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## ***Facilitating Self-Initiated Proto-Declaratives and Proto-Imperatives in Prelinguistic Children with Developmental Disabilities***

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**PAUL J. YODER & STEVEN F. WARREN**  
*Vanderbilt University*

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*This study tested the effects of 2 prelinguistic communication interventions on generalized use of communication for two major pragmatic functions: proto-imperatives and proto-declaratives. Outcomes were measured immediately following intervention, and 6 months later. Fifty-eight children with developmental disabilities in the prelinguistic communication period of development were assigned randomly to either a treatment or contrast intervention. In families with high responsivity to children's communication acts at the pre-treatment period, the prelinguistic milieu teaching (PMT) treatment facilitated post treatment increases in generalized use of self-initiated proto-imperatives and self-initiated proto-declaratives. In families with low responsivity to children's communication acts, the responsive small group (RSG) comparison intervention facilitated post treatment increases in generalized use of self-initiated proto-imperatives. Weaker evidence at the 6-month follow-up suggests some effects of RSG on self-initiated proto-declaratives.*

Past research has found that behavioral interventions can increase the use of prelinguistic intentional communication in children with disabilities (Yoder & Warren, 1998a). Children with disabilities who use relatively frequent intentional communication develop language abilities earlier than their peers with less frequent intentional communication (Mundy, Kasari, Sigman, & Ruskin, 1995; Smith & von Tetzchner, 1986; Yoder & Warren, 1999a).

Although knowing that we can facilitate intentional prelinguistic communication is encouraging, doing so may or may not facilitate later language development. Our confidence that facilitating intentional communication might facilitate later language would increase, if we knew which pragmatic functions were being facilitated, and whether the effect maintained over time. For example, some readers might reasonably argue that the aforementioned treatment effects actually occurred primarily on prelinguistic communication for

only one pragmatic function: proto-imperatives (i.e., requests for objects and actions; Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979). If only proto-imperatives are affected, then the probability that facilitating prelinguistic communication will affect later vocabulary is reduced because the other frequently occurring pragmatic function during the prelinguistic period, proto-declaratives, may have special significance (discussed later) in laying the groundwork for later language development (McCathren, Yoder, & Warren, 1999; Mundy, 1995). Proto-declaratives are child communication that direct the adult's attention to an object or event, or share affect or an experience of an object or event with a partner (Bates et al., 1979). Washout of initial effects is a frequent outcome of early intervention (Farran, 1990). Therefore, it cannot be assumed that children will maintain the initial advantage intervention first provides. If the effects of the aforementioned prelinguistic communication interventions did not maintain

over time, then it may be less likely that the aforementioned prelinguistic communication interventions will have an eventual effect on language development.

The present study is a re-analysis and extension of Yoder and Warren (1998a) in which only post-treatment period results were presented and the pragmatic functions of the children's communication acts were not differentiated. The goal of this re-analysis was to determine (a) whether the treatment effects previously seen on intentional communication involved both major pragmatic functions during the prelinguistic period (proto-imperatives and proto-declaratives) and (b) whether these treatment effects maintain several months after the end of treatment.

Past analyses in Yoder and Warren's program of research have demonstrated the following: (a) Prelinguistic communication intervention can facilitate the use of prelinguistic intentional communication; (b) the specific treatment method considered most beneficial varies as a function of pre-treatment levels of maternal responsivity to children's communication; (c) if parents use above-average responsivity before the treatment phase begins, staff-implemented prelinguistic milieu teaching (PMT) is superior to a contrast treatment, responsive small group (RSG), in facilitating children's communication; (d) if parents are relatively unresponsive to children's communication before the treatment begins, staff-implemented RSG is superior to PMT in facilitating children's communication. Mothers' interaction style may influence which treatments are most beneficial. Young children may develop generalized expectations concerning interactions with adults (including trainers) through their interactions with their mothers. To read more about the possible explanations for why treatment effects varied by pretreatment maternal responsivity, the reader is referred to Yoder and Warren (1998a). These past analyses provide the context for the present analyses, the purpose of which is to determine the effects of PMT and RSG on the two major pragmatic functions observed during the prelinguistic period.

