

# Maternal Responsivity Predicts the Prelinguistic Communication Intervention That Facilitates Generalized Intentional Communication

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Family systems theory posits that the relative effectiveness of early interventions will vary depending on various aspects of the family. This study tested whether maternal responsivity would predict the extent to which Prelinguistic Milieu Teaching (PMT) facilitated generalized intentional communication better than a contrast treatment that was conducted in a small group by a responsive adult (i.e., Responsive Small Group, RSG). Fifty-eight children with developmental disabilities in the prelinguistic communication period of development were randomly assigned to one of the two staff-implemented treatment groups. Thirty were assigned to RSG; 28 were assigned to PMT. Mothers were kept naive to the intervention methods, hypotheses, and measures. In families with mothers who responded to a high percentage of the children's communication acts at the pre-treatment period, the children in the PMT group used more frequent intentional communication in post-treatment generalization sessions with a trainer and mothers than did children in the RSG group. In the families with mothers who responded to fewer than 39% of their children's communication acts, children in the RSG intervention used more frequent intentional communication in post-treatment generalization sessions with the mothers than did children in the PMT intervention. Other family variables and no child variables that we measured could account for these findings.

**KEY WORDS:** mother-child interaction, prelinguistic communication, intervention, children with developmental disabilities, systems theory

When faced with a nonverbal client, many clinicians may be tempted to try to teach the child to talk. However, there is good reason to expect that sufficient neurological maturation is necessary for language intervention to be effective (Wakefield & Wilcox, 1995). For example, Wilcox and colleagues posit that sufficient myelination and synaptogenesis in the prefrontal cortex must have occurred before children can make sound–meaning associations. Therefore, it is not surprising that attempts to teach language to children with developmental disabilities who are not yet talking have largely been unsuccessful (e.g., Girolametto, 1988).

As an alternative to teaching children to talk, Yoder and Warren (1993) suggested that we enhance children's ability to use the type of

prelinguistic communication acts that might elicit language-facilitating maternal responses. Such communication acts are what Shatz (1987) referred to as “eliciting bootstrapping operations.” Eliciting bootstrapping operations are ways that children enhance their own language development. There is sequential (Yoder & Warren, 1997a; Yoder, Warren, Kim, & Gazdag, 1994) and summary level (Yoder & Warren, 1997b) correlational evidence that intentional communication is associated with maternal responsivity, which is in turn associated with later language in children with disabilities.

Furthermore, mothers are more likely to respond to intentional communication than to preintentional communication (Yoder & Warren, 1997a). Therefore, intentional communication enables children to increase their effect on their social environment and to increase the probability that their needs will be met.

Existing single-subject research lends support to the proposition that we can facilitate intentional communication in children with disabilities through intervention (Warren, Yoder, Kim, Gazdag, & Jones, 1993; Yoder et al., 1994). These studies demonstrated that Prelinguistic Milieu Teaching increased intentional communication within the intervention sessions. Increases in generalized intentional communication also occurred concurrent with treatment. However, the multiple baselines across subjects designs used in these studies do not allow strong confidence that the treatment was responsible for the increased generalized intentional communication. Increases in generalized intentional communication began long after the onset of treatment; therefore the design could not control for alternative explanations for this increase (e.g., history and maturation). Additionally, group design research is necessary to identify variables that describe the subjects who benefit most from prelinguistic communication intervention.

General systems theory (Sameroff, 1983) and family systems theory (Turnbull & Turnbull, 1997) suggest that the family context can either enhance or inhibit the effectiveness of communication interventions that are implemented in the school or clinic. Many have pointed to the family’s socioeconomic status as one factor that may affect communication outcomes (e.g., Hunt, 1961). However, it is likely that socioeconomic status is a distal variable that covaries with how the parents interact with the child (Bradley, Caldwell, & Rock, 1990). Parent-child interaction patterns are more likely to affect children’s response to communication treatments than are socioeconomic variables such as maternal educational or occupational status (Bradley et al., 1990).

We predicted that the effectiveness of clinic-based prelinguistic communication intervention would vary as a function of maternal responsivity to children’s

communication acts. To understand our rationale for this prediction, it is important to know that the most frequent way that children in the prelinguistic period display intentional communication is by using gestures or vocalizations with attention to the adult message recipient and the object or event being communicated about (Adamson & Bakeman, 1991). Clinical experience indicates that most preintentional communication acts lack attention to the mother, but show attention to the object or event being communicated about. Mothers’ responsivity may augment what the child is learning in the clinic. Mothers’ compliance with the presumed meaning of their children’s communication acts may encourage children to direct future communication acts to the mother. The children may thus come to understand that the mother is a social agent on their behalf (Yoder & Warren, 1997a).

Therefore, this study examined whether Prelinguistic Milieu Teaching can facilitate generalized intentional communication in children with disabilities. We predicted that the treatment effect would be strongest for children who had mothers who were relatively responsive to their children’s communication acts. Statistically speaking, we predicted an interaction between pre-treatment maternal responsivity and treatment group predicting post-treatment intentional communication (Aiken & West, 1991).

