Early Effects of Responsivity Education/Prelinguistic Milieu Teaching for Children With Developmental Delays and Their Parents

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Purpose: To evaluate the efficacy of a 6-month course of responsivity education/prelinguistic milieu teaching (RE/PMT) for children with developmental delay and RE/PMT's effects on parenting stress in a randomized clinical trial.
Method: Fifty-one children, age 24–33 months, with no more than 10 expressive words or signs, were randomly assigned to treatment/no-treatment groups. Thirteen children in each group had a diagnosis of Down syndrome.
Results: In 1 of 2 multivariate comparisons, the RE/PMT group exhibited superior gains in communication compared with the no-treatment group. The treatment effect for overall use of intentional communication acts in the child–examiner context was significant ($d = .68$, 95% confidence interval = 0.12–1.24). There were no effects on child outcomes due to presence or absence of Down syndrome. RE/PMT led to modest increases in recoding of child acts by parents of children who did not have Down syndrome. There were no effects on parenting stress associated with the intervention or the presence or absence of Down syndrome.
Conclusions: RE/PMT may be applied clinically with the expectation of medium-size effects on the child's rate of intentional communication acts after 6 months of intervention. The approach warrants further investigation with modifications, such as delivery at higher intensity levels.

KEY WORDS: early intervention, language intervention, early communication, milieu teaching, developmental delay

Prelinguistic milieu teaching (PMT) is an intervention for children with language delays who have a very limited or nonexistent lexical inventory and may be having significant difficulties in their production of nonlinguistic communicative acts. Unlike other less direct intervention methods (e.g., the Hanen Early Language Parent Program; Girolametto, 1988; Tannock, Girolametto, & Siegel, 1992), in PMT, steps are taken directly to teach specific gestures, vocalizations, and coordinated eye gaze behavior. PMT procedures are embedded within the ongoing social interactions that take place in the child's natural environment. Yoder and Warren (2002) have combined PMT with parent responsivity education, forming a hybrid approach, which we now refer to as *responsivity education/prelinguistic milieu teaching (RE/PMT)*. The responsivity education component of RE/PMT targets parents' compliance to and recoding of children's verbal and nonverbal acts. The present investigation

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was, in part, a replication of the Yoder and Warren (2002) study in an effort to further evaluate the effects of RE/PMT on the communication development of children with developmental disabilities and to determine its effects on stress in the children's families.

Child Outcomes of PMT

There is a significant literature documenting the effects of the PMT approach on the prelinguistic abilities (Yoder & Warren, 1998, 1999, 2001) and, ultimately, linguistic abilities (Yoder & Warren, 2001, 2002) of young children with developmental disabilities. In Yoder and Warren's (1998) study, children who received individual PMT displayed greater development of intentional communication than did children who received an alternative group intervention. In the alternative treatment, clinicians were highly responsive to child acts but did not provide specific opportunities for children to initiate communication, as is commonly done in PMT and many other approaches. Most important, the observed effect was noted only for children whose mothers responded at high rates to their children's intentional acts. This interaction between PMT and maternal responsivity was confirmed for verbal follow-up variables (Yoder & Warren, 2001). Children who received PMT made greater gains in both lexical diversity and on a standardized language test 12 months after the completion of PMT, compared with children who participated in the alternative treatment. Once again, this effect was only observed for children who had parents who were highly responsive to their communicative bids.

Yoder and Warren (2002) attempted to accommodate this interaction between PMT and maternal responsivity by providing a course of RE to the mothers of all children receiving PMT. The logic of this RE/PMT was to ensure responsivity of all primary caregivers. This should have maximized PMT effects across a sample of parents with diverse levels of educational attainment and child interaction skills and habits.

Again, Yoder and Warren (2002) observed a treatment effect in only a subgroup of the children. Children in the RE/PMT group who began treatment with relatively low rates of comments and canonical vocalizations at the outset of intervention showed faster growth in comments and word diversity than did similar children who did not receive intervention. Furthermore, RE/PMT only positively affected the use of requests among children who did not have Down syndrome (DS). Children with DS actually displayed faster growth in requests if they *had not* received RE/PMT than if they had received it. To explain this finding, Yoder and Warren (2002) noted that children with DS often are reluctant to persist in the completion of a task under circumstances in which they are challenged or not immediately successful (Kasari & Freeman, 2001). Because of this, these children may have shifted their attention from their original objects and events of interest and desire when challenged by adult prompts for a complex requestive act. This may have interrupted teaching episodes and rendered them ineffective. Alternatively, PMT, as implemented in the Yoder and Warren (2002) study, may have prompted request forms that were too complex to facilitate learning in many of the children with DS.

Modifications of PMT

The positive trends and significant treatment effects of PMT and RE/PMT on subgroups of children in previous studies motivated the current evaluation. Three procedural modifications were implemented to help strengthen the effectiveness of RE/PMT and broaden its effects across participants. First, when prompting for requests, interventionists in the Yoder and Warren (2002) study required children to combine gestures or vocalization with gaze shifts between the child's object of attention and the adult. This may have been too difficult for some children who have particular difficulty producing requestive acts. In the present application of the approach, less complex approximations were initially accepted as child requests. For example, for some children, gaze shift alone was initially accepted as an approximation of a request. As children became proficient at producing approximations, response requirements increased until they eventually equaled those used by Yoder and Warren (2002; i.e., gaze shift, plus vocalization or gesture). This more gradual approach may have made the intervention more suitable for children who are disinclined to persist in their efforts to obtain desired objects and services when challenged, as is characteristic of many children with DS (Kasari & Freeman, 2001).

Second, in the Yoder and Warren (2002) implementation of RE/PMT, clinicians typically followed child vocalizations with a vocal imitation. For example, if a child produced "didi" while pointing toward a juice box, the clinician might have responded by imitating the child, saying "didi." In our study, when a child produced a nonverbal vocalization that clearly made reference to a specific object or event, adults responded by complying with the act and/or by mapping it linguistically. In the previous example, the clinician might have responded by saying "juice" rather than "didi." This practice was designed to reduce the likelihood that the child would incorrectly associate a nonverbal model with a meaningful referent within the child's focus of attention.

Third, unlike PMT in the Yoder and Warren (2002) study, speech-language pathologists (SLPs), rather than trained paraprofessionals, implemented PMT in the current study. Delivery of PMT requires a good understanding of the procedures and objectives of the approach as well as the ability to adapt to the differences within and across children. It may be that SLPs differ from non-SLP professionals in their ability to make these subtle adaptations.

Parental Outcomes of RE/PMT

In contrast to what is known about the effects of RE/PMT on child outcomes, relatively less is known about its impact on parent and family variables. The general logic of RE/PMT depends on parent education having some positive effects on parental responsivity to their children. There is evidence indicating that this is possible. For example, the Hanen Program (Manolson, 1992) is a parent-implemented intervention model that is delivered to parents in groups. Girolametto (1988) observed positive effects on parent and child interaction behaviors following a 12-week course of this approach, and Tannock et al. (1992) replicated this finding, but for parents only. Yoder and Warren (2002) presented RE in a series of individual sessions between the parent and clinician. They observed that their version of parent RE led to moderate increases in parents' use of optimal responses following their children's communication acts (d = 0.61). That is, parents who received the parent intervention complied with and linguistically mapped/recasted more of their children's communication acts than did parents of children in the control group.

The effects of these direct efforts to modify child and parent communication behaviors on family variables are not well understood. Early intervention has been found to have positive (Robertson & Ellis Weismer, 1999; Shonkoff, Hauser-Cram, Krauss, & Upshur, 1992; Tannock et al., 1992) and negative (Brinker, Seifer, & Sameroff, 1994) effects on parental stress. Robertson and Ellis Weismer (1999) observed that their 12-week, center-based, clinician-implemented early language intervention program not only led to significant gains on language measures but also facilitated reductions in stress as measured by the Child Domain of the Parenting Stress Index (PSI; Abidin, 1995). The children in this study were classified as late talkers and were functioning cognitively and linguistically at much higher levels than were the participants of the other studies cited here as well as our own. Similarly, based on a study of 190 mothers of children with developmental disabilities, Shonkoff et al. (1992) reported decreases in parenting stress among mothers in families that received more early intervention services. The nonexperimental design of the Shonkoff et al. study, however, precludes any strong conclusions regarding the association of treatment intensity and stress. Tannock et al. also reported a positive effect of the Hanen approach on stress levels of parents of children with general developmental disabilities, but the authors expressed concern that the effect might be spurious because of the large number of statistical tests they completed. Finally, Brinker et al. (1994) observed that more intensive interventions targeting parent–child interactions in families with children with developmental disabilities led to less child improvement and more stress among mothers, at least for those who were initially high in stress. As PMT has developed into a broader RE/PMT approach with a clear parent component, it is essential to determine the positive or negative effects of RE/PMT on stress within the family context.

In this article, we report on the immediate outcomes of 6 months of RE/PMT delivered to children with developmental disabilities. We addressed one primary and two secondary questions.

Primary Question

Does RE/PMT significantly increase children's rates of imperative acts, declarative acts, and/or overall communicative acts compared with use of these same acts by children who do not receive RE/PMT?

