

Early Predictors of Language in Children With and Without Down Syndrome

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Abstract

Predictors of productive and receptive language development in 39 children with intellectual disabilities (17 with Down syndrome) and their parents were identified. Children were in the prelinguistic or first stage of productive language acquisition (Brown, 1973). The Down syndrome and non-Down syndrome groups were matched on several variables, including IQ, CA, and vocabulary level. After controlling for initial language level, we attempted to identify unique early predictors of language measured 6 months later. Results indicate that Down syndrome negatively affected language development. Additionally, frequency of optimal parental responding predicted later productive language above and beyond etiology. Finally, canonical vocal communication and commenting predicted later productive language only in children without Down syndrome.

Children with intellectual disabilities have greatly varying language acquisition rates (Hart, 1996). Understanding the predictors of this variability may eventually (a) help professionals understand its causes and (b) enable development of effective early interventions. Etiology of intellectual disability is one potential predictor of language development. Down syndrome is the most common known genetic cause of intellectual disability. Most researchers who have examined the language of children with Down syndrome have compared them to typically developing children matched for mental age (MA) or language level (e.g., Chapman, 1995; Chapman, Seung, Schwartz, & Raining Bird, 1998). Because the comparison groups in these studies were typically developing individuals, language difference in the Down syndrome group could be explained by the presence of mental retardation in general or by the specific phenotype of Down syndrome. One way to disentangle the effects of the specific phenotypic characteristics of Down syndrome from that of mental retardation in general is to compare children with this syndrome to children with mixed-etiology mental retardation matched on degree of mental retardation and developmental level.

Ninety-six percent of Down syndrome cases are caused by a third copy of chromosome 21 (Chapman & Hesketh, 2000). The precise mechanisms that govern the translation of an extra copy of chromosome 21 into the set of behavioral and intellectual characteristics of Down syndrome are not yet known (Chapman & Hesketh, 2000). However, researchers have found that about 50% of children with this syndrome who have MAs under 36 months have communication and language skills that are delayed in comparison to what is expected for their MAs (Miller, 1999). Although school-age children with mixed-etiology intellectual disability may have receptive language below MA level (Abbeduto, Furman, & Davies, 1989), preschoolers or toddlers with mixed-etiology intellectual disabilities tend to have communication and language commensurate with their MAs (Miller, 1999). The etiological group difference in developmental profiles tends to increase with MA and chronological age—CA (Miller, 1999) and may indicate that children with Down syndrome encounter more obstacles in acquiring communication and language than do children with intellectual disabilities due to other etiolo-

gies. Therefore, one might expect children with Down syndrome to have different language abilities than do matched peers with mixed-etiology intellectual disabilities (children without Down syndrome).

The primary approaches to identifying whether children with Down syndrome have additional obstacles to language development above and beyond that expected by their degree of intellectual disabilities all have their advantages and disadvantages (Abbeduto et al., 2003). The approach we have selected is to compare children with Down syndrome to a group of children with intellectual disabilities due to mixed etiologies while matching on a number of variables that can account for individual differences in language. Because it is impossible to match on all important variables simultaneously, one must decide which variables are most important to control through matching or selection criteria. Our reading of the present literature suggests that CA, developmental level, and degree of intellectual disability must be controlled to address our central research question. It would be difficult to control for all these variables using a single-etiology comparison group because of the low incidence of single-etiology groups other than Down syndrome.

If presence of Down syndrome influences language development above and beyond presence of intellectual disability, then we would find Down syndrome–non-Down syndrome group differences in the variance, mean, and predictors of language development. Smaller variance on language scores is expected in a Down syndrome group than in a non-Down syndrome group because the genotype of Down syndrome is more homogeneous. If this prediction is not true, then one might reasonably question the importance of characterizing groups of children with intellectual disability by the genetic etiology for intellectual disability. To our surprise, we have found no support for this most basic of predictions in the extant literature on language of people with Down syndrome. Smaller mean language scores were expected in the Down syndrome group because this syndrome may affect the *rate* of language development above and beyond the presence of intellectual disability. We know of no studies showing Down syndrome versus non-Down syndrome group differences in early language development. It is important to remember that our prediction requires a comparison group of children with mixed-etiology mental retardation matched on

level of intellectual disability and initial developmental level. Finally, if Down syndrome strongly influences the *process* of language development, then the predictors of language development for these individuals may be different than for those with mental retardation from other causes. Again, we know of no studies supporting this prediction.

There are probably some predictors of language development that are common to both Down syndrome and non-Down syndrome groups. The transactional model of development (Sameroff & Chandler, 1975) suggests that attention to both parent and child factors are more helpful than attention to just one of these factors in explaining why some children with intellectual disabilities acquire language before others. One specification of the model for the prelinguistic period suggests that prelinguistic communication (a) reveals children's readiness to acquire language and (b) elicits parental language-facilitating responses (Yoder & Warren, 1993; Yoder, Warren, & McCathren, 1998). From among the child variables that have been found to predict later language in children with intellectual disabilities, we have selected vocabulary comprehension and frequency of requests, comments, and canonical vocal communication to investigate.

One might consider early comprehension to be the most logical predictor of later productive language. Typically, words are understood before they are produced. In the prelinguistic period, vocabulary comprehension has predicted later language production in several samples of typically developing children (e.g., Bates, Benigni, Bretherton, Camioni, & Volterra, 1979; Bates, Bretherton, & Synder, 1988). In late talkers (i.e., children with low productive vocabularies for their CAs), early comprehension level predicts who will "catch up" with their age-mates a year later (Paul, Looney, & Dahm, 1991; Thal, Tobias, & Morrison, 1991).

