism (Mundy, Kasari, & Sigman, 1990), and with general developmental delays (McCathren, 1996).

However, maternal responses and intentional communication will predict who will become functional speakers in the near future only if the child has no major word retrieval or oral motor problems. It has long been thought that one way to infer the presence of such problems is to examine the discrepancy between expressive and productive language skills (e.g., Shane & Bashir, 1980). However, this discrepancy has mainly been applied with older children (e.g., adolescents with mental retardation; Musselwhite & St. Louis, 1988). Measuring this discrepancy is particularly difficult in young children. Children of this age group may choose not to talk or perform in situations that are unfamiliar to them. In response to this well-known problem (Fenson et al., 1991), parent report of children's vocabulary use and understanding has become very popular (Yoder, Warren, & Biggar, 1997). A conservative interpretation of a discrepancy ratio based on parental report is "a ratio of the parents' perception of the words understood that are also spoken." No claim is made here about vocabulary size; rather, we are interested in measuring individual differences in the extent to which there are obstacles to production. The Communication Development Inventory is a popular parent report checklist of early vocabulary (Fenson et al., 1991). We will refer to the ratio of words that parents report their children understand that are also produced as the "CDI discrepancy ratio." Thal, Bates, Goodman, and Jahn-Samilo (in press) found that, when taken at 2 years, this CDI discrepancy ratio was one of only two variables that predicted above and beyond other predictors of which children would remain "late-talkers" a year later.

A more specific measure of oral motor functioning is canonical vocal communication. Canonical vocal communication is a communication act with a vocalization that is composed of at least one consonant-vowel sequence. These vocal communication acts sound like the child is "trying to talk" (Oller, 1986). The prediction that children with many canonical vocal communication acts will become functional speakers within a year is based on two primary assumptions. First, children with more complex vocalizations are thought to have the oral motor skills for speech production (Stoel-Gammon, 1992). Second, children who use their complex vocalizations to communicate are thought to be more predisposed to subsequently use speech to communicate (Wetherby, Cain, Yonclas, & Walker, 1988). Empirically, canonical babbling has a concurrent correlation with language level in children with mental retardation (Oller & Siebert, 1988) and a longitudinal

correlation with spoken language and articulation skills in typically developing children (Stoel-Gammon, 1992). In children with specific language impairment, the ratio of vocalizations with consonants to vocalizations with only vowels positively predicted productive language level (Whitehurst, Smith, Fischel, Arnold, & Lonigan, 1991). Finally, prelinguistic communication with a multisyllabic vocalization containing a consonant has been found to predict later amounts of communication acts in the single word stage (Wetherby et al., 1988).

Children also need the representational ability to use words to represent referents. Piaget (1962) hypothesized that symbolic play and language both reveal the child's ability to use one thing to represent another. Amount or highest level of symbolic play is concurrently related to language in typically developing children (Bloom, 1993; McCune, 1995) and in children with developmental disabilities (Casby & Ruder, 1983; Mundy, Sigman, Kasari, & Yirmiya, 1988). Symbolic play level is longitudinally related to spoken language in children with developmental disabilities (McCathren, 1996).

In summary, the purpose for examining these seven variables was to identify the minimum number of variables that maximize the accurate prediction of who would become functional speakers 12 months after the initial assessment period. Our analysis was completed in two stages. First, we determined which of the seven predictors differentiated children that became functional speakers from children that did not at the end of the study. Statistically, this involves testing whether the group means differed on these seven variables. Second, using only variables that differentiated the groups, we determined which predictors represent the smallest set of variables needed to maximize correct classification of the children into groups as functional speakers or prefunctional speakers. To conduct this second step, we used a statistical method (i.e., discriminant analysis) that controls for other significant predictors while testing whether each variable adds accuracy to predicting which children became functional speakers a year later. We studied a sample of children with identified developmental disabilities to increase the generalizability of the results to the types of children for which clinicians are likely to need the information.