## Method

### Participants

The children were recruited through three early intervention programs for children with developmental disabilities. The selection criteria for the study were (a) Bayley Mental Development Index (MDI) between 85 and extrapolated 35 (i.e., using the extrapolated norms in Naglieri, 1981 for the 1969 version and those computed using the same procedure for the 1993 version; McCathren & Yoder, 1994); (b) production of fewer than 10 different words as indicated by teacher report and direct observation during three communication samples; (c) at least one instance of coordinated attention to a person and an object, of reach to a distant object, or of vocalization with attention to an adult as indicated in three communication samples; (d) no evidence of severe visual or hearing impairment as indicated by school files and parent and teacher report; (e) the ability to hold an object while rotating the torso; and (f) a chronological age between 17 and 36 months.

Sixty children with developmental disabilities and their primary parent (the one who reported that they spent the most time with the child) enrolled in the study. After examining the distributions of all pre-treatment variables, it was apparent that two subjects were extreme

outliers ( $z$  scores  $> 4.00$ ) on at least three pre-treatment variables. We excluded these children, leaving 58 subjects (Tabachnick & Fidell, 1989). The remainder of this report deals with these 58 children and their parents.

The hypotheses were tested on the remaining 58 children with disabilities and their primary caretakers. Ninety percent (i.e., 52) of the caretakers were the children's mothers. Table 1 presents descriptive statistics on several child variables. The children's cognitive scores were estimated using the Bayley Scales of Infant Development (2nd ed., Bayley, 1993). The means and standard deviations for the Communication and Symbolic Behavior Scale (Wetherby & Prizant, 1993) were also presented.

The Uzgiris-Hunt Means-End scale (Uzgiris & Hunt, 1975) revealed that 14% of the children scored at stage IV, 45% scored at stage V, and 41% scored at stage VI. Sixty-four percent of the children were boys. Fifty-seven percent of the families were Caucasian, 36% were African American, and 7% were Hispanic.

All of the children fit the Tennessee definition for developmental delay (i.e., 40% delay in one domain, 25% delay in two domains). The etiology for these developmental delays varied. Four children had Down syndrome, four were premature with medical complications (e.g., chronic lung disease), three had "failure to thrive" diagnoses,

two were diagnosed as having pervasive developmental delay—not otherwise specified, one had macrocephaly, one had microcephaly, one had Duane's syndrome, one had neonatal meningitis, one had Fetal Alcohol Syndrome, one had tuberous sclerosis, and the remaining 39 had no identifiable etiology or diagnosis other than developmental delay.

A certified audiologist screened children for hearing losses using sound field screening at 500, 1000, and 2000 Hz. All but four children attended hearing screening sessions sometime during the study. No child scored worse than 50 dB at any frequency. Six children scored between 26 and 50 dB on at least one of the three frequencies. For the 3 children in the PMT group with some evidence of at least temporary hearing loss, one child scored 50 at all three frequencies, another scored 45 at 500 Hz and 35 at 2000 Hz, and the third scored 35 at 500 Hz and 30 at 2000 Hz. For the 3 children in the RSG group with some evidence of at least temporary hearing loss, one child scored 50 at 1000 Hz, another scored 40 at 500 and 1000 Hz, and the third scored 45 at 500 Hz. Hearing at other frequencies were at 25 dB or better. Ear inspection revealed that all six children had evidence of otitis media with effusion at the time of testing. These children were referred for medical management of otitis media with effusion.

At the beginning of the study, parents were given a demographic questionnaire containing questions about the parents' employment and level of school they completed. From the parents' responses, staff members identified the parents' occupational title (Stevens & Cho, 1985; International Standard Classification of Occupations, 1986). The occupational status of the U.S. population averages 34.5 ( $SD = 18$ ; Stevens & Cho, 1985). The median occupational status of our sample was 23 ( $SD = 22$ ). The distribution for occupational status was positively skewed in our sample (i.e., more low-status participants than would be expected in a normal distribution). Therefore, our sample's occupational status was lower than that of the general population.

The formal education of the mothers averaged high school graduation and ranged from one year of school to postgraduate training. Neither racial composition nor level of formal education is representative of the 1980 U.S. census data (Zill & Schoenborn, 1990), but the two treatment groups showed equal distributions ( $p > .25$ ). The number of years of school completed were scaled on an adapted metric used by Hollingshead and Redlich (1985): 1 = 0 years; 2 = 1–6 years; 3 = 7–9 years; 4 = 10–11 years; 5 = graduation from high school or GED of school completed; 6 = 1–2 years of college or technical school; 7 = 3–4 years of college or technical school; 8 = 1–2 years of graduate or professional school; 9 = over 3 years of graduate school or postgraduate training.

**Table 1.** Means (and standard deviations) on selected pre-treatment variables within the treatment groups.

Variables	PMT ( <i>n</i> = 28)	RSG ( <i>n</i> = 30)
<b>Children</b>		
Chronological age	22 mos (4 mos)	23 mos (4 mos)
Mental age (MA)	15 mos (2 mos)	15 mos (2 mos)
Mental development index (MDI)	55 (13)	53 (12)
Highest level of play (ECX)	2.9 (1.32)	2.5 (1.34)
Parent report of words understood (CDI/I)	127 (101)	113 (90)
Number of communication acts (CSBS; pro-rated for 15')	27 (14)	27 (14)
Proportion of intentional acts (CSBS)	.80 (.11)	.79 (.16)
<b>Family</b>		
Mothers' education level	5.5 (1.5)	4.7 (1.4)
Average family resource scale item score	4 (.58)	4 (.71)
Parental tendency to interpret nonverbal behavior	100' (8)	93 (15')
Proportion of acts mothers responded to (i.e., maternal responsivity; MCX)	.48 (.17)	.53 (.15)

\*Group difference ( $p < .05$ ); two-tailed test.