We predicted that the rate of use of all these acts would be greater by children receiving RE/PMT than by children who did not receive this service. This prediction was based on two considerations. First, there is a record of success with earlier versions of PMT (Yoder & Warren, 1998, 2001, 2002). Second, we modified Yoder and Warren's (2002) version of RE/PMT in ways that should strengthen its effects and make them more uniform across children. We sought to determine whether the interaction between diagnosis (i.e., with vs. without DS) and treatment group (i.e., RE/PMT vs. no treatment) that Yoder and Warren (2002) reported would be observed with this modified version of RE/PMT.

Secondary Questions

1. Does RE/PMT lead to increases in parental use of contingent, verbal responses that recode the child's intended meanings?

We selected the proportion of child acts that were recoded by the parent as the primary dependent variable because these are highly desirable behaviors that provide the child with important information regardless of the child's level of performance. Based on the findings of Yoder and Warren (2002), we predicted at least moderate effects of RE/PMT on parent's use of recoding.

2. Does RE/PMT reduce or exacerbate pretreatment levels of parental stress, as measured by the PSI (Abidin, 1995)?

Because the extant literature on this point is equivocal, we made no directional predictions.

Method

Participants

Children. Participants were 51 children with developmental disabilities between the ages of 24 and 33 months. All participants had (a) evidence of mild to moderate mental retardation, with Mental Development Indexes (MDIs) below 70 on the Bayley Scales of Infant Development, Mental Scales (BSID; Bayley, 1993); (b) no diagnosis of autism; (c) no more than 10 words or signs at experimental outset, based on maternal report and verified by the child's SLP on the Infant Scale of the MacArthur Communicative Developmental Inventory: Words and Gestures (CDI; Fenson et al., 1993); (d) vision and hearing within normal limits, with or without correction; and (e) upper body motor skills adequate to perform basic gestures such as reaching.

Children first were identified based on referrals from local agencies that were already providing them with speech-language and other services. Throughout the project, all children received some form of community-based intervention. These community-based services were not withheld from any child entering the project, and no child in either group withdrew from their existing community-based programs to participate in the project interventions. In a phone interview with the child's parent, it was confirmed that the child appeared to meet all entry criteria and that the family was willing to participate. The parents and their children then came to the University of Kansas Medical Center for further information about the project, for signing of the informed-consent form, and for an assessment of their child's cognitive abilities. Eighty-seven children passed the telephone screening and were examined in this manner. A staff psychologist (not affiliated with the research team) administered the BSID on this visit.

The same psychologist provided an assessment of the child's use of autistic-like behaviors. If she observed numerous examples of behaviors associated with autism spectrum disorder, she administered the Childhood Autism Rating Scale (CARS; Schopler, Reichler, & Renner, 1988). One child who scored in the clearly autistic range (above 36) on the CARS (Schopler et al., 1988) was excluded from the study. Participating children passed a hearing screening in both ears at 25 dB at 500, 1000, and 2000 Hz. One child wore bilateral hearing aids, which enabled her to pass the screening passed by all other children.

Qualifying children participated on another day in two communication sampling contexts. These contexts were designed to provide numerous opportunities for children's use of requestive acts and comments on objects and events. The first of these samples included the Communication Temptations and Book Sharing components of the Communication and Symbolic Behaviors Scales (CSBS, Wetherby & Prizant, 1993). The second sample was a 15-min interaction between parent and child. We video- and audiotaped the interactions through a one-way mirror, using an analog VHS camera and a high-fidelity VCR with two-channel audio capabilities. The high-quality videotape signals were digitized and then coded using the Noldus Observer (Version 4.1; Noldus Information Technology, 2002). The Observer is a computer-based system for time locking user-customized codes to specific points on a video file and for counting these behaviors and performing reliability and elementary statistical analyses on the data.

The imperatives, declaratives, and other communicative acts produced by the child during the CSBS were coded to ensure that the child's rate of these acts and their production of canonical vocalizations did not exceed criteria used in our past work (Yoder & Warren, 2002). The upper limits for rates of each class of behaviors per minute were as follows: 1.16 for imperatives, 1.17 for declaratives, 1.28 for canonical vocalizations, and 2.12 for overall rate of communication acts. Children producing rates in excess of these limits typically proceed to linguistic communication within a short period of time and hence would not be considered appropriate candidates for RE/PMT.

Fifty-one of the 87 children tested qualified for the study. Of the children who qualified, the average age at start was approximately 26 months. Twenty-six children had developmental delays associated with DS, 1 had Trisomy 8, 1 had a mitochondrial disorder, 1 had microcephaly, 1 experienced a right cerebrovascular accident at birth. One participant with developmental delay of unknown origin had renal disease as a complicating factor, and another had a repaired cleft palate. Two participants originally described as having delays of unknown etiology later received diagnoses of Angelman's syndrome and Fragile X syndrome, respectively. The remaining 17 children had developmental delays of unknown etiology. Only 4 children had measurable MDIs between 58 and 68. All others had scores that placed them below MDIs of 50. Five, or roughly 10% of the children, were African American, 4 children had a Hispanic background, and the remaining 42 children were White and non-Hispanic. On average, each child had approximately 1.5 siblings (SD = 1.25).

The children averaged approximately 100 words understood (SD = 82.47), as measured by the Infant Scale of the CDI. The children averaged less than 5 productive conventional words and signs (SD = 2.76), as reported by parents and confirmed by the child's SLPs. To determine children's phonetic inventories, we used a criterion of two or more observations across all sampling contexts (approximately 1 hr of combined parent and examiner interaction). On average, the children produced only 5.6 different consonants in initial position (SD = 2.52) and less than 1 consonant in final position (SD = 0.88).

Parents. Fifty mothers and 1 father participated in the RE component of RE/PMT and the assessments of parent–child interaction that took place at the beginning and end of the 6-month period. Despite considerable variability, parents of the children were generally well educated, averaging 2 years of postsecondary education. Total scores from the PSI (Abidin, 1995) averaged approximately 215 (SD = 40.92) at the first assessment, which fell approximately at the median for parents of children with developmental delays in this same general age range. Parenting stress levels were lower than those for parents of typical 2-year-olds, with average scores falling slightly below the median for this typical group.

Group assignment. As participants qualified, they were assigned at random to a group that received 6 months of RE/PMT (n = 25) or to a no-treatment (no-Tx) group (n = 26). Children assigned to the no-Tx group were slated to receive a project-based milieu language intervention after a 12-month wait. Thus, they received no project-based intervention over the period described in this report. Random group assignments were made after the initial assessment was completed, using a computerized system developed at Vanderbilt University. The randomization process was carried out, and the results recorded by one investigator in the presence of an observer. Among children assigned in this manner, there were no dropouts over the 6-month treatment period, and all children followed the protocol for the group to which they originally were assigned.

Preexperimental Variables

The extent to which the participant randomization yielded equivalent groups was evaluated by comparing the RE/PMT and the no-Tx groups on 24 preexperimental variables, including the children's Time 1 performance on each of the 6 dependent variables (described below). Means and standard deviations for each group on each variable are provided in Table 1. Independent samples t tests yielded no significant differences on any of the measures (all ts < 1.70, ps > .09). There was a trend for children in the no-Tx group (M = 6.27 hr/month, SD = 7.28) to be receiving more community-based intervention than those in the RE/PMT group (M = 3.94 hr/month, SD = 1.77) before the study began, but this difference was not statistically reliable (p = .13). On one measure that covaried with the outcome of the Yoder and Warren (2002) study, presence of DS, the subgroups were identical, with 13 children with DS in the RE/PMT group and 13 children with DS in the no-Tx group. In general, the randomization process effectively divided the children into equally sized groups that were very similar in all respects measured.

Because one of the planned analyses dealt with the effects of treatment on children with and without DS, we were also concerned with the effects of randomization on the group assignments of children within the subgroup of participants with DS and within the group of children with other etiologies. Tables 2 and 3 contain a reduced set of variables that illustrate the general equivalence of the treatment groups for each participant subset based on etiology. Only one of the set of 24 variables reliably distinguished the subgroup of children with DS who received RE/PMT from the subgroup that served in the no-Tx group. This variable was the Total Stress score from the PSI (Abidin, 1995). Within the DS group, before any project intervention, the parents of children who received RE/PMT had lower overall stress levels than did the parents of children within the no-Tx group. This measure was not correlated with any of the outcome variables, however (all rs < .14, all ps > .31). Within the other-etiology group, the RE/PMT and no-Tx subgroups could not be distinguished on any of the preexperimental measures (all ts < 1.97, ps > .06). In sum, randomization had the desired effect of parsing the DS and other-etiology subgroups into treatment and control groups that, with only one exception, did not differ reliably on any measure tested preexperimentally.

The RE/PMT Procedures

RE. Over the 6-month treatment period, parents of children in the early intervention group were scheduled to receive eight, 1-hr individual sessions of RE as an adjunct to PMT (M = 7.72 sessions, SD = 0.89). Although our individual approach differs in some important ways from the group-oriented method described in It Takes Two to Talk—The Hanen Program for Parents (The Hanen Centre), it was modeled after the Hanen method, and all parent education was completed by an SLP who was Hanen certified. It is crucial to note that parents were not taught explicitly to implement PMT. Rather, they were taught to recognize real or possible communicative attempts as they increased in frequency in parent–child interactions and to respond to them meaningfully. Thus, the major goals of RE were (a) to heighten parents' awareness of their children's developing nonintentional and intentional communication behaviors, (b) to encourage parents to wait for their children to produce interpretable behaviors, (c) to encourage parents to attend to their children's focus of attention by following the child's lead, and (d) to provide appropriate verbal and nonverbal consequences to their children's acts. Responsive parent acts, such as recasting of the child's verbal and linguistic mapping of nonverbal communication acts, were expected to increase directly as a result of the intervention, at least for parents who used low rates of these responsive behaviors at the outset of the study.