One must also consider children's communicative production. In the prelinguistic stage, *communicative production* refers to prespeech methods of communication. Requesting and commenting are two such prespeech acts. *Requests* are (a) gestures, or nonword vocalizations coordinated with attention to adult; (b) conventional gestures; or (c) symbols used to acquire objects and events other than the listener's attention, affect, or labels (Bates et al., 1979; Wetherby & Prizant, 1993). *Comments* are (a) gestures or nonword vocalizations coordinated with attention to adult, (b) con-

ventional gestures, or (c) symbols used to share interest or positive affect about an event or object (Mundy, 1995). The frequency of requests has been found to predict later language level in young children with Down syndrome (Mundy, Kasari, Sigman, & Ruskin, 1995; Smith & von Tetzchner, 1986) and with mixed-etiology intellectual disabilities (Yoder et al., 1998). The number of comments have predicted language level a year later in samples of children with Down syndrome (Mundy et al., 1995), autism (Mundy, Sigman, & Kasari, 1990), and mixed-etiology intellectual disabilities (Yoder et al., 1998). However, we note that the associations of requests and comments with later language in the Down syndrome samples did not control for initial language status (Mundy et al., 1995; Smith & von Tetzchner, 1986). Therefore, the association could be explained by individual differences in initial language causing individual variation on requests or comments.

In addition to frequent use of particular prespeech communicative *functions*, the frequent use of a particular prespeech *form* may be an important predictor of later language. Canonical vocal communication, which is one such form, is comprised of a vocalization with a consonant–vowel syllable that is combined with a gesture or attention to the message recipient (Yoder et al., 1998). Similar measures of vocal communication have been associated with later language level in children who are typically developing (Vihman & Greenlee, 1987) and in children with delayed expressive language (Whitehurst, Smith, Fischel, Arnold, & Lonigan, 1991). Frequency of canonical vocal communication has predicted later language in toddlers with mixed-etiology intellectual disabilities (Yoder et al., 1998). However, Yoder et al.'s past sample contained few children with Down syndrome.

One reason why prelinguistic communication is associated with later language may be because it tends to elicit language-facilitating input from responsive parents. Three such adult responses were measured in this study: linguistic mapping, compliance to child communication, and vocal imitation of the child. *Linguistic mapping* is defined here as the adult putting the child's immediately preceding, nonverbal-communication act into words. *Compliance* is immediately doing what the child requested in the prior communication act. *Vocal imitation* is the adult imitating the child's vocalizations either exactly or with slight modifications. Measured as one class of behaviors,

frequency of these parental responses has been found to mediate the association between intentional prelinguistic communication and later language in children with mixed-etiology intellectual disabilities (Yoder & Warren, 1999a). We call this class of behaviors "optimal responses to child communication." Frequency of optimal responses is clearly a dyadic variable. It reflects both frequency of child communication and probability of parental response.

Although past research supports these variables as predictors of later language, no researchers have as yet explicitly tested whether they are unique predictors of later language in children with intellectual disabilities due to Down syndrome and other etiologies. In addition, no other researchers have investigated whether these predictors have different predictive validity for children who differ in their etiology of intellectual disability. In this study we addressed the following research questions: (a) Do requests, comments, canonical vocal communication, and number of optimal responses to child communication predict productive and receptive language development in children with intellectual disabilities? (b) Does etiology of intellectual disability (i.e., Down syndrome vs. non-Down syndrome) predict the mean and variance of later productive and receptive language? We expected lower means and standard deviations (*SDs*) for the Down syndrome group. (c) Finally, which predictors account for unique variance in language development in children with intellectual disabilities above and beyond etiology? (d) Is there a difference in the magnitude of the association between predictors and later language in children with than in those without Down syndrome? We examined the latter question by testing a statistical interaction between the predictor and etiology predicting language. These questions are addressed with a sample of toddlers who had intellectual disabilities and were in the early linguistic stage of development (Brown, 1973).

Method

Participants

Participants were 39 toddlers with intellectual disabilities and their primary caregiver, 35 of whom were mothers (87%); 2 were grandmothers, 1 was a foster mother, and 1 was a father. All children scored below the 10th percentile on the Expressive scale of the Communication Development Inventory (Fenson et al., 1991). In addi-

tion, they all fit the Tennessee definition for having developmental delay. Finally, all children's mental development indices (MDI) on the Bayley Scales of Infant Development (Bayley, 1993) were below 70. Twenty-two children (56%) were male; 19 (49%) were African American, 19 (48%) were Caucasian, and 1 child was classified as "other." The median formal parental education level was high school graduation (range = 8th grade to more than 4 years of graduate school). The median occupational status score was 29 ($SD = 23$). The median occupational status of our sample was slightly below the national average (Stevens & Cho, 1985). Other data on the children is presented in Table 1. As can be seen, the groups were not significantly different on CA, Bayley MDI, and number of vocabulary words parents reported at Time 1.

The etiology of the children's intellectual disabilities varied: 17 (44%) had Down syndrome. The non-Down syndrome group was composed of 2 children with William syndrome, 1 with mild cerebral palsy due to unknown etiology, and 1 whose disability was caused by encephalitis. The rest of the non-Down syndrome group ($n = 17$) had unknown etiologies.

A certified audiologist screened children for hearing losses using sound field screening at 500, 1000, and 2000 Hz. Thirty-eight percent of the Down syndrome group and 63% of the non-Down syndrome group passed the hearing screening (at or better than 25 dB HL). Range of hearing thresholds were from 15 to 70 dB HL. Children were retained for analysis, regardless of whether they passed the hearing screening, because (a) as many as 40% of children with intellectual disability due to unspecified etiologies (Yeates, 1995) and as many as 60% to 80% of children with Down syndrome (Pueschel, 1990) have hearing

impairments, and (b) other researchers have found that hearing accounts for only 2% to 3% of the variance in productive and receptive language measures in children with Down syndrome (e.g., Chapman, 1995; Marcell & Cohen, 1992). However, we note that Chapman excluded children with severe and profound impairments. That is, excluding children who failed hearing screening would have rendered the sample nonrepresentative of the population of children with mental retardation without necessarily affecting our ability to predict variance in later language.