## Design

Treatment effects were evaluated through a randomized group experiment. Children were randomly assigned to one of two groups. Each group received one of two educational treatments. We elected to use a contrast treatment group to control for the well-known Hawthorne effect and the amount of attention from a responsive adult. Parents or children in an experimental treatment group may behave differently than parents or children in a nontreatment group simply because participating in a treatment may alter parental expectations of children's progress. Additionally, the parents were kept naive to the treatment methods, hypotheses, and variables coded to avoid influencing their behavior through our expectations. The relationship between pre-treatment maternal responsivity and the degree to which treatment group assignment affected later intentional communication was tested using a longitudinal correlational design.

## Procedures

### Communication and Symbolic Behavior Scales (CSBS)

In both the pre- and post-treatment periods, the Communication Temptations and Sharing Books sections of the CSBS (Wetherby & Prizant, 1993) procedure were administered to derive estimates of child communication rate. The procedures were conducted by an experienced examiner who was not the child's trainer during the intervention. 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. Sharing Books provides a less structured sampling context.

### Experimenter-Child Interaction Session (ECX)

In the pre- and post-treatment periods, the children 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. Level of play and communication measures were coded in the pre-treatment period. Intentional communication was coded in the post-treatment period. 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. 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.

### Mother-Child Interaction Session (MCX)

During pre- and post-treatment periods, mothers were asked to play with their children for a total of 15 minutes, which was divided into three 5-minute segments. A trained observer coded mothers' responsivity to the children's communication through repeated viewings of the videotaped sessions. During these sessions, the child was seated in a chair that was attached to a table to discourage the child from getting up. Because pilot testing indicated that unstructured mother-child interaction sessions resulted in almost no opportunities for mothers to respond, the first two 5-minute segments of the MCX 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 mother 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 mother was told to ignore these events until the child drew the mother'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 mother-child session was freeplay.

### MacArthur Communication Development Inventory (CDI), Infant Scale

In the pre-treatment period, the mother filled out the Infant Scale of the CDI (Fenson et al., 1991). Parents were asked to indicate whether their child "understands only" or "understands and says" (or signs) each word. The number of words understood was used as a measure of vocabulary comprehension level.

### Family Resource Scale (FRS)

In the pre-treatment period, the mothers were administered the FRS (Dunst & Leet, 1987) to measure their perception of the adequacy of their family resources. The FRS is a questionnaire in which mothers rate the adequacy of their time, money, and energy to meet 30 different needs. The average score was used as the index of the mothers' perception of the adequacy of their family resources.

## General Tendency to Attribute Communication (GTAC)

In the pre-treatment period, mothers were shown 20 videotaped scenes that depict an infant communicating to an adult using prelinguistic behaviors that range widely in clarity of communication (see Yoder & Feagans, 1988 for a more detailed description). After viewing each scene, the mother indicated whether she considered the behavior communicative and how confident she was of her judgment. This instrument measures the extent to which mothers confidently attribute communicative value to infant nonverbal behaviors.

## Coding

All interaction sessions were coded using repeated viewings of videotaped sessions. Observers were pretrained to at least 85% summary-level reliability. The pre- and post-treatment CSBS, ECX, and MCX sessions were coded for intentional and preintentional communication acts. Definitions and examples for these types of acts are shown in Table 2. Because the duration of the CSBS sessions varied across children, frequencies of communication and of intentional communication were prorated by the duration of the sessions. The ECX

and MCX sessions were consistent in duration; thus, the number of communication acts and number of intentional communication acts from these sessions were used.

Maternal responsivity was coded from the pre-treatment MCX session. The definition and examples for maternal responsivity are shown in Table 2. We used the proportion of child communication acts to which the mother responded as our measure of maternal responsivity.

The highest level of play was coded from the pre-treatment ECX session using an adaptation of McCune's (1995) representational play scale. This scale measures five levels of play, from presymbolic play schemes to hierarchical symbolic play. We added a Level 0, which included only mouthing and banging objects that were not designed to be mouthed or banged (e.g., mouthing a ball, shaking a car). We also distinguished *mastered* (add .5 to the highest level of play observed) from *emerging* levels of play (McCathren, 1996).

## The Treatments

The assigned treatment sessions were scheduled 4 times a week for 6 months. Each session lasted 20 minutes. If a child missed a session, it was not made up.