Table 1. Preexperimental (i.e., Time 1) characteristics of the RE/PMT (n = 25) and no-Tx (n = 26) groups, collapsed across diagnostic group, and probability of observed t value.

Preexperimental variable	Group	*M*	*SD*	*p*
No. children w/ DS	RE/PMT	13		
	No-Tx	13		
Chronological age	RE/PMT	26.20	2.81	.41
	No-Tx	25.58	2.50	
Maternal education (in years)	RE/PMT	14.56	1.96	.43
	No-Tx	15.12	2.92	
No. siblings	RE/PMT	1.72	1.43	.24
	No-Tx	1.31	1.05	
Bayley raw score	RE/PMT	98.64	9.86	.96
	No-Tx	98.50	7.94	
Male–female ratio	RE/PMT	1.77/1		.21
	No-Tx	0.86/1		
Proportion African American or Asian	RE/PMT	.16		.48
	No-Tx	.07		
CDI words understood (maternal report)	RE/PMT	97.92	69.35	.73
	No-Tx	105.88	93.34	
CDI words produced (SLP report)	RE/PMT	4.36	2.58	.94
	No-Tx	4.42	2.92	
Monthly speech service hours	RE/PMT	3.94	1.77	.13
	No-Tx	6.27	7.28	
Monthly total service hours	RE/PMT	13.50	5.55	.33
	No-Tx	17.15	17.56	
PSI: Child Domain	RE/PMT	99.36	22.63	.10
	No-Tx	110.59	22.61	
PSI: Parent Domain	RE/PMT	111.48	26.76	.73
	No-Tx	113.77	16.34	
PSI: Total score	RE/PMT	210.84	47.02	.27
	No-Tx	224.36	34.04	
Initial consonants in inventory	RE/PMT	5.76	2.83	.60
	No-Tx	5.38	2.19	
Final consonants in inventory	RE/PMT	.60	.76	.50
	No-Tx	.77	.99	
CSBS–PI: Time 1	RE/PMT	0.69	0.31	.18
	No-Tx	0.85	0.52	
CSBS–PD: Time 1	RE/PMT	0.66	0.56	.49
	No-Tx	0.80	0.55	

(table continues)

Table 1 *(continued).*

Preexperimental variable	Group	*M*	*SD*	*p*
CSBS–IA: Time 1	RE/PMT	1.62	0.73	.22
	No-Tx	1.88	0.80	
CSBS–CV: Time 1	RE/PMT	0.25	0.29	.64
	No-Tx	0.29	0.29	
PCX–PI: Time 1	RE/PMT	0.67	0.51	.75
	No-Tx	0.72	0.45	
PCX–PD: Time 1	RE/PMT	0.68	0.72	.61
	No-Tx	0.78	0.71	
PCX–IA: Time 1	RE/PMT	1.59	1.15	.65
	No-Tx	1.72	0.93	
PCX–CV: Time 1	RE/PMT	0.29	0.47	.94
	No-Tx	0.30	0.35	

Note. RE/PMT = responsivity education/prelinguistic milieu teaching; no-TX = no treatment; DS = Down syndrome; CDI = MacArthur Communicative Developmental Inventory; PSI = Parenting Stress Index; CSBS = Communication and Symbolic Behaviors Scales; PI = Proto-imperatives; PD = Proto-declaratives; IA = Intentional Acts; CV = Canonical Vocalizations; PCX = parent–child interaction.

Table 2. Representative preexperimental data for children with Down syndrome assigned to either the RE/PMT (n = 13) or the no-Tx (n = 13) group.

Preexperimental variable	Group	*M*	*SD*	*p*
Chronological age	RE/PMT	25.31	1.89	.62
	No-Tx	24.92	2.02	
CDI words produced (SLP report)	RE/PMT	5.77	2.01	.61
	No-Tx	5.33	2.23	
CDI words understood (maternal report)	RE/PMT	90.31	53.53	.69
	No-Tx	81.77	53.45	
Bayley raw score	RE/PMT	96.23	5.28	.74
	No-Tx	97.00	6.38	
Maternal education (in years)	RE/PMT	14.23	1.92	.23
	No-Tx	15.38	2.79	
Initial consonants in inventory	RE/PMT	7.38	1.71	.60
	No-Tx	6.15	2.19	
Final consonants in inventory	RE/PMT	0.62	0.87	.50
	No-Tx	1.00	1.08	
Monthly nonproject speech service (hours)	RE/PMT	3.77	1.30	.68
	No-Tx	4.08	2.29	
Parental Stress Index: Total Stress score	RE/PMT	184.62	38.49	.04
	No-Tx	214.09	26.26	

Table 3. Representative preexperimental data for children with other etiologies assigned to either the RE/PMT (n = 12) or the no-Tx (n = 13) group.

Preexperimental variable	Group	*M*	*SD*	*p*
Chronological age (in months)	RE/PMT	27.17	3.38	.46
	No-Tx	26.23	2.83	
CDI words produced (SLP report)	RE/PMT	2.83	2.29	.57
	No-Tx	3.50	3.32	
CDI words understood (maternal report)	RE/PMT	106.17	85.01	.57
	No-Tx	130.00	118.48	
Bayley raw score	RE/PMT	101.25	12.94	.78
	No-Tx	100.00	9.26	
Maternal education (in years)	RE/PMT	14.92	2.02	.95
	No-Tx	14.85	3.13	
Initial consonants in inventory	RE/PMT	4.00	2.80	.53
	No-Tx	4.62	1.98	
Final consonants in inventory	RE/PMT	0.58	0.67	.89
	No-Tx	0.54	0.88	
Monthly nonproject speech service (hours)	RE/PMT	4.13	2.22	.15
	No-Tx	8.46	9.73	
Parental Stress Index: Total Stress score	RE/PMT	239.25	38.93	.78
	No-Tx	234.64	38.89	

The SLP used role-play to teach goals of waiting and following the child's lead. When necessary, the SLP showed video clips of the child's PMT sessions that clearly demonstrated the clinician using these and the remaining major RE targets. At least once during the eight sessions, parents were videotaped interacting with their child while engaged in an activity of the parent's choosing for a period of 5 to 6 min. During this same session, the SLP and parent watched the tape together, first in its entirety without comment. Then, as they viewed the tape again, parents were encouraged to pause the tape whenever they identified an opportunity to respond in a positive manner. The SLP did not point out negative behaviors but rather encouraged parents to critique their own performance, primarily by identifying positive parent responses to child acts.

These techniques were supplemented by having parents read the book, *You Make the Difference in Helping Your Child Learn* (Manolson, Ward, & Dodington, 1995). In most cases, one or more chapters were assigned for each visit. The SLP also assigned tasks for the parents to do with their child. The parents' success or failure with these tasks was then discussed at the next visit. Examples of assignments and targeted behaviors are presented in Table 4.

PMT. PMT sessions were scheduled to take place in the children's homes and/or in their day care facilities 4 days per week in 20-min sessions, and children averaged 3.32 weekly sessions (SD = 0.29). Typically, 3 of the weekly sessions were carried out by a primary clinician, and 1 session was staffed by a secondary clinician. All clinicians had master's degrees in speech-language pathology and held the Certificate of Clinical Competence in Speech-Language Pathology from the American Speech-Language-Hearing Association.

The basic procedures for PMT have been described in detail by Warren et al. (2006), so only a limited description is provided here. PMT is based on principles of milieu teaching (MT; Warren & Bambara, 1989). MT is an approach to teaching words and early grammatical constructions that borrows methods from highly intrusive behavioral programs and uses them under much more naturalistic conditions with naturally occurring reinforcers that are selected by the child. Considerable evidence has been amassed to support MT use (Kaiser, Yoder, & Keetz, 1992), especially for lexical and early grammatical intervention targets.

Table 4. Examples of assignments and goals for responsivity education.

Assignment	Goal
• Identify five different ways your child communicated with you during the last week	• Heighten awareness of child's nonintentional and intentional communication behaviors
• Count to 10 before making an additional request or comment	• Wait for child to produce an interpretable behavior
• Play for 5 min with your child, doing what they do, without making any decisions (example: playing a board game without enforcing the rules)	• Attend to child's focus of attention by following child's lead
• Complete the language wheel from the *You Make the Difference in Helping Your Child Learn* (Manolson, Ward, & Dodington, 1995) for a chosen activity	• Provide appropriate verbal (e.g., recoding) and nonverbal consequences to child's acts
• Identify a familiar routine and choose target words to use consistently during that routine	• Provide appropriate verbal (e.g., recoding) and nonverbal consequences to child's acts

PMT is most distinctly different from MT in that it targets nonverbal communicative acts rather than verbal ones. Thus, for PMT, targets include nonverbal communication attempts that use combinations of (a) gestures, (b) vocalizations, and (c) eye gazing that shifts from referents of interest to a communication partner. Clinicians responded to these targets in ways consistent with the perceived intent of the child. For example, after a child request, the clinician produced the desired objects and actions. In PMT, although words are valued mechanisms for communication (and many of our participants used a few words or signs at the outset), the clinician never requires the child to use words. Consequently, the clinicians waited for, prompted, and responded to the child's nonverbal communicative efforts in a manner designed to be consistent with the child's communicative intent.

