
Effects of Prelinguistic Milieu Teaching and Parent Responsivity Education on Dyads Involving Children With Intellectual Disabilities

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This study tested the effect of a method of facilitating prelinguistic communication on parents' responsivity and children's communication and productive language development. The method involved Responsivity education for the parents and Prelinguistic Milieu Teaching for the children (RPMT). Thirty-nine prelinguistic toddlers with intellectual disabilities and their primary caregivers participated in this study. Parent-child pairs were randomly assigned to either the RPMT group or a control group. Communication and language were assessed at study entry and 6, 9, and 12 months later. RPMT facilitated parental responsivity in the posttreatment period. The effect of RPMT on growth rate of child-initiated comments (i.e., the most common type of initiating joint attention) varied by pretreatment measures of that variable. The effect of RPMT on growth rate of child-initiated requests (i.e., the most common type of initiating behavior regulation) varied by presence or absence of Down syndrome. Finally, the effect of RPMT on growth of productive language varied by pretreatment frequency of canonical vocal communication. Recommended alterations in PMT and implications for defining which nonspeaking children are appropriate for prelinguistic goals and treatment were discussed.

KEY WORDS: prelinguistic communication, developmental disability/delay, intervention, prelinguistic vocalizations, symbolic communication

This report presents the test of the efficacy of a prelinguistic communication intervention (Responsive education for parents combined with Prelinguistic Milieu Teaching for children, abbreviated RPMT) on two aspects of children's pragmatic development: requests (i.e., the most common type of initiating behavior regulation; Wetherby & Prizant, 1993) and comments (i.e., the most common type of initiating joint attention; Mundy, 1995). Additionally, we investigated the effects of RPMT on parental use of linguistic mapping to child communication, compliance to child communication, and vocal imitation of child vocalizations as one class that we refer to as "optimal responses to child communication." We also investigated the effect of RPMT on children's productive language. Finally, select pretreatment child variables were examined as potential predictors of children's response to RPMT.

It is well known that children with intellectual disabilities, including those with Down syndrome, have delayed and widely varying productive language development (e.g., Hart, 1996). The transactional model of development (Sameroff & Chandler, 1975) suggests that attention to both parent and child factors is more helpful than attention to just one of these factors in explaining why some children with intellectual disabilities acquire productive language before others. One specification of the model for the prelinguistic period suggests that prelinguistic communication reveals children's ability to (a) acquire language and (b) elicit parental language-facilitating responses (Yoder & Warren, 1993; Yoder, Warren, & McCathren, 1998).

If early intervention can affect child prelinguistic communication and parental responses, then we may be able to facilitate the language development of children with intellectual disabilities who may not yet benefit from more direct attempts to facilitate spoken language (e.g., elicited production of words). Wilcox and Shannon (1998) stated:

A child whose brain has not reached the state of maturation compatible with verbal representations will derive minimal benefit from an intervention strategy that targets language acquisition [directly]. With such children, the most effective intervention might be one that targets the enhancement of nonlinguistic communication skills, building the motivational foundations for later language acquisition. (p. 387)

Additionally, it may be most efficient to use professional treatment time to facilitate the use of communicative forms that are more within the child's zone of proximal development than is speech and to support parents in using language-facilitating responses to these child communication acts. Such a treatment may also provide parents with the tools to stimulate their children's language development outside of treatment sessions and may help the child develop the cognitive and oral motor underpinnings of spoken language.

Early work focused on correlational studies of the association between prelinguistic and linguistic communication. There is replicated evidence that the frequency of prelinguistic communication predicts later language level in both typically developing populations (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Mundy, Sigman, Kasari, & Yirmiya, 1988) and developmentally delayed populations (Calandrella & Wilcox, 2000; Yoder & Warren, 1999a). However, correlational designs are not sufficient to establish a causal link between prelinguistic and linguistic communication.

Yoder and Warren (1999b) showed that prelinguistic communication intervention could facilitate generalized and maintained, child-initiated requests and comments

in children with intellectual disabilities. It has been shown that treatment designed to facilitate intentional communication in children with intellectual disabilities also resulted in indirectly influencing parents to respond to such communication acts, which in turn was partly responsible for subsequent effects on language development (Yoder & Warren, 2001a, 2001b). One of the treatments tested in the Yoder and Warren study is Prelinguistic Milieu Teaching (PMT). PMT uses child-centered play to teach intentional vocal and gestural communication for requesting and commenting purposes (Warren & Yoder, 1998). However, PMT effects were only seen in children of parents who had relatively high responsivity to their children's communication before treatment began (Yoder & Warren, 1998, 1999b, 2001b).

In an attempt to increase the size of the subgroup for which PMT is effective, the present study added parent education and support sessions designed to increase the probability that parents would respond to their children's communication acts. We call the combination of these two methods Responsivity education and Prelinguistic Milieu Teaching (RPMT). The curriculum for the parents' sessions was modeled after that of the Hanen Centre (Manolson, 1992). The child-dependent variables for the current study were requests, comments, and a measure of productive language termed lexical density.

Requests refer to the child using gestures or nonword vocalizations with attention to adult, conventional gestures or symbols to ask an adult to get an object or do an action. Requests may facilitate language development because they reveal that the child understands that communication is effective in getting his or her needs met and because requests may elicit language-facilitating parental responses (McCathren, Yoder, & Warren, 1999). Empirically, frequency of requesting is positively associated with later language in young children with Down syndrome (Mundy, Kasari, Sigman, & Ruskin, 1995; Smith & von Tetzchner, 1986) and with intellectual disabilities for a variety of reasons (Yoder et al., 1998).

Comments (which include the prelinguistic forms or proto-declaratives, e.g., Yoder et al., 1998) are gestures or nonword vocalizations coordinated with attention to adult, conventional gestures, or symbols for the purpose of sharing interest or positive affect about an event or object (Mundy, 1995). Children who use many prelinguistic comments may be motivated to share their experience with adults (Mundy, 1995), which may be a primary reason children learn to talk (Bloom, 1993). Empirically, the number of prelinguistic comments predicted who talked 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). Comments, under the label of initiating joint attention, have drawn much research attention partly because initiating joint attention may be a prototypical behavioral indicator of social, not just instrumental, communication in the prelinguistic period (Mundy, 1995).