In the present study, we found that hearing thresholds were not related to later productive language, $r = -.19$, nor did they interact with etiology to predict later productive language. The children's hearing did not predict, $r = -.27$, or interact with etiology to predict later receptive language. Hearing was significantly worse in the Down syndrome group than in the non-Down syndrome group, $t(38) = -2.41$, $p = .03$. However, as indicated above, hearing was unrelated to later language. Therefore, variance in hearing could not explain possible etiological differences in later language. Further, hearing did not interact with any Time 1 variable to predict any Time 2 language variable.

Design and Procedure

In this analysis we utilized a longitudinal correlational design; language measures were administered at entry into the study (Time 1) and 6 months later (Time 2). Time 1 productive and receptive language were controlled to eliminate the possibility that Time 1 language differences caused the associations between Time 1 predictors and Time 2 language.

Children's school records were reviewed to derive diagnostic information. The procedures

Table 1. Medians and *SDs* for Participant Description Variables by Group

Variable	Down syndrome		No Down syndrome	
	Median	<i>SD</i>	Median	<i>SD</i>
CA (in months)	30	6	29	6
Bayley MDI ^{a,b}	42	15	44	10
Bayley MA ^a (in months)	13	2	15	3
No. words parent reports child understands ^c	183	119	200	107
No. words or signs parent reports child produces ^{c,d}	74	85	58	55

^aBayley Scales of Infant Development. ^bUsing extrapolated norms when needed (Robinson & Mervis, 1996).

^cCommunication Development Inventory-Infant scale (Fenson et al., 1991). ^dApparent differences in means were non-significant. All between-etiology mean differences were nonsignificant.

given at Time 1 were (a) Communication Development Inventory–Infant scale (Fenson et al., 1991), (b) the Communication and Symbolic Behavior Scales (Wetherby & Prizant, 1993), (c) experimenter–child play session (Yoder & Warren, 1998), and (d) a parent–child session (Yoder & Warren, 1998). At Time 2, the experimenter–child play session and the Communication and Symbolic Behavior Scales were repeated, and the (a) Receptive scale of the Reynell Developmental Language Scales (Reynell & Gruber, 1990) and (b) an experimental measure called the Comprehension of Semantic Relations Test (Yoder & Warren, 2001b) was administered. The reason for giving the Reynell Developmental Language Scales and Comprehension of Semantic Relations Test only at Time 2 only was because pilot testing indicated that a majority of the children did not cooperate during the testing protocol at Time 1. Therefore, the Communication Development Inventory–Infant scale was used to control for individual differences in Time 1 receptive language level.

Reynell Developmental Language Scales. The Receptive scales of the Reynell were administered to the children to assess global receptive language level at Time 2. The split-half reliability for the scales ranged from .60 to .97, depending on the age of the children (Reynell & Gruber, 1990). The raw score from the Reynell Developmental Language Scales was a component of the receptive language outcome used in the current study.

Comprehension of Semantic Relations Test. This experimental procedure was adapted from procedures described in Bates et al. (1988) and is similar to those described in Miller and Paul (1995). Our assessment was composed of 12 pairs of directives. Two pairs of directives exemplify 1 of 6 semantic relations (i.e., Action + Object, Agent + Action, Action + Location, Modifier + Entity; Possessor + Entity, Entity + Location). Within each pair, there was an “easy” and a “hard” directive. The easy directive could be correctly responded to largely by relying on nonlinguistic comprehension strategies (Chapman, 1980). An example of a hard directive was “Kiss the ball.” To correctly answer this latter directive, the child had to understand both the action verb and the direct object noun. The number of hard directives the child responded to correctly was a component of the receptive language variable at Time 2.

Communication Development Inventory–Infant scale. This scale was used to derive the parents’ report of the number of understood words at

Time 1. This number is the sum of the words only understood plus the words and/or signs understood and produced. For the expressive score, parents were told to report only nonimitative words or signs. For the comprehension scores, parents were to report words or signs the child seemed to understand without the use of gestures.

Communication and Symbolic Behavior Scales. We administered the Communication Temptations and Book Sharing sections of the Communication and Symbolic Behavior Scales procedure. An unfamiliar, experienced examiner conducted these assessments. The Communication Temptations and Sharing Books are procedures designed to entice a variety of child-initiated communicative acts. Communication Temptations consist of structured communication-eliciting situations in which environmental arrangement, toy selection, and verbal and gestural prompts are used to encourage communication (e.g., outstretched, palm-up gesture plus “Do you need help?”). Sharing Books consists of question-asking and responding around a picture book. The Communication and Symbolic Behavior Scales was used to derive measures of child prelinguistic communication at Time 1. In addition, the Communication and Symbolic Behavior Scales was used to derive an estimate of productive language from Times 1 and 2 that were later averaged with a similar variable from the experimenter–child play session.

Experimenter–child play session. In this session, 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 the play. She was instructed to avoid directives for action or communication and to avoid modeling levels of play higher than she had seen the child use during the session. These sessions lasted 15 minutes. The toys were a baby doll, two baby bottles, baby spoon, doll hairbrush, rattle, blanket, teapot and two cups and saucers, four colored cylindrical sticks, a large car, and a toy telephone. This session was used to derive a second set of estimates of Time 1 child prelinguistic communication. In addition, productive language from the experimenter–child play session was combined with that from the Communication and Symbolic Behavior Scales to enable us to estimate productive language at Times 1 and 2. More information on the procedure and rationale for producing language aggregates is provided below.