The basic and intermediate intervention goals and procedures for PMT are outlined in Table 5. The procedures were carefully embedded into ongoing interactions and used as the communication situation required. The clinician created opportunities for communication by arranging the environment. For example, toys might have been available but out of reach or nonfunctional without assistance, a favorite toy not expected in a routine might have suddenly appeared, or the adult might have failed either to take her turn or to offer the child his or her own turn in a desirable routine. The clinician then followed the child's lead by observing the child's attempts to obtain and manipulate the toys, waiting for the child to respond, and responding verbally and nonverbally to the child's communication and noncommunication acts. Some techniques were appropriate at all stages of intervention (e.g., waiting for the child to produce a more elaborate communicative act or using words to linguistically map the child's nonverbal efforts); others were useful only at specific stages of acquisition of the target behaviors (e.g., prompting a child to look at her or his partner by calling the child's name).

Setting up social routines to serve as the context for teaching episodes is a consistent aspect of PMT. Routines were as basic as requesting the opening of a toy box or as elaborate as acting out a story line from a book. Clinicians then embedded PMT teaching procedures into these routines. For all other intermediate goals in Table 5, the procedures were applied in a hierarchical fashion. Those techniques presented first require the most sophisticated child responses. If a child failed to respond to a higher order procedure, the clinician dropped to a lower level technique, providing a more explicit prompt to elicit a response from the child, whenever it was still meaningful and appropriate to doso. The clinician constantly adjusted the level of the procedure used to ensure that the child was being appropriately challenged while maintaining high attentional engagement.

PMT is designed for children who are making little or no use of conventional words and signs. It may be inappropriate to use PMT procedures for children who have passed this early stage of communicative development (Yoder & Warren, 2002). Therefore, after children exceeded the criteria used to qualify participants for the study (1.16 for imperatives, 1.17 for declaratives, 1.28 for canonical vocalizations, and 2.12 for overall rate of communication acts), clinicians began using a word-oriented MT program. In fact, 9 of 25 children in our RE/PMT group (36%), including 3 with DS (12%), met these criteria and graduated from RE/PMT to RE/MT during the 6-month period of intervention. Overall, children in the RE/PMT group averaged a total of 80 PMT sessions over the 6-month treatment period. The 9 children who graduated to MT during the treatment period were assigned to MT after they had received from 17 to 74 sessions of PMT (M = 46). Thus, on average, approximately half of the sessions provided to

Table 5. PMT goals and procedures.

Intermediate goal	Specific techniques
1. Establish routines to serve as the context for communicative acts.	A. Imitate the child's motor acts. B. Imitate the child's vocal acts C. Interrupt the child's established pattern of actions with an adult turn and then wait for the child to take a turn. D. Perform an action the child finds funny or interesting; pause, then repeat to get more laughter. E. When the child produces one part of the routine, oblige by performing the act needed to complete it.
2. Increase the frequency of nonverbal vocalizations.	If the child's incomplete communicative act is focused on a clear referent, A. Recast the child's nonverbal vocalization with a word. If the child's incomplete communicative act is not focused on a clear referent, A. Model vocalizations with sounds and word shapes known to be outside the child's repertoire. B. Model a sound within the child's sound and word shape repertoire. C. Imitate the child's spontaneous vocalizations with sounds and syllable shapes known to be within the child's repertoire. D. Imitate the child's spontaneous vocalizations as precisely as possible.
3. Increase the frequency and spontaneity of coordinated eye gaze.	Create a need for communication within a routine in which the child looks at the object, then A. Provide the child with the desired object or action contingent on looking. B. Verbally prompt for eye gaze. C. Move the desired object to the adult's face to encourage a more explicit look. D. Intersect the child's gaze by moving the adult's face into the child's line of regard. E. Once the child complies, explicitly acknowledge the child's look with fun and well-pleased affect.
4. Increase the frequency, spontaneity, and range of conventional and nonconventional gestures.	Create a need for communication within a routine (e.g., by placing a desired object out of reach), then A. Provide the child with the desired object or action contingent on the use of a gesture. B. Pretend not to understand by looking and gesturing quizzically and saying ''What?'' or ''What do you want?'' C. Ask or tell the child to be more specific (e.g., ''Show me which one!'' ''Which one do you want?''). D. Tell the child, explicitly, to produce a particular gesture (e.g., ''Show me!'' ''Give it to me!''). E. Model an appropriate gesture. F. Once the child complies, verbally acknowledge child's gesture.

(table continues)

Table 5 *(continued).*

Intermediate goal	Specific techniques
5. Combine components of intentional communication acts. The three components of intentional communication acts are eye contact with partner, vocalization and gesture.	A. If the child produces one or two components of a communication act, wait expectantly (i.e., use time delay) to prompt the second (or third) component. B. If the child produces one or two components of a communication act and does not add another component after the time delay, 1. Ask, ''What do you want?'' or another general prompt and wait again. 2. Intersect the child's gaze or use the child's name to prompt eye gaze. 3. Model or help the child to produce a gesture. 4. If the child has produced a communicative act that is focused clearly on an object, attribute, or event, the clinician should recast the act by producing a word. 5. If the child produces components yielding a communicative act, the clinician should not produce a nonverbal model. 6. Immediately after the child produces the targeted component, provide the appropriate consequence and verbal feedback, as described under Intermediate Goals 1–4 above. 7. If, after using the methods above, the child fails to produce the targeted act, provide the child with the desired object or action.

Note. From ''Responsivity Education/Prelinguistic Milieu Teaching,'' by S. F. Warren, S. L. Bredin-Oja, M. Fairchild, L. H. Finestack, M. E. Fey, and N. C. Brady in *Treatment of Language Disorders in Children* (pp. 60–61) by R. J. McCauley & M. E. Fey (Eds.), 2006, Baltimore: Brookes. Copyright 2006 by Paul H. Brookes Publishing Company. Adapted with permission.

these children focused on teaching words with MT methods instead of teaching nonverbal communication with PMT.

Fidelity of Treatment

Our concerns over treatment fidelity were managed using four separate procedures. First, all investigators met on a weekly basis to discuss the clinicians' selection of goals and use of RE/PMT procedures and to assist the clinicians in addressing problems specific to each child. Second, to facilitate this process, each child receiving RE/PMT was videotaped approximately once per month during a PMT or MT session in the child's home or day care center. Parts of these sessions were observed and discussed during the weekly group meeting. Third, after a collection of videotaped PMT and MT sessions had been accumulated, they were copied to CDs with at least one example of each type of intervention on each CD. Three graduate assistants who were uninformed about the specific details of the study or the goals for each child reviewed these CDs (a total of 107). Each assistant used a worksheet containing the possible goals for PMT or MT and the procedures appropriate for each goal (adapted from Table 5). The assistants indicated use of a particular procedure for a particular goal by making tally marks on the worksheet. After observing for 10 min, the assistants were asked to judge (a) whether the clinician was using PMT or MT and (b) which of five intermediate objectives for PMT or three objectives for MT were being primarily addressed (e.g., increasing vocalizations, increasing coordinated eye gaze, increasing the number of single-word or multiword utterances). The assistants correctly distinguished PMT from MT sessions in 93% of all cases and selected the intermediate objective designated by the clinician as the first or second priority goal in 90% of all cases. Thus, observers who were unaware of the type of intervention the clinician was attempting to provide reliably distinguished PMT from MT and successfully identified the clinician's intended goals for the PMT and MT sessions.

Finally, because PMT procedures are individualized, the approach differs discernibly from child to child. Nevertheless, we wished to provide some information on how the clinicians generally applied the procedures. Our scheduled videotaping of treatment sessions every

4 to 6 weeks yielded a corpus of 82 PMT samples (plus a corpus of MT samples for children who graduated to MT). Twenty-one PMT samples (26%) were selected at random, with the provision that no more than 2 sessions would be selected for a single child. Two coders independently identified the number of successful teaching episodes in each session. To consider the teaching episode to be successful, the coder had to determine that (a) the clinician had used a PMT procedure, (b) the child had responded with a target behavior, and (c) the clinician had provided a prescribed consequence. Only those episodes identified by both of the coders were counted. When these criteria were applied, successful teaching episodes were observed at an average rate of 1.37 per minute (*SD* = 0.76, range = 0.19–2.67).

Communication Sample Contexts

Communication samples were collected preexperimentally (Time 1) and 6 months after the initiation of treatment (Time 2) in two contexts: the CSBS (Wetherby & Prizant, 1993) and a parent–child interaction (PCX). These two samples were selected for analysis for three main reasons. First, we wanted to measure communication in two contexts with two different adults differing greatly in familiarity. One context (the CSBS) is an interaction with an adult examiner who did not serve as the child's primary intervention clinician and was unfamiliar with the child. The other context (the PCX) involved the child's parent or other caregiver, who was highly familiar with the child. Second, the caregivers of the children in the RE/PMT group had observed many PMT sessions and also had participated in RE. Thus, variables measured from these samples might have been influenced by the parents' use of RE techniques during the session, giving these children an advantage over those whose parents had not participated in RE. Third, the CSBS and PCX were the two contexts in which Yoder and Warren (2002) observed their significant outcomes involving interactions between pretreatment variables and the treatment variable.