Method

Participants

The sample for this study was a part of a longitudinal intervention study being conducted by the authors. In this larger study, children were randomly assigned to receive one of two staff-implemented prelinguistic interventions (Yoder & Warren, 1998-b). These 20-minute intervention sessions were offered daily for 6 months. Both interventions were child-centered and targeted children's intentional gestural and vocal communication. The primary difference between the treatments was that in one group, children's prelinguistic communication was explicitly prompted; in the other it was not prompted. In both treatments, responsivity to children's communication was quite high. For both treatment groups, mothers were kept

naive about the intervention methods used and about the variables measured. More information about these interventions is presented in Yoder and Warren (1998-b).

Because the results of the present investigation could have been influenced by the treatments the children experienced in the larger experiment, we used logistic regression to test whether the treatments affected the extent to which each of the seven predictors accurately classified the children in groups as functional speakers or prefunctional speakers at the end of the study. In these regressions, the interaction term between the pretreatment predictor and the treatment group variable was entered after the main effects as predictors. Spoken language group membership was the outcome variable. The results of these preliminary analyses showed no evidence that treatment influenced the extent to which the predictors accurately predicted functional speaker group membership. Therefore, the remainder of the analyses and presentation will not refer to the larger intervention study.

The children were recruited through three early intervention programs for children with developmental disabilities. The 58 children selected to participate in the study attended one of the three early intervention centers 4–5 days a week for the duration of the study. At least a teacher and an aide staffed the classrooms, and the children's IFSPs guided their curriculum.

The participants were 58 children with disabilities and their primary caretakers. The children ranged in age from 17 months to 32 months. None of the children used more than 5 words according to their classroom teachers, two used 2 words in at least one of the three of our communication samples (one with the mother and two with a staff member), four used 1 word in at least one of the three communication samples, and the remaining 52 used no words in the communication samples. Therefore, this sample of children was considered "prelinguistic." All children scored below the 10th percentile on the expressive scale of the Communication Development Inventory, a frequently used vocabulary checklist (Fenson et al., 1991). Table 1 presents descriptive statistics on the predictor variables and other selected child variables.

Sixty-four percent of the children were males. The etiology for their developmental delays varied. Four children had Down syndrome; four were premature births with medical complications (e.g., chronic lung disease). Three had "failure to thrive" diagnoses. Two were diagnosed with "pervasive developmental delay." One had macrocephaly. Another had microcephaly. One had Duane's syndrome. One had neonatal meningitis. One had fetal alcohol syndrome. Another had tuberous sclerosis, and the rest had no identifiable etiology or diagnosis other than developmental delay. Because a nonverbal intelligence test was not given, we do not know whether any of the children would be diagnosed as having a specific language impairment. However, based on the lack of a diagnosis of specific language impairment in the school records and the low Bayley scores (all MDI scores were under 85, with a mean of 54), it is improbable that any of the children would fit the criteria for specific language impairment. In fact, all children fit the more general category of our state's definition of "developmental delay"

TABLE 1. Means and standard deviations on selected variables at the initial assessment period.

Variables	M	SD
Chronological Age	22 mos	4 mos
Mental Age (MA)[a]	15 mos	2.5 mos
Mental Development Index (MDI)[a]	54	13
Highest Level of Play[b]	2.7	1.3
Parental Report of Words Understood[c]	119	95
Rate of Intentional Communication Acts[d]	1.4	.67
Rate of Proto-Imperatives[d]	.89	.48
Rate of Proto-Declaratives[d]	.61	.56
Number of Maternal Responses[e]	31	17
Number of Canonical Vocal Communication Acts[e]	14	18

[a]Bayley Infant Scales of Mental Development, Bayley (1969); The Psychological Corporation, (1993). [b]Play level was coded from the unstructured play/communication session with a staff member. [c]Communicative Development Inventory, Infant Scale. [d]Selected sections of the Communication and Symbolic Behavior Scales with a staff member. [e]Mother-child interaction session.