Parent–child play session. Parents 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 maximize visibility of child communication and adult responses on the videotape of the session. The procedure had three 5-minute segments. In the first segment, developmentally appropriate toys were placed in clear containers that could not be opened without assistance. In the second segment, the parent was given juice, cereal, and cookies and told to give small portions to the child in response to the child's requests. While the child was eating a snack, brief animal noises and the lowering of a suspended slinky occurred. The parent was told to ignore these events until the child drew the parent's attention to either the sound or the slinky. The last segment of the parent-child session was free play. The parents were told to play with the child as they would at home. The data from these three segments were summarized across the entire session. This procedure has produced measures of parental responsivity that were associated with later intentional communication and later language in past research on children with intellectual disabilities (Yoder, McCathren, Warren, & Watson, 2001). The parent-child play session was used to derive estimates of the number of child communication acts to which parents use optimal responses at Time 1.

Coding and transcription. The Communication and Symbolic Behavior Scales, experimenter-child play session, and parent-child play session were coded, and the Communication and Symbolic Behavior Scales and experimenter-child play session were transcribed. Coding and transcription were conducted using repeated observations of videotaped sessions with the aid of a custom-designed software that scaffolds the coding and transcription process (Tapp & Yoder, 1998). This software formats the observer's records according to the requirements for Systematic Analysis of Transcripts (Miller & Chapman, 1993). This analysis was used to count the coded behaviors to reduce measurement error due to miscounting. Variables were derived from the systematic analysis output. Observers were trained to at least 85% summary-level agreement before coding or transcribing the data to be analyzed. From the parent-child play session, the number of child communication acts to which the parent optimally responded was coded. From the Communication and Symbolic Behavior Scales and experimenter-child play sessions at Time 1, the following variables were coded: (a) frequency of canonical vocal

communication, (b) frequency of child-initiated comments, and (c) frequency of child-initiated requests. Definitions and examples for these categories are given in Table 2.

At Times 1 and 2, lexical density was derived from the Communication and Symbolic Behavior Scales and experimenter-child play session. By *lexical density*, we mean the number of different symbols (i.e., signs and words) the child used nonimitatively in a communication sample. This is not a measure of vocabulary size per se. Lexical density, which is affected by both loquaciousness and vocabulary size (Yoder et al., 1998), differs from type token ratio (i.e., the number of different words used/total number of words used). Lexical density was chosen over type token ratio because the latter index does not change with development (Richards, 1987). Because vocabulary size increases into adulthood and loquaciousness increases during the early stages of language development, we expected that lexical density would increase during the developmental period under study.

To be transcribed and counted as a word or sign, the child's word or sign attempt had to meet four criteria. First, the word had to be included in the American Heritage Dictionary of the English Language (1992) or the Communication Development Inventory-Infant scale or the sign had to be included in A Basic Course in American Sign Language (Humphries, Padden, & O'Rourke, 1980). Second, the word or sign had to be an acceptably close approximation to the adult form, which means it contained at least one accurate phoneme occurring in the correct position and had the same number of syllables as the adult word it was approximating or was a common diminutive of the word (e.g., *sketti* for *spaghetti*). An acceptably close sign approximation occurred when the movement and location with respect to the rest of the body was like the conventional sign. The hand shape did not have to match the conventional sign exactly. Third, the proposed word or sign had to have nonlinguistic support for concluding the child was intending to represent a referent, event, thought, or feeling. For example, if the child said "baba" while pointing to the baby, the transcriber recorded "baby." Fourth, the word or sign had to be used nonimitatively (i.e., not immediately after the adult's use). The word roots for these symbols were counted if at least one instance of the word root was used nonimitatively. A *word root* is the uninflected form of a word. For example, *ball* and *ball/s* were counted

Table 2. Definitions and Examples of Communication and Responsivity Variables

Variable	Definitions	Examples
Child's communication	Gesture & vocalization, vocalization & attention to the adult, or symbol & attention to the adult or symbol with attention to the adult. The list of gestures used is indicated in the Communication and Symbolic Behavior Scales scoring manual.	<ol style="list-style-type: none"> 1. Handing object to adult. 2. Pointing to object and looking at adult. 3. Saying "uhoh" and looking at adult.
Child's requests	Child initiated (i.e., unprompted) communication acts for the purposes of requesting an object, action, or event.	<ol style="list-style-type: none"> 1. Child reaches to object and vocalization. 2. Peek-a-boo routine is interrupted and child vocalizes to adult and points to blanket while smiling. 3. Child reaches up to the adult to be picked up.
Child comments	Child-initiated communication acts that request adult to attend to an object or event or attempts to share affect or experience about an object or event without trying to get the adult to do anything.	<ol style="list-style-type: none"> 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 a box. Adult hands a Snoopy dog to the child. Child shows Snoopy dog to adult and vocalizes and smiles.
Optimal parental response	<p>Complying with the presumed meaning of the immediately prior child's communicative message.</p> <p>Exact, reduced, or expanded imitation of immediately preceding child vocalization.</p> <p>Exact verbal recoding of the child's immediately preceding nonverbal communication act.</p>	<p>Child reaches for toy that is out of reach; mother gets toy for child.</p> <p>Child says "ah"; mother says "agha."</p> <p>Child points to a toy bird; mother says "That's a bird!"</p>

as the same word root. Diminutives (e.g., *kitty*) were counted as identical to conventional word roots (e.g., *cat*).