One reason why it is important to facilitate prelinguistic communication is that it may elicit language-facilitating responses from parents. There is replicated evidence that parents respond more to intentional communication than to pre-intentional communication (Yoder & Warren, 2001a). Three responses were measured in the study being presented here: linguistic mapping, compliance to child communication, and vocal imitation of the child. Linguistic mapping is the adult putting the immediately preceding child nonverbal communication act into words. Compliance is immediately doing what the child requested in the prior communication act. Vocal imitation is the adult imitating, either exactly or with slight modifications, the child's vocalizations. Measured as one class of behaviors, these parental responses have been found to mediate the association between intentional prelinguistic communication and later language (Yoder & Warren, 1999a). We call this class of behaviors "optimal responses to child communication."

Finally, we proposed to test whether RPMT would affect growth in lexical density. By lexical density, we mean the number of different symbols (i.e., signs and words) the child uses in a communication sample. This is not a measure of vocabulary size per se. Instead, lexical density reflects the diversity of meanings conveyed by reasonable approximations or exact productions of conventional symbols that the child uses for frequent communication purposes (Yoder et al., 1998). Lexical density differs from type token ratio (i.e., the number of different words used/number of total 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, lexical density was expected to increase during the developmental period under study in this experiment. Additionally, lexical density may index the degree of automatization of productive language (Chapman et al., 1991).

Our understanding of past literature and theory led us to expect that the majority of the parents and children would benefit from RPMT. However, we also recognized that some children with intellectual disabilities have limitations that place obstacles to developing productive language within 12 months of intervention onset (the length of time many educational goals cover). These obstacles can be thought of as lack of developmental readiness for speech or evidence of disorders that

may complicate or prevent speech production. As an example of the latter class, we recognized that some children might have difficulty with speech planning or oral muscular control. For children who did not experience either type of obstacle to speech development, using prelinguistic treatments and goals would be developmentally inappropriate. Unfortunately, we did not have empirical guidance to determine which nonspeaking children would benefit most from prelinguistic, rather than linguistic, goals before beginning the study. Examining the types of children whose language does not respond to RPMT may be helpful in identifying which aspects of the child to attend to when deciding between prelinguistic and linguistic goals and treatments.

Although our measure of productive language potentially included sign language and other symbols (e.g., graphic, nonspeech symbols), our knowledge of the participant population and location of the research led us to expect that most of our children's symbols were likely to be spoken words. Therefore, vocal development was considered a potential predictor of children's response to RPMT. One measure of vocal development is the number of canonical vocal communication acts. Canonical vocal communication is nonword 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 shown to be associated with later language level in children who are typically developing (Vihman & Greenlee, 1987) and children with expressive language delayed (Whitehurst, Smith, Fischel, Arnold, & Lonigan, 1991), intellectual disabilities (Yoder et al., 1998). Theoretically, frequent canonical vocal communication may indicate the child has the oral motor skills for speech production (Stoel-Gammon, 1992). Additionally, children who frequently use canonical vocal communication may be attempting to talk but are not yet sufficiently intelligible for us to understand them. It has been noted that such vocalizations resemble attempts to talk (Oller, 1986).

Pretreatment number of comments may predict children's response to RPMT on lexical density. As mentioned earlier, some consider prelinguistic comments evidence of the child's desire to socially connect with others (Mundy, 1995), and such a desire has been considered a primary motivation to use language to communicate (Bloom, 1993). Prelinguistic comments have been found to be positively associated with later productive language in children with intellectual disabilities (Yoder et al., 1998). Therefore, number of comments was analyzed as both a potential predictor of response to treatment and as an outcome by which RPMT efficacy was tested.

We also expected pretreatment ratio of produced symbols to understood symbols to predict children's response

to RPMT on lexical density growth. By itself, comprehension vocabulary size has had an equivocal association with onset of later language in children with disabilities. In typically developing infants (Bates et al., 1979; Bates, Bretherton, & Snyder, 1988) and late talking toddlers (Thal, Tobias, & Morrison, 1991), it has a positive association with later productive language. However, in children with intellectual disabilities, it has not been a significant predictor of productive language (McCathren, Yoder, & Warren, 1998; Yoder et al., 1998). The lack of association between comprehension in the prelinguistic stage and later productive language in children with intellectual disabilities could be due to poor oral muscular development or speech planning problems (Yoder et al., 1998). A discrepancy ratio of words produced/words understood has been proposed as a distal measure of several possible "obstacles to producing words the child understands." This ratio predicts later language in children with intellectual delays (Yoder et al., 1998).

Finally, there is much current interest in whether children with different etiologies for intellectual disabilities respond differently to treatment. This interest grows, in part, out of a desire to understand how various genes may affect intellectual development and disability. The largest known genetic etiology for intellectual disability is Down syndrome (DS). Ninety-six percent of DS 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 DS are not yet known (Chapman & Hesketh, 2000). However, about 50% of children with DS with mental ages under 36 months tend to have communication and language skills that are delayed in comparison to what is expected for their mental ages (Miller, 1999). In contrast, young children with intellectual disabilities for unknown reasons tend to have communication and language commensurate with their mental ages (Miller, 1999). This difference in profiles tends to increase with mental and chronological age (Miller, 1999) and may indicate that children with DS encounter more obstacles in acquiring communication and language than do children with non-DS, intellectual disabilities. Therefore, it is possible that the effects of RPMT will vary by presence or absence of DS. This information could help clinicians individualize treatments by stimulating more fine-grained development of the treatments used to help the child accommodate to behavioral characteristics that are often associated with DS.

In summary, this study examined the efficacy of RPMT on children's (a) communication growth, (b) lexical density growth, and (c) parents' posttreatment measure of responses to their children's communication. We

examined whether pretreatment measures of the amount of children's canonical vocal communication, comments, the ratio of symbols used to understood, and diagnosis (DS vs. other) would predict children's responses to RPMT. Statistically speaking, we tested whether these pretreatment characteristics statistically interacted with experimental group assignment to predict growth of child communication and lexical density and posttreatment parent responsivity.

Methods

Participants

Thirty-nine toddlers with intellectual disabilities and their primary caregiver participated. Both caregivers and children participated in the assessments. Thirty-five (87%) of the primary caregivers were mothers, 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). Additionally, all of the children fit the Tennessee definition for developmental delay (i.e., at least a 40% delay in at least one developmental domain, or at least a 25% delay in at least two developmental domains). Finally, all children's mental development indices (Bayley, 1993) were below 70, thus documenting their cognitive impairments. Children's prelinguistic status was indicated by teacher response to the Communication Development Inventory, Infant scale (CDI-I, Fenson et al., 1991) and by direct observation in three different communication sessions (described below). Our selection criteria for teacher report and direct observation was the child's production of fewer than 10 non-imitative, communicative words or signs. Direct observation and teacher report, instead of parent report, were used to indicate prelinguistic status because our past experience with parents of children with disabilities indicated that some parents tend to overestimate the absolute size of their children's vocabularies. This decision may have resulted in the entry of some children with minimal, infrequently used productive vocabulary into the study. Descriptive data on the children is presented in Table 1. Experimental groups did not differ on any of the variables in Table 1 or on those described below.