(i.e., 40% delay in one developmental domain or 25% delay in two developmental domains).

Ninety percent of the caretakers were the children's mothers. The remaining caretakers were fathers (3 dyads) and grandmothers (2 dyads). The median occupational status of the parents was 23 (range = 10–88). The occupational status of U.S. population averages 34.5 (*SD* = 18; *International Standard Classification of Occupations*, 1986; Stevens & Cho, 1985). Therefore, our sample's occupational status was lower than that in the general population and was more variable than that of the population as a whole. Fifty-seven percent of the families were Caucasian and 36% were African American. The remaining 7% indicated "other" to describe their race. The formal education of the mothers averaged high school graduation and ranged from one year of school to post-graduate school training. This sample has more minorities and a lower level of formal education than is represented in the 1980 U.S. census data (Zill & Schoenborn, 1990).

Procedures

Structured Communication Sample With a Staff Member. At the time of the initial assessment and twelve months later, an adaptation of the Communication Temptations and Book Sharing sections of the Communication and Symbolic Behavior Scales (CSBS; Wetherby & Prizant, 1993) procedure was administered. The adaptation we made to the CSBS was that the parent was not present for the session. Instead, a familiar staff member who was not the child's trainer during the intervention study administered the procedure. This modification was made to standardize the procedure across children so that individual differences in scores would reflect differences in children, not differences in whether parents distracted the children or usurped the children's opportunities for communication.

The structured sessions with the staff member that were taken during the initial assessment period were coded for child pre-intentional and intentional communication acts, which were cross-categorized as proto-declaratives, proto-imperatives, or others. Communication acts were gestures or vocalizations directed to the adult. Definitions and examples are shown in Table 2. In the structured sessions, frequencies of proto-declaratives, proto-imperatives, and intentional communication were divided by the duration of the sessions because the duration of the CSBS sessions varied across children. That is, rates of these variables were used as scores in the analyses. Twelve months later, this same procedure was used in combination with an unstructured language sample to determine whether children fit the criteria for functional speaker group membership (see below).

Unstructured Play and Communication Session With a Staff Member. During the initial assessment period and 12 months later, the children engaged in a play session with a staff member. The unstructured sessions lasted 15 minutes. The toys in this session were those typically found in preschool settings, including a baby doll, 2 baby bottles, a baby spoon, doll hairbrush, rattle, blanket, teapot, 2 cups and saucers, 4 colored cylindrical sticks, a large car, and a toy telephone. The adult was instructed to play at the child's level with the toy of the child's choosing, imitate what the child was doing, and comment on his or her play. She was instructed to avoid directives for action or communication and to avoid modeling higher levels of play than she had seen the child use during the session.

The sessions taken during the initial assessment period were coded for the highest level of play observed during this session. The coding system was adapted from McCune's (1995) representational play scale. McCune's scale measures 5 levels of play from presymbolic play schemes to hierarchical symbolic play. We added a Level 0 that included only mouthing and banging objects that were not designed to be mouthed or banged. The levels were exploration, presymbolic play schemes, self-pretend symbolic play, other-pretend symbolic play, combinatorial symbolic play, and hierarchical symbolic play. See the appendix for definitions of these levels. We also distinguished emerging (i.e., 1 act at that level) and independent (i.e., 2 or more different acts at that level, neither of which was modeled or prompted by the adult) by adding ".5" to the score for independent levels of play (McCathren, 1996). The unstructured sessions with the experimenter that were taken 12 months after the initial assessment period were used in combination with the structured sessions at the end of

TABLE 2. Definitions and examples of communication and responsivity variables.