Deriving aggregate language outcome measures. Two aggregate measures of language development were derived: one for productive and one for receptive language. Aggregate measures were created because classical measurement theory suggests

that combining more than one valid, but nonredundant, measure of a construct improves the estimate of the true score for that construct (Allen & Yen, 1979; Baggaley, 1988). To create the receptive aggregate, we standardized the raw scores from the Reynell Developmental Language Scales and the number of correct hard directives from the Comprehension of Semantic Relations Test

and computed their average. We note that these two receptive measures had a correlation of .74, $p < .001$. For the productive measure, we averaged the two lexical density measures from the Communication and Symbolic Behavior Scales and experimenter–child play session. The intercorrelations of these two lexical density measures at Times 1 and 2 were .80 and .83, respectively.

Reliability

Test–retest reliability was assessed on the Communication Development Inventory–Infant scale over a 2-week interval. Interobserver reliability was estimated between two observers for all coded or transcribed variables. Both types of reliability were estimated from a random sample of 20% of the data. The reliability estimate used was the G coefficient (Cronbach, Gleser, Norda, & Rajaratnam, 1972). Test–retest reliability for the number of understood words on the Communication Development Inventory–Infant scale was .98. The average interobserver reliability for lexical density at Times 1 and 2 in the experimenter–child play session and Communication and Symbolic Behavior Scales was .94 and .84, respectively. The average interobserver reliability for the other child communication variables was .92 ($SD = .08$). The interobserver reliability estimates for the number of optimal parental responses was .86.

Analysis

Pearson's correlation coefficient was used to quantify the zero-order correlation of Time 1 predictors with Time 2 language. Multiple regression was used to control for other variables to identify unique predictors of later language. Nonlanguage predictors entered into the final regression to identify unique predictors of later language were selected on the basis of low intercorrelations with each other but significant partial correlations with later language. We tested interactions with etiology by entering dummy coded etiological group (i.e., 0 or 1), the predictor variable, and their product term in simultaneous multiple regressions predicting language.

Results

Preliminary Results

At Time 1, the etiological groups (i.e., Down syndrome vs. non-Down syndrome) were not significantly different on CA, MDI, or number of

symbols understood or produced on the Communication Development Inventory. In addition, etiological groups were not significantly different on number of comments in the Communication and Symbolic Behavior Scales and experimenter–child play session, number of requests in the experimenter–child play session, and number of optimal parental responses (see Table 1).

The non-Down syndrome group's means, however, were higher than those of the Down syndrome group on the following Time 1 variables: lexical density, $t(37) = 2.8, p = .01$, number of canonical vocal communication acts in the Communication and Symbolic Behavior Scales, $t(37) = 2.0, p = .05$, experimenter–child play session, $t(37) = 2.3, p = .03$, and number of requests from the Communication and Symbolic Behavior Scales, $t(37) = 3.0, p = .004$. If any of these four variables predicted language after controlling for Time 1 language, then we controlled for them when testing for the etiological differences in language.

Do Requests, Comments, Canonical Vocal Communication, and Number of Optimal Parental Responses to Child Communication Predict Later Language?

Productive language. Table 3 provides the Pearson values for the zero-order correlations between Time 1 predictors and Time 2 lexical density. All predictors had significant correlations with later productive language, except for the number of requests in the experimenter–child play session. Table 4 provides the partial correlations of these Time 1 variables with Time 2 lexical density after controlling for Time 1 lexical density. The Time 1 predictors of Time 2 lexical density after controlling for Time 1 lexical density were (a) number of optimal parental responses, (b) number of canonical vocal communication acts in the Communication and Symbolic Behavior Scales, and (c) etiology.

Receptive language. All predictors had significant correlations with Time 2 receptive language, with the exception of number of requests in the experimenter–child play session and number of optimal parental responses (see Table 3). After controlling for Time 1 receptive language (i.e., number of words understood on the Communication Development Inventory–Infant scale), Time 1 lexical density, number of canonical vocal communication acts in the Communication and Sym-

Table 3. Zero-Order Correlations With Time 2 Lexical Density and Receptive Language

Time 1 predictor	Time 2	
	Lexical density	Receptive language
Lexical density	.80	.57
No. of words understood on CDI ^a	.42	.44
No. of canonical vocal communication acts in CSBS ^b	.73	.56
No. of canonical vocal communication acts in experimenter–child play session	.79	.54
No. of comments in CSBS	.59	.35
No. of comments in experimenter–child play session	.59	.35
No. of requests in CSBS	.41	.45
No. of requests in experimenter–child play session	ns	ns
Etiology	–.51	–.59
No. of optimal parental responses	.33	ns

^aCommunication Development Inventory-Infant scale. ^bCommunication and Symbolic Behavior Scales.

bolic Behavior Scales and experimenter–child play session, number of requests in the Communication and Symbolic Behavior Scales, and etiology still predicted Time 2 receptive language (see Table 4 for partial r values).

Does the Etiology of Intellectual Disability Predict Mean and Variance of Language?

To provide a rigorous test of whether later language varied by etiology, we tested for an etiology effect on Time 2 language after controlling for Time 1 language and each of the Time 1 variables that (a) varied with etiology and (b) had a significant partial correlation with Time 2 language.

Productive language. Of the variables that covaried with etiology at Time 1, only lexical density at Time 1 predicted lexical density at Time 2, $r = .80$, $p = .003$. After controlling for Time 1 lexical density, we found that etiology continued to predict Time 2 lexical density, partial $r = -.37$, $p = .02$. The standardized mean difference was quite large, $d = 1.17$ (Down syndrome mean = 4.8, $SD = 4.3$; non-Down syndrome mean = 24, $SD = 22$). As suggested by the SD s for these means, the variance was also significantly smaller in the Down syndrome group than in the non-Down syndrome group, $F(1, 38) = 25.7$, $p = .000$. The variance difference was quite large (i.e., over 5 times the variance in the Down syndrome group).