The etiology of the children's intellectual disabilities varied. Seventeen (44%) of the children had DS (RPMT = 8, control = 9). Two had William's syndrome; one had mild cerebral palsy due to unknown etiology; and one had encephalitis. After entry into the study, one was diagnosed as having autism. The rest had unknown etiologies.

A certified audiologist screened children for hearing losses using sound field screening at 500, 1000, and

Table 1. Medians and standard deviations for participant description variables.

Variables	RPMT		Control		Total sample	
	Median	SD	Median	SD	Median	SD
Chronological age	21 mos	4	22 mos	5	22 mos	4
Mental age ^a	14 mos	2	14 mos	3	14 mos	3
Bayley MDI ^{a,b}	36.5	15	42	10	41	12
Number of words parent reports child understands ^c	67.5	123	91	113.5	77	116
Number of words parent reports child says ^c	7.5	19	7	19	7	18
Number of signs parent reports child uses ^c	.5	23	1	13	1	18
Number of non-imitative symbols used in CSBS	.5	1	0	3	0	2
Number of non-imitative symbols used in 15-min experimenter-child play session	0	1	0	2	0	1
Number of non-imitative symbols used in 15-min parent-child session	1	2	2	3	2	2

^a Bayley Infants Scales of Development (Bayley, 1993); ^b Using extrapolated norms when needed (Robinson & Mervis, 1996); ^c Communication Development Inventory-Infant scale (Fenson et al., 1991).

2000 Hz. As is often the case in children with intellectual disabilities, 17 (44%) children failed hearing screening at 25 dB. Those failing the screening were approximately equally distributed between groups (RPMT = 39%; control = 48%). The mean threshold for tones was 32 dB HL ($SD = 15$). This level of hearing loss was considered typical of that occurring in children with intellectual disabilities. Excluding those who failed hearing screenings would have reduced the sample size to such a degree that no test of treatment efficacy would be possible. Because we did not have evidence that this degree of hearing loss affected response to treatment, we decided to retain all participants and test whether hearing loss could account for failure to respond to RPMT in a preliminary analysis.

In terms of demographic variables, 22 (56%) children were male. Nineteen (49%) of the children were African American, 19 (48%) were Caucasian, and one 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 ($SD = 23$). This occupational status score was derived from parents’ responses to questions about their occupations by using the International Standard Classification of Occupations (1986) and the method outlined by Stevens and Cho (1986). The occupational status of the U.S. population averaged 34.5 ($SD = 18$; Stevens & Cho, 1986). Therefore, the median for our sample was slightly below the national average.

Design and Procedures

A randomized group experiment was used to test the efficacy of RPMT. Child-parent pairs were randomly assigned to RPMT or the control group by a computer

program. Children’s school records were reviewed to derive diagnostic information. The procedures used were (a) Communication and Symbolic Behavior Scales (CSBS; Wetherby & Prizant, 1993), (b) Experimenter-Child Play Session (ECX; Yoder & Warren, 1998), (c) Communication Development Inventory-Infant scale (Fenson et al., 1991), and (d) a Parent-Child Session (PCX; Yoder & Warren, 1998). The CDI-I was given at entry into the study (Time 1). The PCX was given at Time 1 and at 6 months after entry (i.e., immediately after the RPMT phase ended, Time 2). The CSBS and ECX were given at Time 1, Time 2, and at 9 (Time 3) and 12 (Time 4) months after entry into the study.

Communication and Symbolic Behavior Scales (CSBS)

The Communication Temptations and Book Sharing sections of the CSBS procedure were administered. An experienced examiner, who was not the child’s trainer during intervention, conducted these assessments. The Communication Temptations and Sharing Books are procedures designed to entice a variety of child-initiated communicative acts in different contexts that vary in the degree of structure provided by the examiner. 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., “Do you need help?”). Sharing Books provides a less structured sampling context. This procedure was used to derive growth curves on child communication and lexical density from Times 1–4 and pretreatment measures of child variables.

Experimenter-Child Play Session (ECX)

The ECX was used to derive second estimates of child communication and lexical density. Two estimates

of these variables were used because the CSBS and ECX procedures differ in degree of predictability, prompting, and similarity to naturally occurring interaction. By examining both contexts, we are better informed about the type of change in performance that the children's growth represents. In the ECX, 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. The child engaged in a play session with an experimenter, who was not the child's trainer, using toys that were not used during the training sessions. The ECX sessions lasted 15 minutes. The toys in this session were a baby doll, two baby bottles, a baby spoon, doll hairbrush, rattle, blanket, teapot and two cups and saucers, four colored cylindrical sticks, a large car, and a toy telephone.

Communication Development Inventory–Infant Scale (CDI-I)

The CDI-I was used to derive the pretreatment ratio of symbols produced divided by the number understood at Time 1. The instructions for the expressive score indicated that parents were to report only non-imitative words or signs. The instructions for the comprehension scores indicated that parents were to report words or signs the child seemed to understand without the use of gestures. The variable derived from this procedure was the number of words and signs parents reported the child produced/number or words of signs parents reported the child understood (i.e., understood only + said and understood + signed and understood).

Parent-Child Session (PCX)

The PCX was used to derive estimates of parental responsiveness to children's communication acts at Time 1 and Time 2 and growth curves of the child variables from Time 1 to Time 4. 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 discourage the child from getting up. Because pilot testing indicated that unstructured parent-child interaction sessions resulted in almost no opportunities for parents to respond, the first two 5-minute segments of the PCX session were more structured than the last one. In the first segment, developmentally appropriate toys were placed in clear containers that could not be opened without assistance. This segment was designed to elicit mostly requests. 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 second segment of the procedure was used to elicit child requests and comments. The last segment of the parent-child session was free play. The data from these three segments were summarized across the entire session. This procedure has produced measures of parental responsibility that were associated with later intentional communication and later language in past research on children with intellectual disabilities (Yoder, McCathren, Warren, & Watson, 2001)

Coding and Transcription

The CSBS, ECX, and PCX sessions were coded and transcribed using repeated observations of videotaped sessions with the aid of 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 (SALT; Miller & Chapman, 1993). SALT was used to count the coded behaviors to reduce measurement error due to miscounting. Variables were derived from the SALT. Observers were trained to at least 85% summary-level agreement before coding or transcribing the data to be analyzed. From all three types of sessions, the following variables were derived: (a) frequency of canonical vocal communication at Time 1, and growth curves for (b) frequency of child-initiated comments, (c) frequency of child-initiated requests, and (d) lexical density (i.e., number of different non-imitative words and signs). From the PCX at Time 1 and Time 2, the number and proportion of child communication acts to which the parent responds optimally were coded. Definitions and examples for these categories are given in Table 2.