Variables	Definitions	Examples
Child's Intentional Communication	Unconventional gesture or vocalization with display of coordinated attention to adult and object or event. Conventional gesture or symbol with attention to the adult.	1. Handing object to adult. 2. Point to object and looking at adult. 3. Signing "more" and looking at adult
Child's Preintentional Communication	Unconventional gesture or vocalization with attention to adult OR to object (no coordinated attention shown). Sustained change in affect.	1. Reach to object (no attention to adult). 2. Vocalization to adult. 3. Vocalization to object. 4. Change from neutral facial expression to smile for 3 seconds.
Child's Proto-Imperatives	Pre-intentional or intentional communication acts for the purposes of requesting an object, action, or event.	1. Reach to object and vocalize. 2. Peek-a-boo routine is interrupted and child vocalizes to adult and points to blanket. 3. Child reaches up to the adult to be picked up.
Child Proto-Declaratives	Child pre-intentional or intentional communication that shares affect or experience about an object or event without trying to get the adult to do anything.	1. Child points in the direction of a noise in the hall. After adult acknowledges the noise, child goes back to playing. 2. Adult hands 5 blocks to child who is putting blocks in box. Adult hands a Snoopy dog to the child. Child shows Snoopy dog to adult and vocalizes and smiles.
Maternal Responses	Complying with the presumed meaning of the immediately prior child's communicative message.	1. Child reaches for toy that is out of reach. Mother gets toy for child. 2. Child points to toy and looks at mother. Mother says "Yeah, that's neat, isn't it."
	Imitating some component of the immediately prior child's communicative act. Maternal attempt to clarify the meaning of the preceding utterance.	1. Child rolls the ball to mother. Mother rolls the ball back to the child. 1. "Do you want the ball?" 2. "Ball?" 3. "This?"
	Maternal utterance that includes the main verb, noun, or function word implicit in the immediately preceding child nonverbal or verbal communication act.	1. Child points to a toy bird. Mother says "That's a bird!". 2. Child reaches for the food. Mother says "You want some food." 3. Child throws the toy off the table and glares at Mother. Mother says, "You're finished with that."

the study to determine if children fit the classification criteria for functional speaker group membership.

Mother-Child Interaction Session. During the initial assessment period, the mothers were asked to play with their children for a total of 15 minutes. During these sessions, the child was seated in a chair that was attached to a table to discourage the child from getting up. Because pilot testing indicated that unstructured mother-child interaction sessions resulted in almost no opportunities for mothers to respond, the first two 5-minute segments of the mother-child interaction session were more structured than the last one. In the first segment, developmentally appropriate toys were placed in clear containers so the child could see them but could not have access to them without assistance from the mother. In the second segment, the mother was given juice, cereal, and cookies and told to give small portions to the child when the child indicated that he or she wanted some. While the child was eating a snack, brief animal noises were produced and a suspended slinky was lowered and moved just behind and above the adult's head, but in view of the child. The mother was told to ignore these events until the child drew the mother's attention to either the sound or the slinky. The last segment of the mother-child session was freeplay.

The number of maternal responses and the number of child canonical vocal communication acts were coded from the mother-child interaction sessions collected during the initial assessment period. The definition and examples for maternal responses are shown in Table 2. We used the number of child communication acts to which the mother responded as our measure of the number of maternal responses. Number of responses, not proportion of acts responded to, was used as our predictor because we reasoned frequent responsive input that was contingent on children's previous communication was likely to be facilitative of vocabulary development. This frequent contingent linguistic input could occur because the child communicated frequently and/or because the mother responded to almost all of the child's communication. Canonical vocal communication acts are communication acts with a vocalization that contained at least one true consonant and a vowel (e.g., ba, aga). The transition between the consonant and vowel had to occur quickly, not in a slurred manner. The number of canonical vocal communication acts was the measure used in the analyses.

MacArthur Communication Development Inventory (CDI), Infant Scale. During the initial assessment period, the mother filled out the Infant Scale of the CDI (Fenson et al., 1991). Parents were asked to indicate whether their child "understands only" or "understands and says" each word. The CDI discrepancy ratio was the number of words the mother reported the child said divided by the number of words she reported the child understood plus the words she reported the child said.