The CSBS sample included the Communication Temptations and Book Sharing subtests of the CSBS. The examiners in these interactions were three certified SLPs who also had been trained to implement treatment procedures. Examiners were always unaware of the child's group assignment during Time 1 samples, but because of resource limitations and our need to include each assistant in several aspects of the project, it was not always possible to keep testers unaware of the child's group assignment at Time 2. No Time 2 tester served as the child's primary clinician. In one case, however, it was necessary to use a child's secondary clinician as the same child's Time 2 tester.

At Time 1 and at Time 2, CSBS samples averaged 22.5 (*SD* = 4.16) and 22.01 (*SD* = 4.35) min long, respectively. Activities in the CSBS provided numerous structured opportunities for children to initiate requests and comments and to repair communication breakdowns.

The PCX involved the same parent in the Time 1 and Time 2 interactions for all but 1 child. In one case, the mother who participated at Time 1 was unable to participate at Time 2. The child's grandmother, who coserved as the child's primary caregiver, substituted for the child's mother in this case. Because different care providers participated at Time 1 and 2, this dyad's data were eliminated from analyses of effects on parents.

The PCX sample comprised three 5-min segments. In all segments, the same toys and communication temptation devices were used for all evaluations. In Segment 1, the examiner presented three toys in bags that were difficult to open. Parents were instructed to select one toy and play with it until their children appeared interested and then put the toy back in a bag. They were told to open the bag and allow their children to play freely only after their children indicated a need for help. Some children played with the same toy for the entire segment, and some required their parents to select a new toy. The same procedure ensued with each new toy.

In Segment 2 of the PCX, examiners placed a snack of juice and Cheerios on the table but out of the children's reach. The examiner instructed the parents to give the children a Cheerio or a sip of juice when they communicated a desire to eat or drink. During this 5-min segment, a slinky bounced from the ceiling, and sounds played from a tape recorder. The parents were instructed not to react to these events until their children directed their attention to them.

In Segment 3 of the PCX, the examiner provided three toys and instructed the parents to play with one by themselves until the children indicated that they wanted a turn. The parents then played with the children as was typical for them at home. Some parents switched toys during the segment when their children seemed disinterested. Also, during this 5-min segment, sounds played from a tape recorder, and bubbles were blown into the room. The examiner instructed the parents not to react to these events until the children commented about them. During each of these three segments, the examiner left the room after providing instructions to the parents.

Dependent Variables

Child variables. Three distinct dependent variables were selected for analysis of child communication behavior: the child's rate of imperative (i.e., requestive) acts, the rate of declarative acts (i.e., comments), and the total rate of intentional acts. Intentionality was generally based on the child's combination of either a vocalization or a gesture (or both) with gaze alternation between the object/event and the adult's face. Some acts did not require a look toward an adult, however. These acts included words; conventional gestures, such as waving, pointing, and head nodding; and some non-conventional gestures. Nonconventional gestures that presuppose coordinated attention to the object and adult, such as giving and showing, did not require the child to look at the adult. Acts were judged as imperative if the child displayed neutral or positive affect while communicating the desire for the adult to perform some act or service (excluding rejections and protests), whether self-initiated or responsive to an adult act. Acts were judged as declarative if they were nonimitated, self-initiated, or responsive intentional acts that aimed to focus adult attention and/or share positive or neutral affect about objects or events. Unlike imperatives, declaratives neither asked nor required the adult to do anything other than to attend to the referent and, possibly, to acknowledge the child's communication. Total intentional acts included all nonimitative communication judged to be intentional, such as all imperatives and declaratives, as well as all other responses, including social responses (e.g., greetings such as "hi" or social games such as "high five"); requests or responses that were produced with negative affect (e.g., protests); and acts that could not unambiguously be judged to be imperatives or declaratives.

Parent variables. To evaluate the effects of intervention on parental behavior, we used the percentage of child acts during the PCX that were linguistically mapped or recasted by the parent. This parent recoding of child acts was selected as the only parent variable for three reasons. First, as a result of the same RE protocol followed in our study, Yoder and Warren (2002) observed increases in parental optimal responding, which included recoding as a key component. Second, increasing parents' use of recoding was a key part of RE for each parent, regardless of their child's communication status. Third, we believed that of all parent measures coded, recoding would be least sensitive to problems associated with the particular tasks parents were instructed to carry out during the PCX. For example, if our instructions somehow misled a parent to conclude that she should wait until the child initiated a complex form of a request before complying, this would negatively affect a measure of parental compliance to the child's acts. These problems seemed less likely with recoding, because it is possible to map an immature child request linguistically to indicate understanding without complying with the request.

To count as an instance of recoding, the adult response had to make explicit reference to the child's intended referent and communicative function. Many contingent utterances that were appropriately related to the child's topic were not counted as recoding, because they failed to meet one of these two criteria.

Coding Reliability

Coding child behaviors. Intentional communicative acts occurring in the CSBS and PCX samples were identified and coded by graduate students in speech-language pathology. All coding was completed using behavior-time stamping software (Noldus Observer; Version 4.1; Noldus Information Technology, 2002). Based on our early concerns with reliability of child coding, we adopted a consensus scoring procedure involving a primary and a secondary judge. Primary judges were always unaware of the children's group assignments. Ideally, secondary judges also would have been masked with respect to group assignments. Because of our need to include these judges in other aspects of the project, however, masking of secondary judges could only be assured at Time 1.

The first step in the coding process was for the primary judge to code the sample for the presence of intentional communication acts. Starting from this judge's transcript, the secondary judge then verified intentional acts and added or removed acts to her own version of the transcript, as she deemed appropriate. This new transcript was then compared with the transcript coded by the primary judge on a point-by-point basis. Across all samples, agreement between original and verified transcripts was 89.6% (SD = 9.09) for the CSBS and 83.9% for the PCX (SD = 14.49). Each disagreement was then discussed by the primary and secondary judges. In cases in which disagreements remained after discussion, the primary coder, who was unaware of group assignment, made the final decision as to whether an intentional communication act had occurred. This procedure was followed for all coded samples.

Next, working independently, without access to each other's codes, coders determined the pragmatic function (e.g., declarative, imperative, or other) and form (e.g., verbal, vocal, or gesture) of each communication act. To estimate reliability for this coding, we applied the consistency definition for the single-rater intraclass correlation coefficient (ICC) to the scores yielded by each judge's codes (Berk, 1979; Suen & Ary, 1989; Weunsch, 2003). The ICC reflects the proportion of variance in scores that is related to actual sample differences rather than to the judges, interactions between judges and samples, or other unknown factors. ICCs for the three measures averaged .94 (Time 1 CSBS), .92 (Time 2 CSBS), .95 (Time 1 PCX), and .91 (Time 2 PCX), indicating acceptable reliability in each context. The primary and secondary judges then reviewed and discussed all discrepancies. The final decision was always made by the primary coder, who was always unaware of each child's group membership.

Coding parent behaviors. Parent coding was performed by a graduate assistant who was unaware of participant group assignments. To do this coding, the assistant began with finalized files that included all intentional child acts. This judge coded all parent acts that immediately followed each child act in every Time 1 and Time 2 sample. Parental acts were judged to be examples of recoding when the parents' consequent utterances mapped both the referent and the intent of the child's communication act. Approximately 50% of samples (N = 56) were selected at random and coded by a second judge, who could have been aware of each child's group participation. To evaluate reliability for the identification of parental recoding, we applied the consistency definition for the ICC. Reliability in this case was strong, with a single-rater ICC of .97 at Times 1 and 2.

Statistical Analyses

Tests for child treatment effects were initiated using two multiple analyses of covariance (MANCOVAs), one for the CSBS sample and the other for the PCX sample. For each analysis, group (i.e., RE/PMT vs. no-Tx) and diagnosis (i.e., DS vs. other etiology) served as between-subjects variables. For each MANCOVA, the three measures (i.e., imperatives, declaratives, and intentional acts) at Time 2 were used as the dependent variables, while the same measures at Time 1 served as the covariates. Another univariate analysis of covariance (ANCOVA) was performed to test the effects of RE/PMT on family stress.

Examinations of the distributions for the child-dependent variables and covariates indicated that approximately half of the subgroup distributions for each measurement context were not normal. This was corrected, for the most part, by using the square-root transformation for each dependent variable and covariate. The transformation normalized the subgroup distributions in all but four cases, including the rate of imperatives at Times 1 and 2, the rate of imperatives at Time 1 for the RE/PMT group, and the rate of intentional acts at Time 2 for the no-Tx group. The data were judged to be suitable for the completion of planned analyses.

In each of the multivariate tests, the covariates were reliably and positively associated with the dependent variables (for both the CSBS and PCX analyses, multiple Rs > .60). Multivariate tests for parallelism of slopes for the CSBS and PCX analyses indicated that there were no interactions between the covariates and the between-subject factors or interaction terms (i.e., Group × Diagnosis; all Rao Rs < 1.70, ps > .10). Thus, the assumption of parallelism of slopes on which ANCOVA rests was met in each case.

For the analysis of parental use of recoding, we intended to use the same type of ANCOVA as for the other variables; however, these data violated most of the assumptions of ANCOVA. The distributions were not normal, variances across groups were not homogeneous, and slopes reflecting the relationships between the covariate (Time 1 score) and the dependent variable (Time 2 score) across groups were not parallel. Consequently, we addressed these data with nonparametric analyses.

Results

We predicted that the children in the RE/PMT group would demonstrate higher levels of communicative performance than the children in the no-Tx group in both communication sampling contexts after 6 months of intervention. The results are consistent with this prediction only for the CSBS sample.