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 CDI-I (Fenson et al., 1991) 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. An acceptably close word approximation contained at least one accurate phoneme/sound 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

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

Variables	Definitions	Examples
Child's communication	Gesture & vocalization, vocalization & attention to the adult, or symbol with attention to the adult. The list of gestures used is indicated in the CSBS scoring manual.	<ol style="list-style-type: none"> 1. Hand object to adult. 2. Point to object and look at adult. 3. Say "uh-oh" and look at adult.
Child's proto-imperatives	Child-initiated (i.e., unprompted) communication acts for the purposes of requesting an object, action, or event.	<ol style="list-style-type: none"> 1. Reach to object and vocalize 2. When peek-a-boo routine is interrupted, child vocalizes to adult and points to blanket while smiling. 3. Child reaches up to adult to be picked up.
Child proto-declaratives	Child-initiated communication acts that request adult to attend to an object or event or attempt 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 child. Child shows Snoopy dog to adult and vocalizes and smiles.
Child canonical vocal communication	Child communication that contains a consonant and a vowel. Can be, but does not have to be, a word.	<ol style="list-style-type: none"> 1. Child says, "Ba." 2. Child says, "Ball" while holding a ball.
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 linguistic mapping 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>

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 non-imitatively (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 non-imitatively using the SALT program. "Word root" was used to refer to the unbound morpheme of a word. For example, "ball" and "ball/s" were counted as same word root. Diminutives (e.g., kitty) were counted as identical to conventional word roots (e.g., cat).

Control Group

Children in both groups, including the control group, were free to participate in nonproject intervention services. Children and parents in the control group did not receive RPMT. All children, regardless of group assignment, received early intervention services from community providers.

Responsive Education and Prelinguistic Milieu Teaching

Prelinguistic Milieu Teaching

The children's treatment sessions were scheduled three to four times a week for 6 months. A project staff member conducted the intervention sessions in a room in the child's early intervention center. Each session lasted 20 minutes. If a child missed a session, it was not made up. Attendance to sessions was measured to determine whether attendance was related to gains in the RPMT group. Average number of sessions children attended was 71 ($SD = 13$). A primary clinician worked with the child 2 days a week, and a secondary clinician worked with the child 1 day a week. A 1:1 teaching format was used in PMT sessions. During PMT sessions, the clinician first attempted to increase the probability of establishing one or more play routines (i.e., turn-taking sequences around an object or activity). When the child was highly motivated to communicate, the least intrusive, but effective, communication prompts were used to elicit requests for objects or actions. PMT teachers attempted to stimulate comments (i.e., drawing attention

to or sharing positive affect about an object or event) through modeling. More description of PMT can be found in Warren and Yoder (1998) and Yoder and Warren (1998).

Responsive Parent Education

Parents were offered up to 12 education sessions. The core curriculum is laid out by Manolson (1992; i.e., the Hanen Method). The instructional format varied depending on the parents and their needs/preferences. About a quarter of the sessions used a small group format, and the remaining sessions used a 1:1 format. Before implementing the curriculum on optimal responding to children's communication acts, the parent-support person engaged in reflective listening and unconditional positive regard to facilitate rapport building and trust between staff and parent.

Empirical Description of Treatment

For each child, one PMT session during each of the 3rd, 4th, and 5th months of treatment was recorded and coded in detail. After achieving at least 80% agreement on all variables for three consecutive sessions, observers coded the number of adult prompts for communication, adult prompts for imitation of word or sign, adult vocal imitations, as well as the proportion of child communication that was followed by specific acknowledgment, verbal recoding, or compliance to child communication. Definitions for these categories are presented in Table 3. Descriptive information about the use of these behaviors in PMT sessions is presented in Table 4.

A checklist in which the parent support person rated the relative curriculum emphasis for each of the parent sessions was created late in the project. The parent support person rated the proportion of the session (5 = high, 1 = low) spent in any of nine activities for sessions 1–8.

Table 3. Definitions and examples of treatment description variables.

Variables	Definitions	Examples
Adult's prompts for child communication	Verbal, gestural, or nonverbal communication that conveys an expectation that the child communicate or use a particular communicative behavior for a proto-imperative function.	<ol style="list-style-type: none"> 1. "What do you want?" 2. "Look at me." 3. Upturned and extended palm. 4. Withholding a turn in a routine and looking expectantly at the child.
Adult's prompts for imitation	Verbal prompt for child to imitate a sign or word	<ol style="list-style-type: none"> 1. "Say ball." 2. "Do this." Adult models sign for more.
Adult's vocal imitation of child vocalizations	Exact, reduced, or expanded imitation of immediately preceding child's vocalization.	<ol style="list-style-type: none"> 1. C: "Aba." A: "Aba." 2. C: "Aba." A: "Abada."
Adult's compliance with child's imperative acts	Complying with the apparent request conveyed by the preceding child's communication act.	<ol style="list-style-type: none"> 1. C: Reaches for out-of-reach bubbles. A: Gives bubbles to child. 2. C: Points in direction of plane noise. A: Looks at plane and says, "Yeah."
Adult's verbal recoding of the child's communication act	Putting into words a reasonable interpretation of the immediately preceding child communication act. These may take the form of questions or statements	<ol style="list-style-type: none"> 1. C: Reaches for the ball and looks at adult. A: "Ball." 2. C: Reaches for the ball and looks at adult. A: "You want the ball?"
Adult's specific acknowledgment child's act	With a display of positive affect, saying what the of the child did that the trainer was targeting.	<ol style="list-style-type: none"> 1. C: Looks at adult and reaches. A: "You looked at me!"
Adult's talk to the child	Trainer says verbal utterance to the child. These include verbal prompts, verbal responses, and verbal descriptions of child's and adult's activities. (Not mutually exclusive with aforementioned prompts and responses)	<ol style="list-style-type: none"> 1. "You are playing with the doll!" 2. "What do you want?" 3. "You looked at me."

Note. Child communication is defined in Table 2.