Transcription and Criteria for Classifying Children

Trained observers transcribed the children's verbal utterances verbatim from videotapes of the structured and unstructured communication samples with the experimenter that were collected 12 months after the time the children entered the study. Because the children were just beginning to talk, word approximations were given "word status." An approximation to a word was a sound sequence that had the following characteristics: (a) It shared at least one phoneme and the same number of syllables with the adult form of the word, (b) it was used concurrently with or sequentially with nonlinguistic evidence that the child was referring to an object or event, and (c) it occurred in an unabridged English dictionary (*The American Heritage Dictionary of English Language*, 1992) or on the CDI. Exceptions to the "same number of syllables" rule were made for common derivatives of words (e.g., nana, sketti, doggie, kitty). When a derivative and the adult form were both used, only one word was credited. All words were coded for whether they imitated an immediately preceding adult word.

Children were classified into two groups. "Functional speakers" used 5 or more nonimitative different words in either the structured or the unstructured session. All others were classified as "prefunctional speakers." There is no consensus in our field concerning how we should measure the number of words a child must produce before we say he or she is using "meaningful speech" (Wilcox & Shannon, 1998). We rejected the CDI as the procedure by which we might judge whether a child is in the "meaningful speech stage" because a child could be credited with a word if he used it just once or just with the mother. We preferred a measure that reflects whether the child uses speech frequently enough for speech to be considered a "meaningful communication modality" with a relative stranger. Stoel-Gammon (1989) used a 60-minute language sample as the procedure and 10 words as the numerical criterion to credit a child with membership in the "meaningful speech" stage (Stoel-Gammon, 1989). Our samples ranged in length from 15 to 25 minutes; therefore, we needed to prorate the number of words by the length of the session to compare our criteria with Stoel-Gammon's. Stoel-Gammon's criterion rate was 1 word every 5.88 minutes (i.e., .17 of a word per minute). In a 15-minute session, .17 words per minute is approximately 3 words. This would mean that a child would be considered "in the stage of meaningful speech" if they used only 3 words. We considered this too liberal because we wanted to avoid giving a child "functional speaker" status on the basis of words that may have little referential meaning (e.g., huh and uh-oh) or transient meaning. Wishing to strike a balance, we settled on the criterion level that Thal, Oroz, and McCaw (1995) also used: 5 words for 15 minutes or .33 words per minute. We also reasoned that a child might have personally poor performance on one procedure, so we allowed inclusion in the "meaningful speech group" if the child met criterion in either language sample.

Reliability

Interobserver reliability was estimated on all coded and transcribed variables. In the case of the CDI (a parent

report), test-retest reliability was estimated. Generalizability (g) coefficients were used to quantify the extent to which these observations were reliable across observers or time because g coefficients reflect the between-subject variability on the variable. An index of reliability that includes information about between-subject variability (as well as between-coder and between-test-periods variability) informs the investigator whether the observed amount of between-coder or between-test-periods disagreement will obscure individual differences between subjects (Cronbach, Gleser, Norda, & Rajaratnam, 1972). Mitchell (1979) considers g coefficients above .60 acceptable. However, because some readers may be unfamiliar with g coefficients, percentage agreement was also included. Summary level reliability was selected because the analysis was at the summary level.

Pairs of trained observers independently coded all reliability sessions. Reliability on variables collected during the initial assessment period was estimated based on 12–15 (i.e., 20–26%) randomly selected sessions from each of the structured and unstructured communication samples with a staff member and from the mother-child interaction session. The g coefficients for variables collected during the initial assessment period ranged from .71 (CDI discrepancy ratio) to .99 (number of proto-declaratives). Percentage agreement for these same variables averaged between 79% (CDI discrepancy ratio) to 83% (number of proto-declaratives).