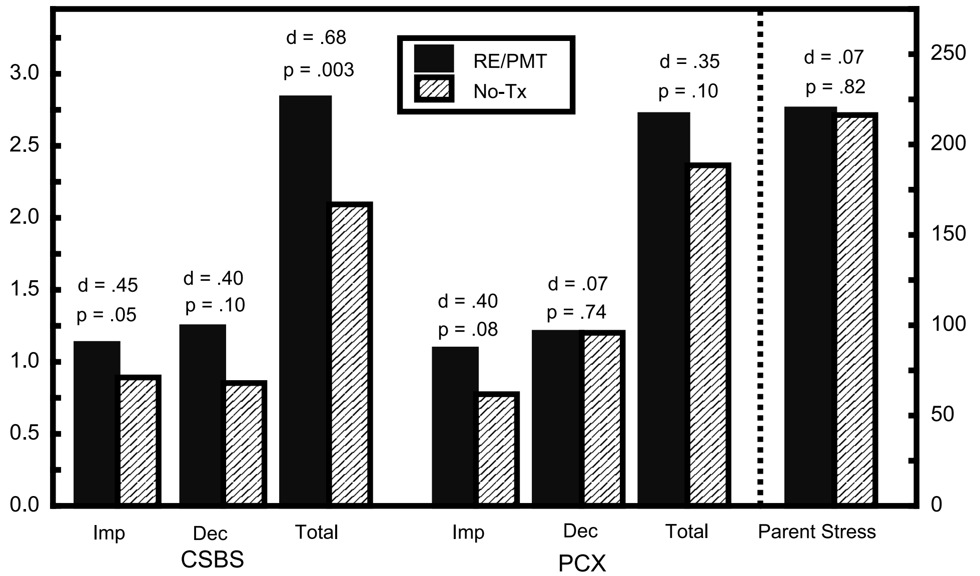
Child Outcomes Based on CSBS Samples

For the MANCOVA involving the CSBS, the multivariate effect for group was significant, Rao's $R(3, 42)$ = 3.35, p = .028. No multivariate effects were observed for diagnostic group, Rao's $R(3, 42)$ = 1.31, p = .28, or for the Group × Diagnosis interaction, Rao's $R(3, 42)$ = 0.52, p = .67.

Although attention should be focused principally on the significant multivariate effect, follow-up univariate analyses of variance were performed to test for the group main effects for each of the three CSBS dependent variables. The main group effects for imperatives, $F(1, 44)$ = 4.02, p = .051, and for declaratives, $F(1, 44)$ = 2.84, p = .099, narrowly missed the level of statistical significance, but the effect for intentional acts was statistically reliable, $F(1, 44)$ = 9.76, p = .003.

Figure 1 presents the Time 2 scores adjusted for scores at Time 1, but the data are not transformed, to improve interpretation. Square-root-transformed means for both groups for each Time 2 variable that have been adjusted based on Time 1 scores are shown in the upper portion of Table 6. Effect size, or d, is reported in this table as the difference between the adjusted means between groups divided by the pooled standard deviation. These effect sizes were calculated using DSTAT (Johnson, 1989) and are corrected to reflect sample size. For each variable, observed effects fell in the direction predicted. That is, children in the RE/PMT group outperformed the group of children who

Figure 1. Nontransformed means (adjusted based on Time 1 scores) and effect sizes following intervention (Time 2). RE/PMT = responsivity education/prelinguistic milieu teaching; no-TX = no treatment; Imp = Imperative; Dec = Declarative; CSBS = Communication and Symbolic Behaviors Scales; PCX = parent–child interaction.



did not receive RE/PMT. The observed effects are generally medium in size (corrected *d*s = 0.40–0.68). The 95% confidence interval surrounding the effect size for the rate of intentional acts does not include zero, enhancing confidence that the effects are not sample specific.

In our study, PMT was provided by four different clinicians. One clinician treated 12 children, and the others treated 6, 4, and 3 children, respectively. Post hoc analyses were undertaken to determine whether differences in children's gains covaried significantly with the primary clinicians. To examine this statistically,

Table 6. Data recorded for the entire group (i.e., main effect for treatment) and for the subgroup with effect sizes in the CSBS sampling context.

		Adjusted *M*	*SD*	*F*	*p*	Corrected *d* (95% CI)
Entire group						
PI	RE/PMT	1.03	0.25	4.02	.05	0.45
	No-Tx	0.89	0.34			(−0.10/1.0)
PD	RE/PMT	1.03	0.47	2.84	.10	0.40
	No-Tx	0.86	0.36			(−0.16/0.95)
IA	RE/PMT	1.66	0.38	9.76	.003	0.68
	No-Tx	1.37	0.43			(0.12/1.24)
DS only						
PI	RE/PMT	0.94	0.16	0.73	.40	0.36
	No-Tx	0.87	0.24			(−0.42/1.13)
PD	RE/PMT	0.91	0.38	1.10	.30	0.19
	No-Tx	0.85	0.26			(−0.58/0.96)
IA	RE/PMT	1.51	0.23	1.41	.24	0.65
	No-Tx	1.35	0.26			(−0.14/1.44)

Note. Included are square-root-transformed means for treatment groups, adjusted for Time 1 scores, along with standard deviations, results of univariate follow-up ANCOVAs, and effect sizes and their 95% confidence intervals.

gains made by the 12 children treated by one clinician were compared with gains made by the remaining pooled group of clinicians (13 children) for all three measures in each sampling context. These analyses revealed no significant differences across clinicians on any variable in the CSBS, all Fs(1, 21) < .90, all ps > .35. Thus, although there was variability in outcomes from clinician to clinician (and from child to child), there is no evidence that clinician traits led to significant differences in intervention outcomes.

The failure to find a significant Group × Diagnosis interaction indicates that in keeping with our prediction, the patterns favoring RE/PMT for the entire group in the CSBS sample also were observed within the group of children with DS. That is, children with DS responded to RE/PMT in much the same way observed for the children with other etiologies. This point is confirmed by the adjusted and transformed means, standard deviations, and effect sizes reported in the bottom portion of Table 6. Although none of the univariate effects differ reliably from zero, they are all positive, indicating that all means favored the group that received RE/PMT, even in the DS subgroup. Furthermore, the effect for intentional acts was equivalent in magnitude to that for the entire group (corrected d = 0.65), although the lower boundary of the 95% confidence interval for d is below zero due to the smaller size of DS subgroup.

Possible Tester Effects on the CSBS Results

As noted in the Method section, children generally were unfamiliar with their Time 2 CSBS testers. With one exception, in which a tester was the child's secondary clinician, contacts between children and Time 2 examiners were limited to a possible contact during Time 1 testing. In approximately half of the cases (n = 26), the Time 2 tester was also the same child's examiner at Time 1, which had taken place 6 months previously. It seems unlikely that this limited contact could have influenced the results. On the other hand, the testers were not evenly distributed across the participants or groups. One Time 2 tester evaluated 26 children, another 14, and the other 11. If testers were significantly associated with patterns of gain over the experimental period, this imbalance could have been a significant factor in the effects we observed. To examine this possibility, we performed a Group (PMT vs. no-Tx) × Tester ANCOVA. The child's Time 1 score for total communication acts served as the covariate, and same score at Time 2 was the dependent measure. This analysis yielded a significant effect for group, $F(1, 46)$ = 8.07, p = .007, but there was no effect for tester, $F(2, 46)$ = 1.52, p = .23. Most important, there was no interaction between group and tester, $F(2, 46)$ = 1.37, p = .26. Thus, the gains made by the children across groups do not appear to be dependent on who their tester was at Time 2.

Child Outcomes Based on PCX Samples

The multivariate and univariate effects observed for group in the CSBS sample were not replicated in the PCX sample. For the MANCOVA involving the PCX, the multivariate effect for group was nonsignificant, Rao's $R(3, 42)$ = 2.24, p = .097. As found in the CSBS sample, the effects for diagnostic group, Rao's R (3, 42) = 1.42, p = .252, and for the Group × Diagnosis interaction, Rao's $R(3, 42)$ = 0.66, p = .581, were small and not statistically reliable. Figure 1 provides the nontransformed means at Time 2, adjusted for Time 1 score for each group. The top portion of Table 7 provides transformed and adjusted means, standard deviations, effect sizes, and the results of univariate analyses for each of the three variables for the group effect in the PCX sampling context. Although all means favor the RE/PMT group, none of the univariate effects differ significantly from zero. The data in the bottom portion of Table 7 reflect the performances of the DS subgroups in the PCX task. These effects are small and do not differ significantly from zero.

Effects of Moving Children From RE/PMT to RE/MT

We changed the focus of intervention from PMT to an MT program once a child's communication profile exceeded our entry criteria for imperatives and/or declaratives, total communication acts, and canonical vocalizations. Nine of the 25 children in the RE/PMT group, including 3 with DS, were graduated to RE/MT during the intervention period. It could be that gains made by these children accounted for either an especially small or an especially large part of the improvements observed for the treatment group. Either of these outcomes would require a major reconsideration of the impact of RE/PMT on the communication behavior of children in the RE/PMT group.