Table 4. Means and standard deviations of PMT description variables averaged across the third, fourth, and fifth months of treatment.

Variables	M	SD
Average number of trainer's prompts for child requests	32	8
Average number of trainer's vocal imitations of child's vocalizations	17	13
Average percentage of child acts to which the trainer complies	37	9
Average percentage of child acts trainer linguistically maps	47	15
Average percentage of child acts trainer specifically acknowledges	22	13
Average number of trainer utterances	249	87

The data on 2 participants are available (i.e., 11% of the RPMT group). Table 5 presents the average relative emphasis rating for Sessions 1 and 8 and the average across all eight sessions. The relative emphasis shifted from information exchange about the child and program and active listening in the first session to live coaching and direct teaching on the Hanen curriculum by the eighth session. The emphasis over the entire treatment period was highest for direct teaching on the Hanen curriculum, followed by live coaching and then by trust-building and active listening.

Amount of Nonproject Treatment Participation

A questionnaire was given to both groups of parents at the posttreatment period to determine if children in the control group received systematically different amounts of nonproject services than children in the

RPMT group. Such variables are some of the few that can become systematically different between groups during the period that follows random assignment to treatment groups and the end of the treatment phase. Therefore, this questionnaire constitutes another check on the internal validity of the study. This questionnaire asked the parent to report the number of hours the child actually attended (a) early intervention and (b) speech/language treatment in the previous month.

Reliability

Test-retest reliability was estimated on the CDI-I 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). Summary level reliability was selected to match the level at which the analyses were conducted.

Test-retest reliability for the Time 1 ratio of symbols used/symbols understood from the CDI-I scores was .07. This unacceptably low reliability indicates that the ratio is not stable over time in this sample. Therefore, analyses were not conducted with this ratio. This low reliability occurred because of low variability between participants and 1 participant probably mis-scoring the form on one occasion. She said that no words were "only understood" on the second administration but 19 were "only understood" on the first administration.

The average interobserver reliability for lexical density at Times 1–4 in the ECX, CSBS, and PCX was .94 ($SD = .05$), .84 ($SD = .21$), and .94 ($SD = .05$), respectively. The one reliability estimate for lexical density that was below .70 was that for lexical density in the CSBS at Time 1 (i.e., .53). This low reliability estimate was due to many scores of zero and low variance at Time 1. The

Table 5. Mean emphasis rating for 2 participants in first, last, and average over eight sessions of the Responsivity education component of RPMT.

Activity	Session 1	Session 8	Grand mean over all sessions
Information exchange re child and study	4.5	3	2.2
Active listening not related to responsivity	4	3	1.9
Active listening related to responsivity	3	0	1.9
Showing and commenting on PMT session with parent's child	0	0	.6
Live coaching	0	5	2.9
Problem-solving obstacles to using responsive strategies	2	3	1.3
Brainstorming how to use responsivity in routines	0	3	1.2
Direct teaching on related articles	0	0	.3
Direct teaching on Hanen curriculum	2	5	3.5

consequence of this low reliability is increased error in estimating the true initial status (i.e., intercept) of lexical density in the CSBS. However, because the lexical density scores for the CSBS were reliable at Times 2–4, it is likely that error in the initial status estimate only slightly increased the probability of Type II error for analyses involving lexical density in the CSBS. Most importantly, the one low reliability estimate would not explain significant findings involving growth in lexical density in the CSBS. The average interobserver reliability for the other child communication variables at Times 1–4 was .92 ($SD = .08$). No reliability estimates for communication variables were below .70.

The average interobserver reliability for the parent variables at Time 1 and Time 2 was .60 and .90, respectively. The lower reliability at Time 1 was due to a restricted range of scores and poor agreement between observers that occurred for 1 participant. The consequence of low reliability of the Time 1 parental variable is an increased probability of Type II errors when testing for Time 1 differences between groups. The average interobserver reliability for the variables used to describe PMT (see Table 4) was .87 with a low of .83 and high of .95.

Analysis

To test the effect of RPMT on communication and language variables, we used mixed-level modeling (i.e., Hierarchical Linear Modeling; Raudenbush, Bryk, Cheong, & Congdon, 2001). This application of mixed-level models allows one to model the change of communication or language performance as a function of time for each individual participant (i.e., Level 1 model). We set the initial value for “time” at zero and subsequent values at “time from entry into the study.” This practice allows one to interpret the intercept of the growth curve as the estimated value of the dependent variable at entry into the study (Singer, 1998). It also allows one to test whether experimental group (dummy coded), pretreatment characteristics, and the interaction of the two (i.e., the product term) account for individual differences in intercept (i.e., initial status). We grand-mean-centered the pretreatment variables to reduce the intercorrelation of main effects and product term (Bryk & Raudenbush, 1992). The restricted maximum likelihood estimation method was used to estimate the parameters. The maximum likelihood method uses an iterative process to produce estimates that maximize the probability of finding the observed sample data (Hox, 1995). To help interpret statistical interactions between pretreatment variables and experimental group, we presented the predicted values of the dependent variable for the average growth curve of the communication or language

variable for $\pm 1 SD$ from the mean of the pretreatment variable. The dependent variables were log10 transformed to address frequently occurring violations of the assumption of homoscedasticity (Tabachnick & Fidell, 1989). Only analyses that met the statistical assumptions of mixed-level modeling were reported.

The parent variables were only measured at Times 1 and 2. Therefore, research questions involving parent variables were tested using posttreatment parent variables as dependent variables. For example, independent t tests were used to test main effects of the treatment on parents. This logic assumes that groups were equivalent on the pretreatment measures of parent variables. This assumption was explicitly tested.

Results

Preliminary Analyses

In order to determine if the metric for the communication and language variables should be rate or number, we tested the correlations between the duration of the observation session (e.g., CSBS) and the number of acts produced for all coded communication and language variables. As the duration and number of acts produced for the ECX, CSBS, and PCX were not significantly correlated, we used the number of acts produced when conducting the statistical analysis of the data.