Reliability on the variable collected 12 months after the initial assessment period was estimated on 13 sessions. The g coefficients for number of different nonimitative words was .98 in the structured sample collected 12 months and .85 in the unstructured sample collected 12 months after the initial assessment period. Percentage agreement for whether a particular child was assigned to the functional speakers group versus the prefunctional speakers group was perfect (i.e., 100%) in 12/13 reliability subjects.

Results

Preliminary Analyses

Following Tabachnick and Fidell (1996), three variables were transformed due to extreme positive skewness (a violation of a statistical assumption): number of canonical vocal communication acts, rate of proto-declaratives, and the CDI discrepancy ratio. After transformation, all variables fit the statistical assumptions of the planned analyses.

Descriptive Statistics of Children's Expressive Vocabulary at Time 2

Before testing the hypotheses, we will present the descriptive statistics on the children's expressive vocabulary at Time 2. There were many more children with a relatively low number of words used than is expected for a normal distribution (i.e., these variables were highly skewed in the positive direction). For highly skewed variables, the median is a more informative measure of central tendency than the mean. Prorating for 15 minutes, children used a

median of 5.5 and 7 words in the experimenter-child interaction session (ECX) and CSBS, respectively. Only two children used more than 50 words in either of the communication samples. Prorating the rate of nonimitative words for 15 minutes, the median number of words for the children who used fewer than 5 words ($n = 16$) was 1 word and 0 words during the CSBS and ECX, respectively. The median number of words for children who used more than 5 words ($n = 42$) was 10 words for both the CSBS and ECX. There were only two children in each group that scored on the margin of the group membership criterion.

Identifying Individual Predictors of Spoken Language Group Membership

We used a series of t tests to determine whether there were mean differences between functional speakers and prefunctional speakers on these seven variables. Table 3 indicates that functional speakers had higher values than prefunctional speakers on the following 5 variables: (a) CDI discrepancy ratio, (b) number of canonical vocal communication acts, (c) rate of proto-declaratives, (d) rate of intentional communication acts, and (e) number of maternal responses. Medians and ranges on the original scale are presented in Table 3 to aid interpretation. Based on the results of these t tests, we reduced the number of predictors from 7 to 5.

All 5 of the significant predictor variables were entered into a backward, stepwise discriminant analysis (see Table 4). In this analysis, variables that no longer predicted who would become a functional speaker a year later after controlling for the other 4 variables were excluded from the model. Only rate of proto-declaratives, number of canonical vocal communication acts, and the CDI discrepancy ratio predicted who would become a functional speaker a year later when the other four significant predictors were statistically controlled ($\chi^2 = 16.63$; $p = .0008$). This model, which included only 3 variables, classified 83% of the 58 children correctly. Fifteen of 16 prefunctional speakers were correctly categorized (94%) and 33 of 42 functional speakers were correctly classified (79%).

Because the children had developmental delays, one might expect that the degree to which they experienced cognitive delays might predict whether they became functional speakers a year later. Additionally, because the children varied in terms of chronological age and degree of delay, children with higher mental ages might be expected to become functional speakers a year later. Neither mental age nor Mental Development Index from the Bayley predicted who would become functional speakers a year later ($t < 1.0$, $t = -1.46$; $p > .15$, respectively).

Discussion

This study was conducted to identify a small set of variables that predicts which prelinguistic children with developmental delays (DD) would become functional speakers within a year. The results indicated that number of canonical vocal communication acts, rate of proto-declaratives, and the CDI discrepancy ratio predicted with

TABLE 3. Medians and ranges for the Time 1 predictors by functional and prefunctional speakers a year later.

| | Group Membership a Year After Entering the Study | | | |
| | Functional Speakers (i.e., used 5 words or more; $n = 42$) | | Prefunctional speakers (i.e., used fewer than 5 words; $n = 16$) | |
Time 1 Variables	Median	Range	Median	Range
CDI discrepancy ratio[a]	.09*	0–.83	.04	0–.20
Number of canonical vocal communication acts[b]	10.5*	0–98	3.8	0–16
Number of mothers' responses[b]	33*	13–81	17	3–48
Rate of proto-declarative communication acts[c]	.58*	0–2.84	.19	.04–1.45
Rate of intentional communication[c]	1.4*	.53–3.07	1.0	.13–2.34