**Table 2.** Definitions and examples of communication and responsivity codes.

Variables	Definitions	Examples
Child's preintentional communication	Unconventional gesture or vocalization with attention to adult OR to object (no coordinated attention shown). Sustained change in affect.	<ol style="list-style-type: none"> <li>1. Reach to object (no attention to adult).</li> <li>2. Vocalization to adult.</li> <li>3. Vocalization to object.</li> <li>4. Change from neutral facial expression to smile for 3 seconds.</li> </ol>
Child's intentional communication	Unconventional gesture or vocalization with display of coordinated attention to adult and object or event. Conventional gesture or symbol with attention to the adult.	<ol style="list-style-type: none"> <li>1. Hand object to adult.</li> <li>2. Point to object and look at adult.</li> <li>3. Sign <i>more</i> and look at adult.</li> </ol>
Maternal responses	Complying with the presumed meaning of the child's immediately prior communicative message.	<ol style="list-style-type: none"> <li>1. Child reaches for toy that is out of reach. Mother gets toy for child.</li> <li>2. Child points to toy and looks at mother. Mother says, "Yeah, that's neat, isn't it."</li> </ol>
	Imitating some component of the child's immediately prior communicative act.	<ol style="list-style-type: none"> <li>1. Child rolls the ball to mother. Mother rolls the ball back to the child.</li> </ol>
	Maternal attempt to clarify the meaning of the preceding utterance.	<ol style="list-style-type: none"> <li>1. "Do you want the ball?"</li> <li>2. "Ball?"</li> <li>3. "This?"</li> </ol>
	Maternal utterance that includes the main verb, noun, or function word implicit in the child's immediately preceding nonverbal or verbal communication act.	<ol style="list-style-type: none"> <li>1. Child points to a toy bird. Mother says "That's a bird!"</li> <li>2. Child reaches for the food. Mother says, "You want some food."</li> <li>3. Child throws the toy off the table and glares at Mother. Mother says, "You're finished with that."</li> </ol>

Children in both groups attended early intervention in addition to the treatment sessions.

### Prelinguistic Milieu Teaching (PMT)

PMT was specifically designed to facilitate intentional communication in children with mental retardation (Warren & Yoder, in press; Warren et al., 1993; Yoder & Warren, 1993; Yoder et al., 1994). A primary trainer worked with each child 3 days a week, and a secondary trainer worked with the child 1 day a week. Specific behavioral targets were selected for each child in view of their current performance in the three communication samples (i.e., ECX, CSBS, and MCX) and a developmental sequence of intentional communication development based on the literature with typically developing infants (Adamson & Bakeman, 1991). A 1:1 teaching format was used in PMT sessions.

Proto-imperatives (i.e., requests for objects or actions) were targeted first. During PMT sessions, the trainer first attempted to increase the probability of establishing one or more play routines. Play routines were turn-taking sequences around a central theme (e.g., peek-a-boo, ball rolling). Once the child had engaged in at least three turns in a routine, the adult trainer withheld his or her turn. If the child did not respond to the withheld turn by requesting the recurrence of the routine or if the child requested a continuation using a behavior that was less mature than their targeted behavior, the trainer prompted for the missing component behavior (e.g., "Look at me."). The least intrusive prompt method was used and later faded. If the child gave the targeted behavior, the routine was continued and the trainer gave specific verbal acknowledgment of the behavior (e.g., "You looked at me!"). If the child still did not ask that the routine continue, the trainer continued the routine anyway to maintain a positive affective milieu for teaching.

Once proto-imperatives were used more frequently, proto-declaratives were addressed. Proto-declaratives were communication acts that drew the partner's attention to or shared experience or affect about an interesting object. These acts were stimulated by demonstrating proto-declaratives and increasing the children's need to draw the trainers' attention to the children's focus of attention and interest. The latter involved trainers' withdrawing their attention from the children occasionally. This technique was used once the child expected the trainer's continuous attention to child-selected objects of interest. This occurred at least 3 months into the treatment period (see Warren & Yoder, 1998).

### Responsive Small Group (RSG)

The research design required that we construct a contrast group that would not inhibit the children's development, yet would provide sufficiently different experiences

to allow a treatment effect of PMT to become apparent. We selected RSG as a contrasting treatment because responsiveness facilitates the development of intentional communication (Wilcox, 1992). One trainer and three children engaged in parallel play during the RSG sessions. The trainer was instructed to respond to the children's communication, but not to make any communicative or noncommunicative demands. The trainers were also instructed not to imitate the children's motor or nonword vocal behavior because this was used in the PMT method. Thus, we did not compare a full-blown responsiveness treatment with PMT.

### Fidelity of Treatment and Coding for Treatment Description

A supervisor observed one of the trainers per week on a rotating schedule. During months 3, 4, and 5, supervisors videotaped one training session for each trainer-child pair. These sessions were coded in detail. Table 3 includes the categories and definitions along with examples.

### Reliability

Interobserver reliability was assessed every 5th session for a total of at least 20% of the data for each procedure. Test-retest reliability was conducted over a 2-week period for the CDI, the FRS, and the GTAC. Reliability was estimated by generalizability (G) coefficients (Cronbach, Gleser, Norda, & Rajaratnam, 1972). Summary reliability was calculated to correspond to the level of the primary analyses.

The G coefficients for the coded variables during the pre-treatment period ranged from .88 (Highest level of play) to .99 (Total number of communication acts in the MCX). The test-retest G coefficients were .95 for the CDI, .95 for the FRS, and .70 for the GTAC during pre-treatment. The G coefficient for the treatment description variables at individual periods ranged from .64 (percentage of acts followed by linguistic mapping at the 3rd month of treatment) to .99 (number of prompts for communication in the 3rd month of treatment) and averaged .91 ( $SD = .12$ ). The G coefficient for number of intentional communication acts from the ECX, CSBS, and MCX during post-treatment was .99, .93, and .94, respectively. These reliability estimates are unusually high because of careful training, frequent reliability checks, and large between-child variability (Cronbach et al., 1972).