To determine whether the groups were nonsignificantly different before implementation of treatment, we tested between-group differences on 31 pretreatment variables. The groups were statistically different on two pretreatment variables: (a) number of child-initiated comments for the PCX, $t(37) = -2.022$, $p = .050$; M for RPMT group = 12.500; SD for RPMT group = 10.200; M for control group = 7.143; SD for control group = 6.118 and (b) the proportion of child requests to which the parent complied, $t(37) = 2.071$, $p = .045$; M for RPMT group = .243; SD for RPMT group = .186; M for control group = .388; SD for control group = .241. However, only one of these was related to the growth curve of any communication or language variable or to the Time 2 parental responsivity variables. The Time 1 number of child-initiated comments in the PCX was related to growth in frequency of comments in the ECX, $t = 2.69$, $p = .01$. Therefore, this Time 1 variable was statistically controlled for analyses involving growth curves of comments in the ECX. Of particular note, hearing level was not different between groups, $t = -.13$, $p = .90$. Additionally, it did not interact with experimental group to predict any outcome. Finally, number of hours in nonproject early intervention, $t = -1.07$, $p = .29$, and nonproject speech treatment, $t = .30$, $p = .76$, as measured at Time 2 were nonsignificantly different between groups.

Treatment Effects on Parent Variables

Because parent responses were directly manipulated by the treatment and because a no-treatment control group was used, a one-tailed t test was used to test for between-group differences on posttreatment variables. The treatment and control groups were statistically different on both posttreatment variables: the number of child communication acts to which the parent optimally responds, $t(37) = -1.88, p = .03$; M for RPMT group = 25; SD for RPMT group = 16; M for control group = 16; SD for control group = 13; $d = .61$ and the proportion of child communication acts to which the parent optimally responds, $t(28.767) = -1.83, p = .04$; M for RPMT group = .40; SD for RPMT group = .17; M for control group = .32; SD for control group = .11; $d = .61$. Due to significant differences in variances between groups, $F(1, 38) = 5.853, p = .021$, adjusted degrees of freedom were used when testing for the main effects on the latter variable.

Treatment Effects on Child Variables

Level 1 Models

In multilevel modeling applied to growth curve analysis, a Level 1 model is the mathematical model used to model growth within the individual. A simple linear model (i.e., intercept and slope) was most appropriate for all but three outcomes. For lexical density in the CSBS, a quadratic parameter (i.e., quantification of acceleration or deceleration of growth) was not different from zero, $t = -.17$, but did show significant variance among individuals, chi square = 80.1; $p < .001$. Therefore, a quadratic model was used to model lexical density growth in the CSBS. An intercept-only model fit the frequency of requests in the CSBS and ECX better than a simple linear model. Substantively, this means that frequency of requests did not show significant

growth or variance in the CSBS or ECX. Because the research questions required us to test predictors of growth (i.e., slope) in the outcomes, we could not test the research questions regarding effects on growth in requests in the CSBS or ECX procedures.

Effects on Child Communication

There were no main effects of treatment on growth of child-initiated requests or child-initiated comments. However, frequency of child-initiated comments in the ECX at Time 1 predicted children's response to RPMT on growth in the number of child-initiated comments in the PCX, $t(35)$ for product term on slope = $-2.15; p = .04; b = -.001322$. Table 6 presents the uncentered means and standard deviations for the predictors and the predicted outcome values at Times 1 and 4 for low ($-1 SD$ from mean) and high ($+1 SD$ from mean) frequency commenters at Time 1 in RPMT and control groups. When interpreting Table 6, it should be noted that the contrasts that control for maturation and history are between the RPMT and control group within children at the same level on the pretreatment variable. Specifically, those with few child-initiated comments in the ECX showed steeper growth curves if they were in the RPMT than in the control group. In contrast, those with initially many child-initiated comments in the ECX had steeper growth curves if they were in the control group. There were no significant fixed effects of the product term on the intercept of the growth curve (i.e., the subgroups were not significantly different before treatment began).

Additionally, presence or absence of Down syndrome predicted children's response to RPMT on growth in child-initiated requests in the PCX, t for product term on slope = $-2.18; p = .04; b = -.044$. Specifically, those without Down syndrome had steeper growth curves if

Table 6. Predicted values of the outcome at Time 1 and Time 4 for four subgroups defined by level on the pretreatment variable and experimental group assignment.

Outcome	Pre-tx variable Label	Pre-tx variable M^a SD		-1 SD on pre-tx variable or non-DS				+1 SD on pre-tx variable or DS			
				RPMT		control		RPMT		control	
				Predicted outcome @ T1 ^b	Predicted outcome @ T4	Predicted outcome @ T1	Predicted outcome @ T4	Predicted outcome @ T1	Predicted outcome @ T4	Predicted outcome @ T1	Predicted outcome @ T4
Comments in the PCX	Comments in the ECX	14	12	9	18	7	12	23	30	11	30
Requests in the PCX	Presence/absence of Down syndrome			16	21	16	11	10	9	8	13
Symbol use in CSBS	Canonical vocal comm. in CSBS	9	10	2	12	2	9	3	10	3	21

^aUncentered mean to aid interpretation.

^bPredicted DV scores have been back-transformed to aid interpretation.

they were in the RPMT than if they were in the control group. In contrast, those with Down syndrome had steeper growth curves if they were in the control group than if they were in the RPMT group (see Table 6). No other pretreatment variables predicted response to RPMT effects on communication outcomes. There were no significant fixed effects of the product term on the intercept of the growth curve (i.e., the subgroups were not significantly different before treatment began).

Effects on Lexical Density

There were no main effects of treatment on growth of lexical density. However, frequency of canonical vocal communication in the CSBS at Time 1 predicted children's response to RPMT on growth of lexical density in the CSBS, $t(35)$ for product term on slope = -2.42 ; $p = .02$; $b = -.0017$. Specifically, those with initially few canonical vocal communication acts in the CSBS had steeper growth curves if they were in the RPMT than in the control group (see Table 6). In contrast, those with initially many canonical vocal communications in the CSBS had steeper growth curves if they were in the control group than if they were in the RPMT group. There were no significant fixed effects of the product term on the intercept of the growth curve (i.e., the subgroups were not significantly different before treatment began). No other pretreatment variables predicted responses to RPMT effects on lexical density.

Test of Post Hoc Hypotheses

To better understand the results, we also examined the association of the three child outcomes at the later two measurement periods. For example, post hoc interviews with coders suggested that many comments, but not many requests, were conveyed through language at the later measurement periods. There was a strong association between lexical density and child-initiated comments at Time 3 and Time 4 in the PCX, $r = .73$; $p < .001$; $r = .87$; $p < .001$, respectively. In contrast, the association between child-initiated requests and lexical density in PCX at Time 3 and Time 4, $r = .37$, $p = .02$; $r = .20$, $p = .22$, was much lower.

Additionally, we examined the intercorrelation of the pretreatment variables that interacted with experimental group to determine if there was much overlap in the children who benefited from RPMT for the three different child outcomes. Diagnosis was not related to commenting, $r = .07$, or canonical vocal communication, $r = .18$, at Time 1. In contrast, commenting was moderately associated with canonical vocal communication at Time 1, $r = .32$, $p = .05$.