To evaluate these possibilities, we excluded the 9 participants who were exposed to MT during the treatment period and compared the resulting RE/PMT and no-Tx groups' gains in intentional communicative acts. Treatment (i.e., RE/PMT vs. no-Tx) and diagnosis (i.e., DS vs. other etiology) were entered as between-subjects variables, and preexperimental rate of intentional acts was used as a covariate. The ANCOVA revealed a statistically significant effect for treatment, $F(1, 37)$ = 6.14, p = .02. Thus, the effect of RE/PMT on

Table 7. Data recorded for the entire group (i.e., main effect for treatment) and for the subgroup with DS in the PCX sampling context.

		Adjusted *M*	*SD*	*F*	*p*	Corrected *d* (95% CI)
Entire group						
PI	RE/PMT	0.98	0.40	3.16	.08	.40
	No-Tx	0.84	0.26			(−0.16/0.95)
PD	RE/PMT	1.02	0.42	0.11	.74	.07
	No-Tx	0.99	0.46			(−0.48/0.62)
IA	RE/PMT	1.61	0.41	2.77	.10	.35
	No-Tx	1.44	0.54			(−0.20/0.91)
DS only						
PI	RE/PMT	0.92	0.29	1.94	.17	.11
	No-Tx	0.89	0.12			(−0.66/0.87)
PD	RE/PMT	0.95	0.31	0.00	.98	.11
	No-Tx	0.91	0.30			(−0.66/0.88)
IA	RE/PMT	1.49	0.32	0.41	.52	.35
	No-Tx	1.39	0.25			(−0.43/1.12)

Note. Included are square-root-transformed means for treatment groups, adjusted for Time 1 scores, along with standard deviations, results of univariate follow-up ANCOVAs, and effect sizes and their 95% confidence intervals.

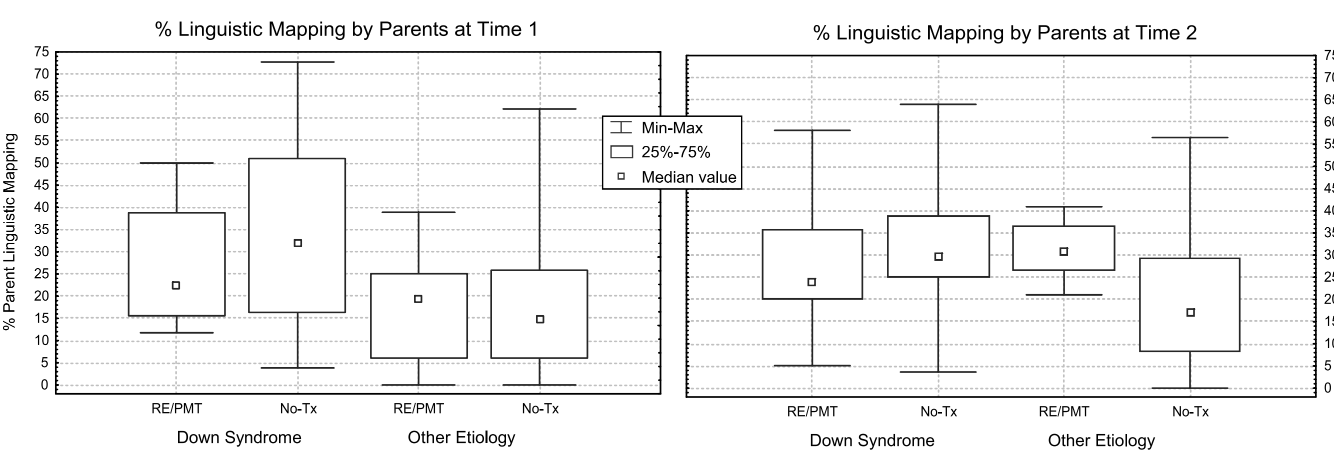
children's use of intentional acts remained, even with the most linguistically advanced children removed from the analysis.

Parental Response to RE/PMT

To analyze parental response to intervention, we compared the groups on parents' use of recoding, reflecting their tendency to map the meanings of simple child communication acts onto more conventional and more complex words and sentences. Three of the 51 participating parents were excluded. One of these parents had a child who produced no intentional acts during the PCX, making it impossible to compute a percentage score. For another dyad, the parent was not the same at both testing times. The 3rd parent was excluded because the video file was corrupted and could not be evaluated.

The box-whisker plots in Figure 2 display the medians, the two middle quartiles, and the ranges for the percentage of child intentional communication acts that were followed by parent recoding. The left side

Figure 2. Percentage of child communication acts followed by parents' recoding at Time 1 (i.e., preexperimentally) and at Time 2 (i.e., 6 months postonset).



of the figure illustrates the performances at Time 1 for RE/PMT and no-Tx groups, further broken down by whether the child had DS. The children and parents were matched exceedingly well on numerous preexperimental variables (see Tables 2 and 3). Still, the figure indicates that the parents of children with DS (n = 25) produced higher percentages of recoding than did parents of children with other etiologies (n = 23). A Mann–Whitney U test indicated that this difference was statistically significant (U = 182, z = 2.18, p = .03). This effect has a Glass rank-biserial correlation coefficient (r_G) of .37 (Welkowitz, Ewen, & Cohen, 1976). This correlation reflects the relationship between group membership and ranking of the members in the groups. It is roughly analogous to the point-biserial correlation coefficient, with values of −1 and 1 indicating no overlap in ranks between groups and 0 reflecting perfect overlap between groups. Thus, the difference in recoding between parents of children with DS and parents of children with other etiologies at Time 1 may be viewed as small to medium in size.

At Time 1, however, the recoding of the parents in the RE/PMT group with DS (n = 13) was not reliably different from that of the no-Tx group with DS (n = 12), U = 66.5, z = −.63, p = .53. Furthermore, the RE/PMT group with other etiologies (n = 10) did not differ from the no-Tx group with other etiologies (n = 13) in their use of recoding (U = 64, z = .06, p = .95). Within each etiologic subgroup, then, RE/PMT and no-Tx groups were roughly equivalent in their use of recoding at Time 1.

The right side of Figure 2 illustrates the performance of each subgroup following the intervention period. As was the case at Time 1, the subgroups of parents with DS did not differ from one another, whether or not their child was in the RE/PMT group. In contrast, the parents in the other-etiology RE/PMT group outperformed the parents in the other-etiology no-Tx group (z = 1.99, p = .05). This effect was medium in size (r_G = .49).

Comparisons across Times 1 and 2 within groups also are revealing and highly supportive of the outcomes of the between-groups comparisons. For example, the production of recoding by parents in each DS subgroup at Time 2 is strikingly similar to that at Time 1. These groups of parents did not change in their use of recoding with or without RE/PMT. Similarly, parents in the other-etiology no-Tx group exhibited no apparent change from their performance at Time 1. A Wilcoxon matched-pairs test confirmed this impression (z = 1.49, p = .14). In contrast, the parents in the other-etiology RE/PMT linguistically mapped their children's communicative acts more frequently at Time 2 than they did at Time 1 (z = 2.40, p = .02). The performance of the other-etiology RE/PMT parents at Time 2 is comparable to that of the parents of children with DS, with scores falling in the 20%–40% range (see Figure 2).

Influence of RE/PMT on Parental Stress

Our final experimental question involved the impact of PMT on parental stress. PSI forms were completed at both Times 1 and 2 by 46 caregivers. The unadjusted postexperimental means for the RE/PMT (M = 213.12) and no-Tx (M = 221.14) groups were well inside the range anticipated by PSI norms for the parents of children with developmental disabilities. In fact, these means are comparable to the PSI mean reported for 2-year-old children from the general population (M = 226). To examine potential differences between RE/PMT and no-Tx groups in parental stress, we performed a univariate ANCOVA with treatment group and diagnosis as the between-groups factors, Time 1 PSI total stress score as the covariate, and the Time 2 PSI total stress score as the dependent variable. There were no significant effects observed for group, $F(1, 41) = 0.13$, p = .72, or diagnosis, $F(1, 41) = .15$, p = .62, or for the Group × Diagnosis interaction, $F(1, 41) = 0.25$, p = .62. This noneffect is shown in Figure 1.

Discussion

Main Effects of RE/PMT

Other studies that have evaluated PMT (e.g., Yoder & Warren, 1998, 1999, 2001) have observed no main effects but, rather, interactions between the treatment and either treatment moderators (e.g., maternal education or responsivity, rate of child comments or canonical vocalizations) or mediators (e.g., the effects of increases on child intentional acts on maternal responsivity). One of the major differences in outcomes between our study and that of Yoder and Warren (2002) was that in the CSBS, we observed a statistically reliable main effect for treatment. With the dependent measures pooled in a multivariate analysis, the RE/PMT group was shown to produce significantly more communicative acts than did the no-Tx group following the intervention.

These differences in outcomes between the present study and the Yoder and Warren (2002) investigation could be due to many factors. For example, from the outset, it must be recognized that our report reflects an endpoint analysis at the end of the 6-month intervention period. Because so many of our participants were still producing few or no words, we performed no analyses involving language measures. Thus, we had no means for replicating the Yoder and Warren finding regarding lexical diversity. Furthermore, the effects reported by Yoder and Warren reflect rates of growth over an 18-month period, the first 6 months of which involved intervention. These differences in time and method of reporting could account for observed differences between the studies' outcomes. Our future analyses of our long-term outcomes will address these issues in detail.