## Results

In this section, we present the results of the analyses of (a) pre-treatment differences between the treatment

**Table 3.** Definitions and examples of treatment description codes.

Variables	Definitions	Examples
Trainer's prompts for child communication	Verbal, gestural, or nonverbal communication that conveys an expectation that the child communicate or use a particular communicative behavior.	<ol style="list-style-type: none"> <li>1. "What do you want?"</li> <li>2. "Look at me."</li> <li>3. Upturned and extended palm.</li> <li>4. Withholding a turn in a routine and looking expectantly at the child.</li> </ol>
Trainer's vocal imitations	Exact, reduced, or expanded imitation of immediately preceding child's vocalization.	<ol style="list-style-type: none"> <li>1. C: "Aba" A: "Aba" 2. C: "Aba" A: "Abada"</li> </ol>
Trainer's compliance with child's act	Complying with the apparent request conveyed by the child's preceding communication act.	<ol style="list-style-type: none"> <li>1. C: Reaches for out-of-reach bubbles A: Gives bubbles to child.</li> <li>2. C: Points in direction of plane noise A: (Looks at plane) and says, "Yeah."</li> </ol>
Trainer's linguistic mapping of the child's act	Saying the noun, main verb, or function word implied in the child's preceding acts.	<ol style="list-style-type: none"> <li>1. C: Reaches for the ball and looks at adult. A: "Ball."</li> <li>2. C: Throws bubbles on floor and looks at adult with frown A: "You're all done with the bubbles."</li> </ol>
Trainer's specific acknowledgment of the child's act	With a display of positive affect, saying what the child did that trainer was targeting.	<ol style="list-style-type: none"> <li>1. C: Looks at adult and reaches. A: "You looked at me!"</li> <li>2. C: "Ah" (reaches for bubbles) A: "I heard you!"</li> </ol>
Trainer's talk to the child	Trainer's verbal prompts, verbal responses, and verbal descriptions of child's and adult's activities.	<ol style="list-style-type: none"> <li>1. "You are playing with the doll!"</li> <li>2. "What do you want?"</li> <li>3. "You looked at me."</li> </ol>

*Note.* See Table 2 for definition of child's communication acts during treatment sessions.

groups, (b) between-group differences in the treatment implementation variables, (c) treatment effects on post-treatment intentional communication, and (d) possible alternative explanations for the results. In all of these analyses, we used a two-tailed .05 alpha level. Where variances were unequal, degrees of freedom were adjusted.

### Pre-Treatment Group Equivalence

As is indicated in Table 1, the children and families in the PMT group were nonsignificantly different from the children and families in the RSG group on all but one of the pre-treatment variables. The PMT mothers tended to interpret a toddler's nonverbal behavior as communicative more often and more confidently (as measured by the GTAC) than did the RSG mothers [ $t(57) = -2.55, p = .05$ ]. Post-treatment intentional communication in the ECX was related to pre-treatment GTAC scores ( $r = .36, p = .006$ ). Therefore, analyses involving the post-treatment intentional communication variable were conducted on the residuals of this variable after

controlling for pre-treatment GTAC scores. The groups were not different from each other in number and percentage of intentional communication acts in the ECX and MCX, the Uzgiris Means-End Scale, the number of maternal responses, maternal mean length of child-directed utterances, and parents' occupational status ( $p > .05$ ).

### Results of Treatment Description Coding

Session attendance was nonsignificantly different between treatments [ $t(57) < 1.0; p > .05$ ]. Table 4 indicates the results of the coding for the monthly taped training session. The PMT trainers used more prompts for communication and more instances of vocal imitation. The PMT children used more communication acts. Therefore, it is not surprising that PMT trainers had more responses to children's communication acts. Additionally, when the children did communicate, PMT trainers were also more likely to respond to children's communication acts with compliance and with specific acknowledgment than were RSG trainers. All of these

**Table 4.** Means and standard deviations of treatment description variables.

Variable	PMT		RSG	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Average number of trainer's prompts for child communication	73*	22	4	3
Average number of trainer's vocal imitations of child's vocalizations	25*	16	.62	.97
Average number of child's communication acts	67*	31	30	20
Average number of child acts trainer complies with	53*	28	19	14
Average percentage of child acts trainer complies with	78*	14	61	16
Average number of child acts trainer linguistically maps	30*	16	12	9
Average percentage of child acts trainer linguistically maps	24	12	32*	08
Average number of child acts trainer specifically acknowledges	6*	5	.29	.47
Average percentage of child acts trainer specifically acknowledges	10*	10	2	5
Average number of trainer utterances	203	61	350*	96

\* $p < .01$ ; if unequal variances, then adjusted degrees of freedom was used.

results reflect the intended differences between the treatments. In contrast, RSG trainers linguistically mapped (i.e., said the message the children were apparently attempting to convey) a greater proportion of the children's acts and talked more often than PMT trainers. The vast majority of the adult utterances described what the child was doing.

### Treatment Effect on Intentional Communication

Before testing the treatment effect on intentional communication, we determined that children used more intentional communication in the post-treatment period (ECX:  $M = 39$ ,  $SD = 24$ ; CSBS:  $M$  rate = 2.2,  $SD = 1.1$ ; MCX:  $M = 29.6$ ,  $SD = 17.7$ ) than in the pre-treatment period (ECX:  $M = 24$ ,  $SD = 15$ ; CSBS:  $M = 1.4$ ,  $SD = .67$ ; MCX:  $M = 18.4$ ,  $SD = 12.9$  [ $F(1, 56) = 16.9, 18.8, 19.2$ , respectively;  $p = .0001$ ). There were no interactions between treatment group and time [ $F(1, 56) < 1.0$ ]. That is, there was no main effect of treatment on intentional communication.