Finally, we examined whether pretreatment comprehension interacted with treatment group to predict

response to RPMT. This was examined because Ronski and Sevcek (1996) found that speech comprehension was related to speed of acquisition of symbolic communication production (albeit in a nonspeech modality) in nonverbal children with severe mental retardation. The number of words and signs on the pretreatment CDI-I did not significantly interact with experimental group assignment to predict any outcome reported in this paper.

Discussion

This study presented the results of a randomized between-group experiment that tested whether RPMT facilitated parental responsivity, child communication, and child lexical density in toddlers with intellectual disabilities. We interpret superior growth in the RPMT group compared to the control group as an indication that RPMT accelerated growth. RPMT facilitated more frequent and proportionally more optimal parental responses to child communication. As to effects on children, there were no main effects for RPMT. However, this treatment did accelerate growth in frequency of child-initiated comments, frequency of child-initiated requests, and lexical density in particular subgroups of children. More on the details of these findings will be discussed later in this section. We interpret superior growth in the control group as indicative that RPMT decelerated growth. Decelerating development was certainly not our intention. However, knowing for whom RPMT is not appropriate or showing that it should be altered is equally important to knowing for whom RPMT is appropriate and that the present form of RPMT accelerated development only in children with particular attributes.

Specifically, RPMT accelerated growth in comments and lexical density if the children began treatment with low frequency comments and canonical vocal communication, respectively. Additionally, RPMT accelerated growth in requests if children did not have Down syndrome. RPMT, as implemented, appeared to decelerate growth in comments and lexical density if children began treatment with relatively frequent comments and canonical vocal communication, respectively. Additionally, RPMT as implemented appeared to decelerate growth in requests in children with Down syndrome.

One weakness of the study was that only 11% of the responsivity education sessions were described. This small subgroup of the RPMT sessions may not represent the entire sample. Additionally, the lack of reliability on this instrument reduces our confidence in the accuracy of the description of the responsivity education sessions. Clearly, future studies need to remediate this weakness.

At a detailed level, many of these findings were unexpected. When unexpected findings occur, it is important to determine whether they could have occurred through some design flaw. The most common alternative explanation to between-group intervention studies is that the experimental groups were different for reasons other than the experience of the treatment. The primary class of explanations for such differences is that the groups may have been different before the treatment phase began. It should be noted that the two experimental groups were equivalent on 29 of the 31 pretreatment variables. This very good pretreatment group equivalence was, in part, due to the random assignment process. The two pretreatment variables on which the groups differed were unrelated to the outcome variables, with one exception: the number of comments in the PCX at Time 1 was related to growth of child-initiated comments in the ECX. Tests of hypotheses involving growth of comments in the ECX statistically controlled for the pretreatment number of comments in the PCX. Additionally, we tested whether groups differed on the amount of nonproject treatment participation during the treatment phase. Group differences on nonproject treatment participation were tested to determine whether the control group compensated for not being in the experimental group by seeking additional treatment. No between-group differences in nonproject treatment participation occurred. Finally, there was no evidence that the four subgroups defined by the pretreatment child variables (i.e., pretreatment comments, canonical vocal communication, and diagnosis) and treatment assignment (i.e., control vs. RPMT) were different on the Time 1 measure of the dependent variables. That is, there were no pretreatment predictor by treatment group interactions on the intercepts of the growth curves. It is always possible that *unmeasured* pretreatment group differences could explain the findings, but this seems unlikely given the large number of nontreatment variables we examined.

Measurement bias is another potential threat to internal validity in treatment studies. Coders and examiners were not blind to treatment assignment. However, the complex and unexpected nature of the findings makes such potential bias an unlikely explanation for the results.

Finally, the results could be sample specific due to multiple statistical tests. The most common protection against this type of error is to divide the alpha level by the number of statistical tests made to test the question (i.e., Bonferroni correction). However, this method assumes that the statistical tests are independent from each other (Blair & Karniski, 1994). The relatively small sample size and intercorrelation of the statistical tests made such a procedure overly conservative (Blair & Karniski, 1994). That is, using the Bonferroni

correction in this study would have increased the probability of a Type II error (i.e., missing an effect that is present in the population) to an unacceptable degree. Ultimately, future studies are needed to determine if the results are sample specific.

Even if the findings are specific to this sample, attempting to understand why they occurred could be helpful in suggesting ways RPMT needs to be altered. There is evidence that canonical vocal communication predicts who will talk a year later in toddlers and preschoolers with disabilities (Yoder et al., 1998). There has also been an observation that canonical vocal communication may indicate which children are already trying to talk (Oller, 1986). However, their immature oral motor skills may prevent their efforts from being intelligible to adults (Yoder et al., 1998). PMT teachers were directed to respond to canonical vocal communication with specific acknowledgment (e.g., "I heard you") or modified contingent imitation (e.g., Child: "ba"; Adult: "bada") until the child reached a certain mastery criterion level on canonical vocal communication (i.e., one per minute). If the child is trying to talk when they are using canonical vocal communication, then specific acknowledging or vocally imitating canonical vocal communication may confuse the child with regard to the meaning of the "words" he is trying to say. In light of this theory, we have decided to change the type of consequence that we give to canonical vocal communication acts. Verbal recoding of canonical vocal communication acts may be more effective in encouraging more canonical vocal communication and more spoken words because they may provide the child with accurate information regarding a word the child is trying to say.

The finding that children with DS did not learn to request more often in PMT was surprising. Other studies have found that children with DS tend to use fewer requests, but the same number of comments, than mental-age-matched, typically developing children (e.g., Mundy et al., 1995). This pattern suggests the possibility that requests are more difficult than comments for children with Down syndrome. We do not know why an extra 21st chromosome may make it more difficult to learn to request. One possibility is that children with DS may find it more difficult to request due to hypotonicity and consequent passivity. Children with DS tend to exhibit more hypotonicity than other children with intellectual disabilities matched for developmental level (Favuto & Cocchi, 1992; Kumin & Bahr, 1999). Additionally, many children with DS exhibit more passivity than other children with intellectual disabilities matched on developmental level (Gunn & Cuskelly, 1991; Linn, Goodman, & Lender, 2000; Ratekin, 1996). However, it should be noted that no study has demonstrated an association between hypotonicity, passivity, and requesting. Future research is needed to investigate this possible association.