Table 4. Partial Correlations With Time 2 Language After Controlling for Time 1 Language

Time 1 predictor	Time 2	
	Lexical density	Receptive language
Lexical density	ns	.49*
No. of canonical vocal communication acts		
In CSBS ^a	.47*	.47*
In experimenter–child play session	ns	.45*
No. of requests in CSBS	ns	.40*
Etiology	–.37*	–.65*
No. of optimal parental responses	.37*	ns

^aCommunication and Symbolic Behavior Scales.

* $p < .05$.

Receptive language. Of the variables that covaried with etiology, the following Time 1 variables predicted Time 2 receptive language above and beyond Time 1 receptive language: (a) lexical density, (b) number of canonical vocal communication acts in the experimenter-child play session, and (c) number of requests in the Communication and Symbolic Behavior Scales. Lexical density and number of canonical vocal communication in the experimenter-child play session were highly correlated, $r = .90$. Therefore, we dropped number of canonical vocal communication in the experimenter-child play session from the list of variables to control. The following Time 1 predictors were controlled when testing the etiology effect on Time 2 receptive language: receptive language, lexical density, number of requests in the Communication and Symbolic Behavior Scales and etiology. Etiology still had a significant effect after controlling for these variables, partial $r = -.59$, $p = .002$. Squaring these partial correlation coefficients indicated that these effects were quite large (i.e., 35% of the variance). The standardized mean difference was also quite large, $d = 1.46$ (Down syndrome mean = $-.62$, $SD = .51$; non-Down syndrome mean = $.48$, $SD = .9$). The variance was also significantly smaller in the Down syndrome group, $F(1, 38) = 6.9$, $p = .01$.

Which Predictors Account for Unique Variance in Language Development Above and Beyond that of Etiology?

Productive language. We only included predictors that did not interact with etiology in our multivariate predictive model. Time 1 lexical density, $t(34) = 7.3$, $p = .000$, partial $r = .78$, number of optimal parental responses, $t(34) = 2.96$, $p = .005$, partial $r = .45$, and etiology, $t(34) = -2.97$, $p = .006$, partial $r = -.45$, all accounted for unique variance in Time 2 lexical density. Together they accounted for 76% of the variance in Time 2 lex-

ical density. However, the population variance explained is probably smaller because of the small sample size used in the present study.

Receptive language. To build a parsimonious predictive model, we reduced the number of predictors by selecting variables with low correlations with Time 1 receptive language and other potential Time 1 predictors. Table 5 provides the intercorrelations of the predictors of Time 2 receptive language above and beyond Time 1 receptive language. Only one canonical vocal communication variable was entered to avoid conceptual redundancy. Because canonical vocal communication in the experimenter-child play session was so highly correlated with Time 1 lexical density, the former was entered into the multivariate model. This left Time 1 receptive language, number of canonical vocal communication acts in the experimenter-child play session, number of requests in the Communication and Symbolic Behavior Scales, and etiology as predictors. Only Time 1 receptive language, $t(35) = 2.6$, $p = .01$, partial $r = .41$, and etiology, $t(35) = -3.6$, $p = .001$, partial $r = -.53$, continued to predict Time 2 receptive language after controlling for the other predictors. When only these two variables were included in the model, they accounted for 55% of the variance in Time 2 receptive language, $F(2, 36) = 20.6$, $p < .001$. Again, the population variance explained is probably smaller because of the small sample size used in the present study.

Is There a Difference in the Magnitude of the Association Between Predictors and Language in Children With Down Syndrome Compared to Those Without Down Syndrome?

We addressed this question through testing the statistical interaction of etiology and predictor, using language as the criterion variable. Number of canonical vocal communication acts in the Communication and Symbolic Behavior Scales

Table 5. Intercorrelations of Time 1 Predictors of Receptive Language

Predictor	1	2	3	4	Etiology
1. Lexical density		.37	.63	.90	-.38
2. No. of words understood			.39	.37	ns
3. No. of canonical vocs ^a in CSBS ^b				.63	ns
4. No. of canonical vocs in experimenter-child play session					-.33

^aCanonical vocal communications.

^bCommunication and Symbolic Behavior Scales.