To determine whether the treatment effect varied as a function of pre-treatment maternal responsivity, we conducted a multiple regression analysis. Pre-treatment maternal responsivity was entered first; treatment group was entered second as a dummy coded variable; and the product term for the interaction of pre-treatment responsivity and group was entered last. The intentional communication variable from the ECX, CSBS, and MCX sessions at the post-treatment were the criterion variables in three separate analyses. We computed the confidence intervals around the regression line for the relationship between the amount of difference between the treatments on post-treatment intentional communication and pre-treatment maternal responsivity. The points at which the confidence intervals intersect

the pre-treatment maternal responsivity axis are called the "regions of significance" (Rogossa, 1980) and represent the maternal responsivity variable scores at which the treatments are different (Pedhazur, 1982). Only regions of significance that had more than one child in each group were interpreted (Aiken & West, 1991). Only regressions that met the statistical assumptions of normally distributed residuals, homoscedasticity, and absence of cases with undue influence were reported.

Although  $R^2$  change for the interaction term is the most common measure of effect size for interactions between continuous and categorical variables (Aiken & West, 1991), standardized scores are also provided. To indicate the smallest significant treatment effect, we computed the standard score of the difference in each group's predicted outcome score at the point at which the groups' slopes differed. To indicate the largest significant treatment effect, the same procedure was repeated for the extreme pre-treatment responsivity score. For example, if only the upper region of significance was interpretable, then the highest level of responsivity represented in the sample (i.e., 86%) would replace the "x" in the within-group regression formula for intentional communication regressed onto pre-treatment responsivity. The difference between each group's predicted score was then standardized by dividing by the standard deviation of the intentional communication outcome variable.

There was a nonsignificant interaction between pre-treatment maternal responsivity and treatment group predicting intentional communication in the post-treatment CSBS. However, maternal responsivity did interact with group to predict intentional communication in the ECX and the MCX. These results are presented in Table 5.

The interaction term between pretreatment maternal responsivity and treatment group predicted the

**Table 5.** The interaction between the pre-treatment variables and treatment predicting intentional communication.

Variables	R <sup>2</sup> change	t	p	upper x*	lower x*
<b>Maternal responsive interaction x treatment</b>					
Number of intentional communication in post-tx ECX	.12	2.82	.007	57%	NA
Number of intentional communication in post-tx MCX	.08	2.15	.04	70%	39%
<b>Maternal education level x treatment</b>					
Number of intentional communication in post-tx MCX	.07	2.07	.04	3–4 yrs college	NA

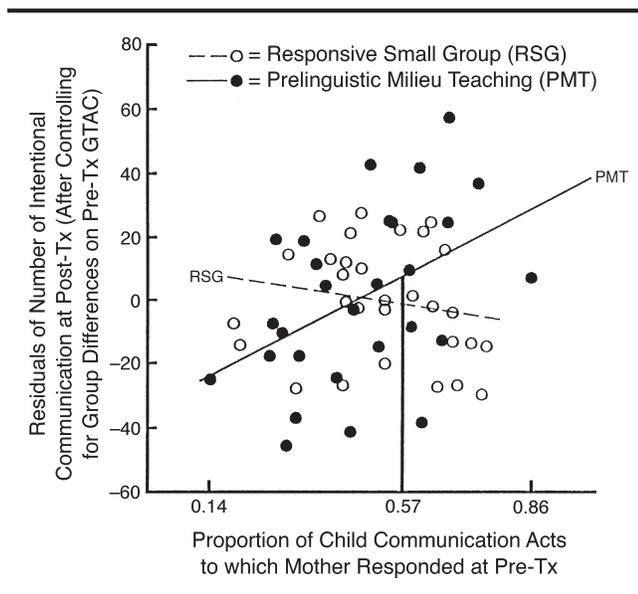
\*The margins of the regions of significance. NA = not interpretable.

number of intentional communication acts in the post-treatment ECX. Only the upper region of significance had more than one child in both groups. The upper region of significance included 9 children in the PMT group (32% of the sample) and 13 children in the RSG group (43% of the sample). The PMT group had significantly more intentional communication than the RSG group in children with highly responsive mothers. The standardized between-treatment difference in predicted intentional communication scores for the children of mothers with 57% and 86% (the maximum in the sample) pre-treatment responsivity was .5 and 1.29, respectively. Figure 1 illustrates the interaction.

The interaction between pretreatment maternal responsivity and treatment group also predicted number of intentional communication acts in the MCX (see Table 5). Both upper and lower regions of significance

had more than one child in both groups. The upper region of significance included 2 children in the PMT group and 3 children in the RSG group. The PMT group had significantly more intentional communication than the RSG group in children with highly responsive mothers. The standardized between-treatment difference in predicted intentional communication was .55 and 1.06 for children of mothers with 70% and 86% (the maximum) pre-treatment responsivity, respectively. The lower region of significance included 8 children in the PMT group and 5 children in the RSG group. In families with relatively unresponsive mothers, children in the RSG group used more intentional communication with their mothers than did children in the PMT group. The standardized between-treatment difference in predicted intentional communication was .55 and 1.39 for children with mothers of 39% and 14% (the minimum) pre-treatment responsivity, respectively.