During PMT sessions, it is possible that most of the forms children with DS used to comment required simpler motor skills than the forms they used to request. During PMT sessions, we usually prompted gives, reaches, or points. In contrast, comments cannot be directly prompted. Additionally, PMT teachers accepted gaze shifts coordinated with vocalizations as comments. The result could be that children with DS tend to actively resist prompts to request. This hypothesis matches the PMT teachers' informal observations. Such resistance may have decelerated growth in requesting because prompt-resisters did not experience as many successes during PMT sessions. Inasmuch as PMT sessions provide opportunities to try out and perfect new communication behaviors, reduced use of requests during PMT sessions could affect requesting outside of treatment sessions

Regarding the clinical implications of the finding that diagnosis (DS vs. non-DS) predicted children's response to RPMT on requests, we recommend looking at the individual to make treatment decisions, not the diagnosis. It should be noted that not all children with DS exhibit hypotonicity and passivity. Therefore, it is likely that not all children with DS will actively resist prompts to request. Perhaps children with DS can teach us something about teaching requesting for all children who actively resist prompts to request. When children actively resist prompts to request, we recommend that clinicians initially accept a requesting behavior that is relatively easy to execute. For example, instead of requiring giving or reaching, the clinician could set up the environment in such a way that a coordinated gaze shift between object and adult can signal the child's wants. Initially, the clinician could accept this type of request by complying. As the child became more fluent with this early form of requesting, more physically challenging requests could be trained (e.g., reaching, giving).

To our knowledge, this is the first time it has been shown that etiology of intellectual disability explains variance in children's response to educational/behavioral treatment on communication or language outcomes. Future research on how children of varying etiologies respond to RPMT is needed. Diagnosis by treatment interactions can highlight the importance of particular behavioral differences that can guide treatment adaptation and selection.

Some of the present results were expected. The positive effect of RPMT on requests in children with intellectual disability from non-DS etiologies was expected. Past research found that PMT in children of responsive mothers facilitated generalized and maintained requesting in children with intellectual disabilities (Yoder & Warren, 1999b). In the present study, the responsive education component of RPMT was successful in facilitating the

parents' responsivity. By chance, the sample in the Yoder and Warren study (1999b) contained only 3 children with DS out of 58 children. Therefore, we wouldn't expect to see DS suppressing the effect on requests in the Yoder and Warren sample.

The effect on child-initiated comments in children with initially low comments was also expected. Yoder and Warren (1999b) also found PMT facilitated comments in children with responsive parents. It is very encouraging that even children with no or extremely infrequent use of comments before treatment can be helped to use generalized, maintained, and child-initiated comments. This replicated finding is particularly encouraging in light of the need to find treatments to address this ability in children who use comments very infrequently (e.g., children with autism). Future research is needed to determine if RPMT is effective in facilitating comments in young children with autism.

Until future research is conducted to identify which children are best served by linguistic intervention (i.e., those who attempt to elicit productive language) versus prelinguistic intervention (i.e., those who attempt to elicit gestures, gaze, and nonword vocal communication), the current study's results may serve as a guide to make these decisions. That is, the pretreatment variables that statistically interacted with experimental group assignment in this study could guide this important clinical decision.

It may be prudent to consider both pretreatment commenting and canonical vocal communication when deciding which children should receive prelinguistic treatments and goals. This recommendation is based on two findings and their possible implications. There were high associations between child-initiated comments and lexical density at Times 3 and 4. This indicates that frequent commenters had high lexical density. These associations and anecdotal reports from the coders suggest that it is likely that learning to talk enhances the child's ability to comment (at least as judged by discriminating adults who were not the child's trainer). Additionally, commenting may facilitate language development because it tends to elicit adult linguistic mapping of the child's referent (McCathren et al., 1999) and because it reveals the child's interest in sharing the contents of mind (Bloom, 1993; Mundy, 1995). Finally, there was a positive association of the predictors of response to RPMT (i.e., pretreatment commenting and canonical vocal communication) for commenting and lexical density. This indicates that some of the children whose comments benefited from RPMT were also the children whose lexical density benefited from RPMT.

Therefore, if the child uses many comments and canonical vocal communication acts, even if the child is not yet speaking, then a linguistic treatment (e.g., *Milieu Language Teaching*) may be more appropriate than

a prelinguistic communication treatment. If the child uses these behaviors infrequently, then the present findings support the selection of prelinguistic communication goals and the use of RPMT. For children who are between the high and low criteria, it may be wisest to use linguistic mapping in response to canonical vocal communication.

One way to define the criterion values (i.e., definition of “high” and “low”) of the pretreatment variables used for goal selection is to use the value that is $\pm 1 SD$ from the mean in our present sample. At present, the measurement context in which one attempts to observe these characteristics should probably be similar to those used to measure the pretreatment variables that predicted response to RPMT in this study. Using this approach, the criteria levels for “high” and “low” pretreatment comments should be 2 per minute (i.e., 26/15 minutes) and 1 every 7.5 minutes (i.e., 2/15 minutes), respectively. The measurement context for pretreatment comments should be similar to the ECX (i.e., a very responsive interaction session in which prompts to communicate are avoided). The criteria levels for “high” and “low” pretreatment canonical vocal communication should be 19 and 1 canonical vocal communication acts, respectively. The measurement procedure for pretreatment canonical vocal communication should be similar to the Communication Temptations and Book Sharing parts of the CSBS. These guidelines should be modified by future research that directly tests who is most appropriate for prelinguistic versus linguistic interventions.

Summary of Recommendations for Future Research

It is important that future research test our hypothesis that children with low canonical vocal communication before treatment are better served by prelinguistic communication goals, whereas children with high canonical vocal communication before treatment are better served by linguistic communication goals. The hypothesis that hypotonicity, passivity, and requesting are associated both within and across etiological groups needs testing. Finally, it is important to test whether the suggested modification to PMT increases its utility. If so, we will have a better understanding of the function that canonical vocal communication has for children who are not yet speaking.

Conclusions

This article found that certain subgroups of children were affected differently by RPMT. For some, RPMT accelerated growth in communication and early productive language. For others, RPMT appeared to decelerate growth on these variables. In light of these findings,

we recommend consistently consequating canonical vocal communication with linguistic mapping and making requests motorically easier for children who initially resist prompts to request. Until future studies clarify criteria for selecting linguistic over prelinguistic communication treatments and goals, we recommend linguistic goals for children who are using frequent comments and canonical vocal communication acts, even if they are not yet speaking. In contrast, children with few comments and canonical vocal communication may be best served by prelinguistic goals.

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