In addition to these manifest differences between Yoder and Warren's (2002) and our research reports, several less apparent differences between studies warrant mention. For example, the participants in our study averaged 4 to 5 months older than the children studied by Yoder and Warren (2002), and they appear to have understood a few more words than did the children in the earlier investigation. Even if our participants had been identical, however, some differences due to sampling error could be expected. Furthermore, although we worked diligently to present an intervention and a coding system that was, with few exceptions, exactly like that of Yoder and Warren (2002), some unplanned differences due to the participants and the clinicians likely occurred.

More important, as noted in the introduction, there were three aspects of the Yoder and Warren implementation of PMT that we intentionally modified to enhance its effects. It is possible that any or all of these modifications could have influenced our results. We have no way of knowing, however, whether and to what extent these planned differences can account for differences in outcomes across studies.

Furthermore, none explanations based on planned differences between studies adequately account for the fact that Yoder and Warren (2002) found an effect for RE/PMT in the PCX, and we did not. CSBS and PCX samples differed in many ways that could influence children's performances, but these influences should have affected both studies similarly. Most obviously, the CSBS involved interaction with an unfamiliar clinician, and the PCX involved interaction with parents. The clinicians were trained to follow the CSBS protocol, and they appeared to do so consistently. This led to a consistently large number of child communication opportunities in the CSBS, whereas opportunities may have been more limited in the PCX, partly by the design of the sampling context and partly due to variability in parent behavior. For example, at least some parents appeared to misinterpret our PCX instruction to share the toys as soon as their child indicated that they wanted to play. Such parents did not readily respond to child communication attempts, apparently waiting for the highest-level form of communication their child could produce. Although they were reinstructed at the beginning of each 5-min segment of the PCX, it could be that the children's responses to these parents were not reflective of their best or even their typical performance. In any case, of the apparently greater variability in parent than in clinician performance could have resulted in a minimization of effects in the PCX.

Effects of RE/PMT on Children With Down Syndrome

The other major difference in outcomes between the present investigation and that of Yoder and Warren (2002) is that these investigators reported that RE/PMT affected growth in production of imperative acts only in the other-etiology group. In fact, the results were consistent with the notion that RE/PMT slowed down the developmental rate of imperatives in the children with DS.

In contrast, in our study, the group of children with DS that received RE/PMT had more imperatives, declaratives, and total communication acts after intervention in each context (though not statistically significantly so). The Treatment × Etiology interactions were never close to the level of statistical significance. Thus, the effects of RE/PMT on children with DS were not statistically significantly different from the effects observed for children in the non-DS group. Our findings indicate that RE/PMT procedures can be used with at least some children with DS with no signs of adverse effects and some important indications of positive impact.

Effects of Treatment on Parents' Use of Recoding

Our prediction that the subgroups whose parents received RE would increase their recoding proved to be only partly correct. The parents of children with other etiologies who received RE significantly increased their use of recoding, whereas parents in the other-etiologies subgroup that did not receive RE/PMT made no changes over the 6-month experimental period. Note that the children in the RE/PMT subgroup also changed over the treatment period. Therefore, it is impossible to determine whether the observed change in their parents' performance was due to RE, to the changes in child communication, or to some combination of both.

In contrast with the parents of children in the other-etiology group, the parents of children with DS did not change over the experimental period, with or without RE. Thus, these parents were unaffected by the combination of RE and changes in their children's communication behavior. It is noteworthy that for most of these parents, the rates of recoding for the parents of children with DS fell roughly in the 20%–40% range at both testing points. This was significantly higher than the rates for parents of children in the other-etiology group at Time 1 and roughly equivalent with the Time 2 rates produced by the subgroup of other-etiology parents who had received a course of RE. Although it is possible for parents to produce even higher rates of recoding, and some *did* produce higher rates, it is also possible that even with training, many parents find it difficult or unnatural to raise their use of recoding beyond the 20%–40% range.

If this is true, perhaps it is not surprising that the parents of children with DS, as a group, reached this asymptote before treatment began. Although the children with DS were not receiving more services preexperimentally than the children with other etiologies at the time of our study (see Tables 1 and 2), children with DS are identified at or even before birth, and their parents often are involved in intervention programs from shortly after birth (Roizen, 2002). Thus, by the time our study began, these parents may have received a greater accumulation of intervention focusing on positive interactions with their children than the parents of children with other etiologies had.

Tannock and Girolametto (1992) noted that the observation of significant change following different forms of RE depends to a considerable extent on a determination that before the intervention, parents are not sufficiently responsive and are truly in need of the intervention. It may be that by the time their children are 24 months of age, many parents of children with DS are already sufficiently responsive due to the parent education that often accompanies these children's early diagnosis. This possibility requires further examination in other sets of data.

Because the children in this subgroup also were changing, possibly as a result of PMT, it is impossible to determine whether the observed change in parent performance caused or itself was caused by improvements in child communication. Our outcome for parents, however, does indicate that it is reasonable to anticipate increases in parents' use of recoding when recoding is targeted within a comprehensive RE/PMT protocol and when parents are not already linguistically mapping more than 20% of children's communication acts.

Effects of RE/PMT on Parental Stress

Our interest in parental stress was motivated by some conflicting claims that early intervention can either reduce parental stress in some families (Robertson & Ellis Weismer, 1999; Shonkoff et al., 1992; Tannock et al., 1992) or increase it (Brinker et al., 1994). The average total stress ratings on the PSI before and after the treatment period were no greater for the parents of children in either the RE/PMT or the no-Tx group than has been reported for parents of children with language impairments or DS (Abidin, 1995). Observed means were roughly at the 50th percentile for parents sampled from the general population. More important, there were no differences between groups in total parenting stress, following the intervention. Thus, at least if it is applied with the intensity and manner found in the present investigation, there are no obvious effects of RE/PMT on parental stress, as measured by the PSI.

Limitations of the Study

There are numerous limitations to this study, some of which already have been clearly acknowledged. First, because of the importance of accurately identifying all intentional communication acts, a consensus procedure was used, and no independent reliability determinations are available for the identification of intentional communication acts. Second, although independent reliability calculations were obtainable for the types of communication functions (i.e., imperative vs. declarative vs. other), for Time 2 coding, the secondary coder was not always unaware of child group assignments. It is possible that these procedures allowed coder biases to affect our measurement of dependent variables and significantly influence our results.

Note also that the testers at the Time 2 samples could have been aware of the children's group assignments. This should have had no impact on the results in the PCX context, in which the children interacted with one of their parents. It could have influenced our positive outcomes in the CSBS sample, however. In fact, at first look, this seems a potential explanation for our positive findings in the CSBS and noneffects in the PCX.

This explanation is weakened, at least somewhat, by two factors. First, all parents knew of their child's treatment status, and the parents in the RE/PMT group received parent RE designed to teach them to be highly responsive to their child's communicative efforts. At least for the parents of children who did not have DS, this intervention appeared to have an influence on parental use of recoding. Assuming that use of recoding enhances child performance of existing communication skills, one would have expected larger treatment effects in the PCX than in the CSBS, if tester bias in administering the procedure had significantly affected the results. This was not what we observed. Second, for the CSBS condition, one Time 2 tester examined far more children than the other two testers. This tester could have exerted undue influence over the results. Our analysis of this possibility failed to reveal an association between testers and the gains made by the groups over the 6-month experimental period. This does not rule out the possibility that tester bias occurred, but it does minimize the possibility that one biased examiner delivered results that somehow drove the overall treatment effect we observed.

Although our study was large by standards of intervention research in early childhood communication disorders, our sample size of 51 was still small, rendering power low. Addition of only a few participants per group may have yielded significant effects where we observed only nonsignificant trends. Note, however, that with few exceptions, the nonsignificant trends we observed were in the direction of our prediction of treatment effects for both the total group of children and for children with DS.

Our use of a control group that received no project-related treatment over the 6-month experimental period leaves open the possibility that the effects we observed were not specific to RE/PMT. Similar effects might have occurred had we merely played with the children and had general conversations with their parents for amounts of time equivalent to those we reserved for RE/PMT. We cannot rule out this possibility, but two facts make it unlikely. First, effects of PMT have been reported, at least for certain subgroups of children, even when compared with another communication intervention (Yoder & Warren, 2001). These results increase the likelihood that our effects are indeed specific to the intervention we provided. Second, although the difference was not statistically significant ($p = .13$), the children in the no-Tx group received an average of 2.3 more hours of communication intervention outside our project per month than the children in the RE/PMT group. If the ingredients specific to RE/PMT were not essential to the treatment effect, this small group difference in amounts of nonproject intervention might have been expected to wash the effects out. It did not. Notwithstanding these points, there is still no way of knowing which parts of our intervention package contributed most significantly to our positive outcomes.

Finally, perhaps the most significant limitation of the study is that it provides no indication of how the children performed after RE/PMT. A basic premise of the intervention is that it prepares preverbal children to acquire the social and linguistic requisites for verbal learning. The ultimate test of its effects, then, lies in its impact on children's later verbal learning. Our research design requires us to follow each child for 12 months after the completion of the first 6-month RE/PMT period. Reports of our analyses of these data are forthcoming.

Despite these limitations, the results of this study continue a growing line of research reports supporting the efficacy of PMT and RE/PMT over the short term (e.g., 6 months). The effect on children's overall use of communicative acts was only medium in size, but it may be important to note that all implementations of PMT thus far have been limited in intensity (e.g., approximately 1 hr of PMT per week) and duration (6 months). The results of studies on these limited approaches suggest that persistent efforts to modify and intensify the general approach are warranted and could bear significant fruit.

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