**Figure 1.** The statistical interaction between treatment group and pre-treatment maternal responsivity predicting post-treatment generalized intentional communication



### Testing Alternative Explanations to the Interactions

We tested whether there were any pre-treatment child variables that could explain the interaction between maternal responsivity and group predicting later intentional communication. The child communication variables, intentional communication variables, mental age, highest level of play, comprehension level, and means-end stage did not covary with pre-treatment maternal responsivity. Therefore, they could not account for the interaction between maternal responsivity and group predicting later intentional communication.

We also tested whether any other maternal or family variable could account for the interaction between group and pre-treatment maternal responsivity. Although race [ $t(57) = 2.65, p = .01$ ], FRS scores ( $r = .32, p = .01$ ), occupational status ( $r = .37, p = .004$ ), and maternal education ( $r = .36, p = .005$ ) covaried with pre-treatment maternal responsivity, only maternal education interacted with group to predict later intentional communication.

As indicated in Table 5, the treatment effect on post-treatment intentional communication to the mother (i.e., MCX session) varied as a function of maternal responsiveness. Only the upper region of significance had more than one subject per group. For children with highly educated mothers, intentional communication to the mother was higher for PMT children than for RSG children. The standardized between-treatment difference in predicted intentional communication scores was .61 and 1.33 for children with mothers with 3 years of college and postgraduate school educations (the maximum in the sample), respectively.

## Discussion

The current study demonstrated that staff-implemented prelinguistic communication intervention facilitated the intentional communication of children with disabilities. These findings represent a strong test of generalization of intentional communication from training sessions and trainer to less structured interactions with the children's mothers and a staff member who was not the children's trainer. The relative effectiveness of the interventions given varied by pre-treatment maternal responsiveness. If mothers were relatively responsive before treatment, PMT was superior. If mothers were relatively unresponsive before treatment, RSG was superior. However, the evidence supporting an RSG effect on intentional communication is relatively weak. There was sufficient data to interpret the region of significance in which RSG was superior only for the interaction between pre-treatment maternal responsiveness and group predicting intentional communication to the mothers. This interaction became nonsignificant when an interaction between maternal education and group was statistically controlled. The interaction between maternal education and group predicting intentional communication to the mother was interpretable only for the region of significance in which PMT was superior. No other measured pre-treatment variables could account for the interaction between pre-treatment responsiveness and group predicting intentional communication in the ECX.

Several possible alternative explanations for the results can be eliminated. Among the possible alternative explanations are (a) an unintended cultural bias in the assessment procedures and coding systems, (b) below normal hearing status of a subset of the children, (c) differential attendance at treatment, (d) differential parental expectations, (e) one of the treatment's inhibiting development. These explanations are improbable for five reasons. First, treatment groups were equivalent on all but one pre-treatment variable, including measures of socioeconomic level (which often covaries with cultural background), attendance at sessions, and

hearing status. There were exactly three children with below-average hearing in each treatment group. Second, our measures of socioeconomic level (except maternal education level) did not interact with treatment group assignment. Third, hearing status did not covary with maternal responsiveness or maternal educational level. Fourth, the use of two potentially effective treatments and keeping the parents naïve to treatment methods and hypotheses greatly reduces the probability that one group of parents expected better progress than the other group. Finally, it is unlikely that either treatment inhibited development because the trainers in both interventions used several techniques that past research suggests are facilitative of communication development (see Yoder et al., 1998; Warren & Yoder, 1998). None are considered to inhibit development.

Maternal interaction style may influence which treatments are most beneficial because children may develop different expectations concerning interactions with adults (including trainers) through their interactions with their mothers. The following explanation contains several hypotheses for future study. For example, children of responsive parents may learn to expect adults to respond to their communication attempts. Such expectations may help children to persist in their communication attempts longer than those who do not expect persistence to "pay off." PMT prompts are used immediately after children's immature attempts to communicate, so gratification in the form of adult compliance with the children's requests is delayed a few seconds. Over time, the information children learn from the PMT prompts may be incorporated into their self-initiated communicative attempts. This improved communicative signal may result in more interpretable and more salient communicative acts, which in turn may result in more highly responsive communicative partners. Highly interpretable, salient, self-initiated communicative acts may be optimal opportunities for communication-facilitating responses (Yoder & Warren, 1993). PMT prompts to communicate may facilitate communication best only if the children persist in their efforts to communicate. If the child changes focus of attention or becomes unengaged when faced with a prompt to communicate in a more mature way, the child will not benefit from the information embedded in the adult prompt and specific acknowledgements that may facilitate the child's use of more mature communicative behaviors. Prompts and specific acknowledgements were not used in RSG.