[a]Communicative Development Inventory, Infant Scale. [b]Mother-child interaction session. [c]Selected sections of the Communication and Symbolic Behavior Scales with a staff member.
*t test is significant at the .05 level or better. t tests were conducted on log10 transformed scores when positive skewness indicated the need. Medians for the original scale are reported here to aid interpretation.

TABLE 4. Results of the discriminant function to find the smallest set of variables that maximized the accurate prediction of spoken language group membership.

Variables entered by order of entry[a]	Variables retained after controlling for other predictors	p value for unique contribution of retained variable
Number of canonical vocal communication acts	Number of canonical vocal communication acts	.001
CDI discrepancy ratio	CDI discrepancy ratio	.002
Number of maternal responses	Rate of proto-declaratives	.004
Rate of intentional communication		
Rate of proto-declaratives		

[a]Order of entry is determined empirically according to which variable accounts for the most variance after controlling for the previously entered variable. Retained variables are those that account for significant variance after controlling for other variables entered into the predictive model.

83% accuracy who would and who would not use at least 5 words in communication samples with skilled clinicians 12 months later. Ninety-four percent of the prefunctional speakers were correctly predicted and 79% of the functional speakers were correctly predicted.

Prediction of individual children's future outcome (particularly a year or more into the future) will always result in some inaccurate predictions because of the number of variables and the complex interactions between variables influencing development. Additionally, prediction efforts are somewhat inaccurate because measuring the true abilities of young children with developmental disabilities is notoriously difficult. Currently accepted standards for screening measures are 70–80% specificity and sensitivity (Barnes, 1982; Squires, Nickel, & Eisert, 1996). Specificity is the percentage of children correctly classified into a positive outcome group (e.g., functional speakers; Glascoe, 1997). Sensitivity is the percentage of children correctly classified into a negative outcome group (e.g., prefunctional speakers; Glascoe, 1997). Clearly, the current findings meet or exceed this standard. Ultimately, the clinical utility of any set of variables used to predict who will become functional speakers in the near future should be judged relative to what is currently available. At present, this study is the first to empirically demonstrate that a relatively small set of variables accurately predicts which children with developmental disorders will become functional speakers in a year. It is hoped that future research will improve on this initial effort.

The three variables that make unique contributions to predicting who became functional speakers a year later are particularly interesting. Together these variables may quantify the extent to which the child is motivated to, elicits the linguistic input for, and has the neurological integrity and maturation to learn to use conversational speech in the next year. On the one hand, we have been using complexity of vocalizations and the discrepancy between receptive and productive language for some time to identify candidates for nonspeech communication systems who are much older than the present sample (Goosens et al., 1994). So one might ask what the present study's results add to what we already knew. For one thing, the results extend support for the value of measuring the parents' perception of discrepancy between expressive and receptive vocabulary in very young children with developmental disabilities. Second, the results bring our attention to the importance of proto-declaratives. Additionally, they suggest that many of the variables we might consider important were either redundant with these 3 predictors (e.g., maternal responses, intentional communication) or did not empirically differentiate functional speakers from prefunctional speakers (e.g., mental age, mental development index, play level). Given that we cannot measure everything, it is important to have empirical guidance about the variables most likely to predict who will become a functional speaker a year later.

These three variables can be considered "risk factors" in identifying young children who are at high risk for not developing speech in the next year. As with all risk factors, the more risk factors the child exhibits and the more delayed the child is on particular risk factors, the more confidence we can have that a particular child will not become a functional speaker within the next year. For clinicians to be able to use these results in predicting whether particular children have a good prognosis for speech development within the next year, they need to know (a) the population to which these results may generalize, (b) the procedures used to measure the predictors, and (c) the score on the predictors that describe the prefunctional speakers (i.e., the "cut-off score"). At present, the best that we can do is to use the current study's participant descriptors to identify the types of children these data may represent, the procedures to identify measurement contexts, and the median values for prefunctional speakers as the cut-off scores.