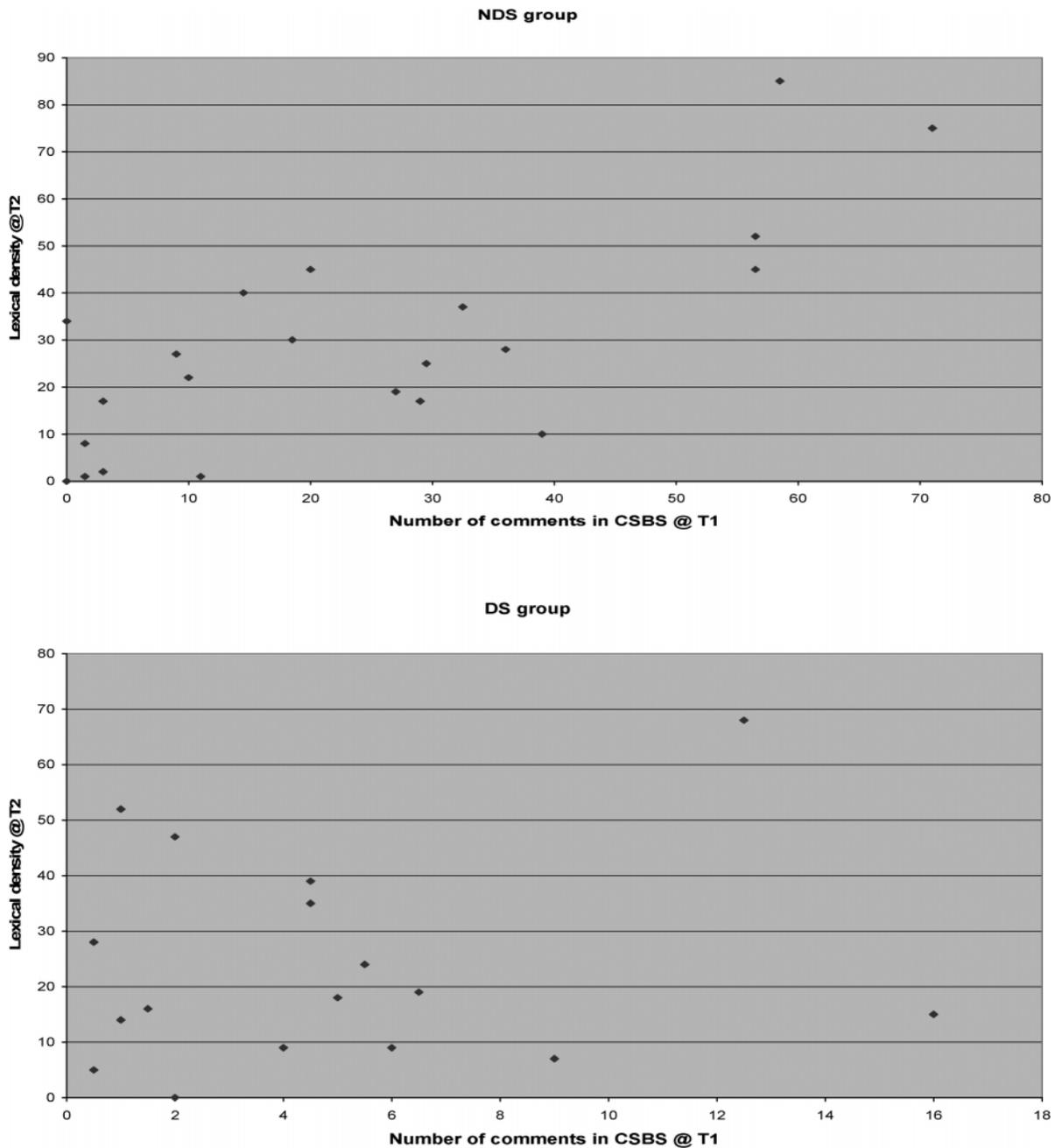


Figure 1. Interaction of number of comments in the experimenter-child play session at Time 1 (T1) and etiology predicting Time 2 (T2) lexical density. NDS = non-Down syndrome, DS = Down syndrome, CSBS = Communication and Symbolic Behavior Scales.

interacted with etiology to predict lexical density at Time 2, even after controlling for Time 1 lexical density, $t(34) = -2.65, p = .01, R^2 \text{ change} = .17$. In addition, number of canonical vocal communication acts in the experimenter-child play session at Time 1, $t(35) = -2.79, p = .008, R^2 \text{ change} = .18$, and number of comments in the

Communication and Symbolic Behavior Scales at Time 1, $t(35) = -2.16; p = .04; R^2 \text{ change} = .12$, also interacted with etiology to predict Time 2 lexical density after controlling for Time 1 lexical density. In all three cases, these interactions occurred because there was a stronger association of the Time 1 predictor and Time 2 lexical density

in the non-Down syndrome group than in the Down syndrome group. Figure 1 illustrates one of these interactions. Etiology did not interact with any of the Time 1 variables to predict Time 2 receptive language.

Summary of Results

The unique Time 1 predictors of later lexical density were initial lexical density, etiology, and number of parental optimal responses. The unique Time 1 predictors of later receptive language were initial receptive language and etiology. Time 1 number of canonical vocal communication and comments predicted later lexical density in the non-Down syndrome group but not in the Down syndrome group. After controlling for all measured variables that could have accounted for the difference, we found that children with Down syndrome had lower mean and less varied receptive and productive language than did those without Down syndrome.

Discussion

In this study we focused on identifying unique predictors of later language in children with intellectual disabilities. We rigorously tested whether etiology of the intellectual disability (Down syndrome vs. non-Down syndrome) affected the level, variability, and predictors of later language. The results highlight the importance of considering etiology as a predictor of later language in three ways. First, children with Down syndrome had less receptive and productive language 6 months after entry into the study than comparable children with intellectual disabilities due to other reasons. Second, the receptive and productive language in the children with Down syndrome was less variable. Finally, canonical vocal communication and comments predicted later productive language more strongly in the non-Down syndrome group than in the Down syndrome group. Further, the results highlight the continued importance of considering parental optimal responding to child communication as a predictor of later productive language in children with intellectual disabilities, regardless of etiology.

Determining the behavioral phenotype for Down syndrome in humans is restricted to a non-experimental research design because we obviously cannot experimentally manipulate the presence of Down syndrome in humans. Therefore, it is possible that apparent differences between, or in-

teractions with, etiological groups could be due to variables that coincidentally covary with etiology in this sample. However, we note that the children did not differ significantly on CA, MA, and intellectual impairment level (i.e., Bayley MDI) and parent-reported vocabulary size at Time 1. In addition, all measured Time 1 variables were statistically controlled if they could account for the etiological differences. Therefore, it is unlikely that these results are spurious. The design and results suggest that the presence of Down syndrome, per se, affected the developmental course of language development above and beyond that caused by degree of general intellectual impairment and initial developmental level. Even so, it is important to remember that replication is the only way to determine whether the apparent etiological differences in this study were due to *unmeasured* covarying variables.