Unresponsive mothers are likely to be either infrequent and/or directive interactants when interacting with their children. By *directive*, we mean a high proportion of the mother's interactions with her child involve telling the child what to do. Children of infrequent interactants may expect to be left alone when adults are near. When faced with an adult who is undemanding,

spatially close, attentive, and responsive (i.e., RSG staff), children of infrequent interactants may become actively engaged in interaction. In contrast, when faced with an adult who makes many demands on them in the form of communication prompts (i.e., PMT staff), such children may withdraw or actively resist demands. Children of directive mothers may expect adult interactors to tell them how to behave, even in nonthreatening play situations. When faced with adults who give a lot of prompts (i.e., PMT staff), these children may become passive communicators. Children may process the input from compliance or linguistic mapping of prompted child communication less effectively than that from responses to self-initiated communication. When faced with adults who do not give prompts, but are responsive (i.e., RSG staff), children of directive mothers may use unusually high rates of self-initiated, clear communication. Such communication may result in more easily processed adult responses, thereby increasing the efficacy of adult responses in facilitating future communication. Future research is needed to test these hypotheses concerning how children of mothers with different interaction styles behave during RSG and PMT.

The interactions between treatment group and pre-treatment maternal responsivity accounted for 7–12% of the variance in intentional communication at the post-treatment period. For those more familiar with standardized differences between groups, the smallest significant group difference was between .5 to .55 of a *SD*. Cohen (1977) considered this effect size as “moderate” effect sizes in the behavioral sciences. This effect size is difficult to compare with those in other studies because no other published group design study has investigated the efficacy of prelinguistic communication on generalized intentional communication in children with disabilities.

Although we controlled for many possible threats to internal validity (including the Hawthorne effect), we did not test the extent to which either treatment *can* be effective. In the effort to conduct a highly controlled experiment, we implemented a very limited version of the treatments. We administered PMT and RSG only 20 minutes a day 4 days a week for 6 months. Parents and teachers were purposefully kept naive about the treatment methods and hypotheses. The literature review by Stokes and Baer (1977) found that using many trainers in many contexts is more effective in facilitating generalized outcomes than using only one or two people in a controlled context. As mentioned earlier, RSG does not represent a full-scale responsivity treatment model. For example, adult imitation of child behavior was not allowed in RSG but is encouraged in typical responsivity models (e.g., Wilcox, 1992). Additionally, the current study compared two treatments, each using techniques that have long been thought to facilitate communication development (Wilcox, 1992; Warren & Yoder, 1998).

As argued earlier, it is probable that each treatment affected the communication development of at least some of the children, thus reducing the amount of apparent treatment effect assigned to the superior treatment. In summary, the current study probably represents a conservative estimate of the effect of either treatment on intentional communication in children with disabilities.

The primary findings showed that treatment effects varied as a function of maternal responsivity. We were able to rule out several child and family variables as possible explanations for the interaction between maternal responsivity and treatment group. Only maternal education could account for the finding that children of highly responsive mothers used more intentional communication with the mother if assigned to the PMT group than if assigned to the RSG group. It is probable that maternal education is a covariate of some aspect of mothers’ beliefs about their proper role in child rearing or appropriate parent-child interaction style. Others have found that maternal education is the aspect of socioeconomic status (SES) that is most highly correlated with parenting variables (Alwin, 1984; Richman, Miller, & LeVine, 1992; Wright & Wright, 1976). Presumably, maternal education influences expectations of their children and parental values, which in turn affect how they interact with their children (Hoff-Ginsberg & Tardif, 1995). For example, Ninio (1988) found that adults with university educations tended to expect infants to achieve various milestones at an earlier age than did adults with high school educations or less. Many studies have reported that high-SES parents tend to want their children to be self-directed, whereas lower SES parents tend to think it more important to conform (Alwin, 1984; Kohn, 1979; Luster, Rhodes, & Hass, 1989; Pearlin & Kohn, 1966; Wright & Wright, 1976). In terms of mother-child interaction, there is replicated evidence that lower SES parents tend to be more controlling and disapproving of their children than higher SES parents (Hoff-Ginsberg & Tardif, 1995). In contrast, higher SES parents tend to talk more, provide more object labels, sustain conversational topics longer, and respond contingently to children’s speech than do lower SES parents (Hoff-Ginsberg & Tardif, 1995). Despite our failure to find alternative explanations for the identified statistical interactions, it is possible that the variable that caused the individual differences in response to treatments was a covarying variable with maternal responsivity or maternal education.

Parents may be able to enhance the benefits their children gain from school- or clinic-based communication intervention by responding to their children’s nonverbal communication. Maternal compliance may reinforce children’s communicative attempts, increasing the probability of future attempts (Harding, 1983). Asking for clarification of unclear communication acts may help

the child direct his or her acts to the message recipient or to the object being communicated about, thereby making the communication act intentional (Golinkoff, 1986).

Parent responsivity training may be an important adjunct to PMT in facilitating the intentional communication of children with relatively unresponsive primary parents. The value of parent responsivity training may depend on whether responsiveness to nonverbal communication is consistent with the parents' beliefs (Yoder, Warren, McCathren, & Leew, 1998) and the degree to which parents are willing and able to learn such techniques (Turnbull & Turnbull, 1997). For example, if parents view responsivity to children's communication as possibly "spoiling" the child, they may find such an approach undesirable. Future research is needed to determine whether teaching mothers to be responsive will enhance the efficacy of PMT and for whom such training is most effective.

In summary, the present study provides strong evidence that PMT facilitates intentional communication in children whose parents are relatively responsive. More limited and more ambiguous evidence was found that children of low-responsive mothers used more intentional communication if they experienced RSG than if they experienced PMT. Future research is needed to help interpret this latter finding. Future research is also needed to determine whether and for whom parent responsivity training is a helpful adjunct to PMT in helping children with disabilities make the transition from preintentional to intentional communication.

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