The children we studied averaged about 2 years of age (range 17–32 months), had mild to moderate mental retardation, and used fewer than 3 words in three communication samples. It should be noted that the children at the young end of the continuum all scored in the moderate range of mental retardation. All children used at least one instance of intentional communication at the time they entered the study. Even for prefunctional speakers, the mean number of intentional communication acts was 1 per minute in the CSBS. Of particular importance is the fact that all children were enrolled in early intervention and participated in developmentally appropriate prelinguistic communication interventions during the year of the study. At least part of the day throughout the year, the children were in environments that were designed to facilitate communicative development.

In terms of assessment contexts, we used the communication temptations and book-reading sections of the CSBS to measure proto-declaratives, a 15-minute semi-structured mother-child interaction session to measure the number of canonical vocal communication acts, and the CDI to measure the discrepancy ratio for words said to words understood. The median values for the prefunctional speakers for the rate of proto-declaratives, the number of canonical vocal communication acts in a 15-minute session, and the CDI discrepancy ratio were .19, 3.8, and .04, respectively (see Table 3). Therefore, a particular child who used fewer than 1 proto-declarative every 5 minutes, used fewer than 1 canonical vocal communication act every 4 minutes, and whose parent reports fewer than 4 words said to every 100 words understood is at high risk for remaining a prefunctional speaker during the next year.

As mentioned in the introduction, using AAC with children under age 3 is still controversial. Some clinicians recommend AAC for children who do some speaking, but not enough to meet their needs (Beukelman & Mirenda, 1992). Others would be more inclined to focus primarily on speech development once the child begins to speak (Girolametto, 1988). Still others emphasize treating gestures and vocalizations as treatment goals for prelinguistic children who have a good prognosis for speech

development (Yoder & Warren, 1998-a). The decision between treatment options is not mutually exclusive, but the relative emphasis and timing of one option over the other is likely to be influenced by knowledge of being at risk for not developing speech within a year. With some assurance that a child who is already intentionally communicating is not likely to begin to use spoken words in the next year, clinicians and parents may opt for an AAC system earlier than otherwise might be the case. However, it should be noted that replication of the current results is necessary before we can be confident that these predictors as measured in the current study and the cut-off values recommended here have the necessary validity to be used clinically.

Author Note

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Appendix

Levels of Play

Level 0 : Exploration

Child mouths or bangs toys as a means of exploring items. (Mouthing the spoon or bottle, banging the sticks, or shaking the rattle belong in this category if those schemes are used indiscriminately on other objects).

Level 1: Presymbolic functional play

The child recognizes the function of an object by use.

Level 2: Self-pretend

The child pretends at self-related activities such as eating, drinking, sleeping, or grooming while showing by elaboration such as sound effects, affect, and gesture an awareness of the pretend aspects of the behavior.

Level 3: Other-pretend

The child extends pretending beyond the self by (a) pretending at others' activities or (b) having others enact pretend schemes.

Level 4: Combinatorial pretend

The child uses several schemes in a sequence. These consist of either of the following: (a) a single theme with several agents or (b) different schemes played in a sequence. To be scored in this level, at least one of the actions must be directed toward another agent and at least one of the actions must be initiated and not imitated.

Level 5: Hierarchical pretend

The child uses a single act that exhibits hierarchical structure in one of the following ways: (a) a plan is apparent before the enactment as the child verbalizes, searches for materials, or engages in other preparation, (b) one object is substituted for another with evidence that the child is aware of the multiple meanings expressed, and (c) a doll (or car) is treated as if it could act independently.

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Am J Speech Lang Pathol 1998;7;77-87

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