Another potential limitation of the study was that the associations could be sample-specific. The potential causes of this sample specificity are small sample size and multiple tests of significance. Unless we control for it, such multiple significance testing causes elevated experiment-wise error above the .05 level. The Bonferroni method was not used in this study because the sample size was relatively small and the effect sizes of correlates of language development are typically moderate. Further, the Bonferroni method is too conservative when predictors are nonindependent (Yoder, Blackford, Waller, & Kim, 2003). Using the Bonferroni correction method in our situation would have almost ensured high type II error rates. Therefore, replication is the primary method of determining whether the results of the present study have generality.

In the interests of aiding future efforts at more confirmatory analyses of predictors of later language, we examine here the extent to which results of past studies are consistent with our present findings. As indicated in the introduction, comments have been found to predict later language in other samples of young children with Down syndrome (Mundy et al., 1995; Smith & von Tetzchner, 1986) and with intellectual disabilities for a variety of reasons (Yoder et al., 1998). However, in Mundy et al., when initial language measures were controlled, comments no longer predicted later language in children with Down syndrome. In the present study we also controlled initial language status. Therefore, our finding that comments more strongly predict productive language

in the non-Down syndrome sample than in the Down syndrome sample is consonant with Mundy et al.'s data.

In contrast, the past literature that has shown that canonical vocal communication is related to later productive language in children with intellectual disabilities included only three children with Down syndrome (Yoder et al., 1998). Together with our present finding that canonical vocal communication predicts later productive language more powerfully in the non-Down syndrome group than in the Down syndrome group, this suggests that we should limit our generalization to the former group. Additional research is needed to determine why canonical vocal communication would not predict later productive language in children with Down syndrome.

In profile analysis studies, Miller (1999) reported that children with Down syndrome tend to have special difficulty with expressive language. Miller did not carefully match on intellectual impairment and cognitive level and did not find special difficulty with receptive language. In addition, we focused on children in the prelinguistic and early linguistic stages of development; whereas Miller's analysis showed that the productive-delay profile was most salient in older children with Down syndrome. Therefore, the most conservative approach to interpreting our results is to wait for replication to conclude that Down syndrome, per se, affects the level and variability of language development in the early stages of language acquisition.

If future research confirms that children with Down syndrome have more trouble developing language than do those with non-Down syndrome intellectual disability, then additional research will be needed to identify what aspect of the language acquisition process is different in children with Down syndrome. That is, there may be obstacles to language development that are associated with Down syndrome that are not as prevalent or as severe in children with non-Down syndrome intellectual disabilities. For example, those with Down syndrome tend to have substantially worse auditory memory than do developmentally matched children with non-Down syndrome intellectual disabilities (Marcell, Ridgeway, Sewell, & Whelan, 1995). Compared to their visual memories, children with Down syndrome have relatively weak verbal short-term memories (Marcell & Weeks, 1988). Also, auditory memory has been found to be associated with, and is approximately

on the same level with, expressive language in children with Down syndrome (Chapman, 1995). Therefore, it is possible the etiology-specific results of the present study are due to relatively weak auditory memories, which necessitate more exposures to language input before these children can use the linguistic input they receive to acquire language. Future work is needed to test this hypothesis.

Above and beyond etiology, we found that the number of optimal parental responses predicted later productive and receptive language. Frequency of optimal responding to child communication predicted receptive and productive language in another sample of children with intellectual disabilities (Yoder, McCathren et al., 2001). Therefore, we have growing confidence that optimal parental responding will continue to replicate as a predictor of productive language in future studies of children with intellectual disabilities. This finding is important, in part, because it is a malleable environmental variable. We note that it was *number*, not proportion, of communication acts to which parents optimally responded that predicted later language. This is clearly a variable that is influenced by both parent and child. One cannot respond to communication unless the child communicates. Fortunately, learning to be responsive has been shown to facilitate child intentional communication (Wilcox, 1992; Yoder & Warren, 1999b, 2002). Furthermore, intentional communication has been shown to elicit optimal responses from responsive parents (Yoder & Warren, 2001a). Therefore, working on both child communication and parental responses to child communication is likely to have a synergistic effect on children's language development. Treatment approaches that are focused on increasing frequency and clarity of child communication and consistency of parental responsivity to child communication (e.g., Responsive Education and Prelinguistic Milieu Teaching, Yoder & Warren, 2002; Enhanced Milieu Teaching, Kaiser, Hester, & McDuffie, 2001) appear particularly appropriate for young children with intellectual disabilities in the prelinguistic and early linguistic stages of development.

In summary, parents of children with Down syndrome need not interpret this report as having negative implications. Research suggests that they can maximize their child's language development by enhancing their responsivity to their child's communication. Future etiology-specific

research is needed to elucidate the cause and appropriate clinical response of the different pattern of findings for the children with Down syndrome. Relative weakness of auditory memory in children with Down syndrome is offered as a hypothesized explanation for etiological differences in language development and in the predictors of language development. The relative effectiveness of intervention approaches designed to address the specific strengths and deficits of children with Down syndrome need to be directly tested as well.

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Editor-in-charge: Leonard Abbeduto

This work was supported by National Institute of Child Health and Human Development (NICHD) Grant R01-34520 awarded to the authors and NICDH Core Grant HD15052, which supports the John F. Kennedy Center at Vanderbilt University. Thanks are given for the work of the research staff (Ann Edwards, Dawn Garcia, Melanee Horton, Melanie Jacobs, Melanie Jarzynka, Aimee McKey, Lisa Stepp, Carole Pickett, and Hope Vanbeselaere) and families who participated in this research. Requests for reprints should be sent to Paul Yoder, Peabody Box 328, Vanderbilt University, Nashville, TN 37203. E-mail: paul.yoder@vanderbilt.edu

Received 9/9/02, accepted 8/2/03.