The most frequently observed pragmatic

functions during the prelinguistic stage are proto-imperatives and proto-declaratives (Wetherby, Cain, Yonclas, & Walker, 1988). Nine- to 12-month old children with disabilities have fewer proto-imperatives and proto-declaratives than typically developing children of the same age (Mundy, Sigman, Kasari, & Yirmiya, 1988). Additionally, at least some children with disabilities are known to have less frequent proto-imperatives (e.g., Down syndrome; Mundy et al., 1988; Smith & von Tetzchner, 1986) and proto-declaratives (e.g., autism; Mundy, Sigman, Ungerer, & Sherman, 1986) than mental-age-matched children without disabilities.

Given the nature of the PMT and RSG intervention methods, one might reasonably hypothesize that only proto-imperatives are being facilitated. For example, interrupting play routines, using time delays, and making environmental arrangement are all designed to elicit proto-imperatives. Compliance with children's communication may be effective primarily with facilitating the use of children's proto-imperatives because compliance rewards communication acts and the resulting communicative function with a functionally related and perceptually salient consequence. In fact, there is replicated evidence that PMT facilitates proto-imperatives in children with developmental disabilities (Warren, Yoder, Gazdag, Kim, & Jones, 1993; Yoder, Warren, Kim, & Gazdag, 1994).

Knowing whether intervention can affect proto-declaratives might be particularly important because proto-declaratives predict and may aid language acquisition (McCathren et al., 1999). Proto-declaratives may signal the child's desire for linguistic input (Locke, Young, Service, & Chandler, 1990). They may tend to elicit linguistic input from adults (Franco, Fabia, & Butterworth, 1996; Kessler-Shaw, 1992). Furthermore, children who use many proto-declaratives may be particularly interested in sharing their experience with adults (Mundy, 1995), which may be a primary reason children learn to talk (Bloom, 1993). Empirically, proto-declaratives have been found to predict expressive vocabulary in children with developmental disabilities as

prelinguistic stage are and proto-declaratives (McCathren, & Walker, 1988). Young children with disabilities use proto-imperatives and proto-declaratives (Mundy, Sigman, Kasari, & Kasari, 1993). Additionally, at least some children with disabilities are known to have used proto-imperatives (e.g., Downes et al., 1988; Smith & von Klee, 1991) and proto-declaratives (e.g., Kasari, Kover, Ungerer, & Sherman, 1993) before matched children with-

outcomes of the PMT and RSG interventions. One might reasonably hypothesize that children who use proto-imperatives are better able to understand the meaning of these behaviors. For example, interrupting play activities, making eye contact, and making vocalizations are all designed to draw attention to the speaker. Compliance with these behaviors may be effective because children learn to use them because compliance results in positive social interactions and the resulting attention with a functionally significant consequence. There is also indirect evidence that PMT interventions for children with disabilities (Warren, Yoder, & Kasari, 1993; Yoder, Warren, & Kasari, 1994).

Interventions that can affect the use of proto-imperatives might be particularly important for children who use proto-declaratives predict and acquisition (McCathren et al., 1988). Proto-declaratives may signal the linguistic input (Locke, & Kasari, 1990). They may also signal linguistic input from adults (Kasari, 1996; Kessler, 1996). Furthermore, children who use proto-imperatives may be particularly good at learning from their experience with these behaviors (Bloom, 1985), which may be a primary way children learn to talk. Children who use proto-declaratives have better expressive vocabulary than children with developmental disabilities as

much as 1-year following treatment, even when proto-imperatives were statistically controlled (McCathren et al., 1999).

There are at least three reasons why RSG and PMT may affect proto-declaratives, as well as proto-imperatives. First, several researchers have hypothesized that children with disabilities use emerging communication behaviors first in the context of proto-imperatives, and later these behaviors are generalized to proto-declaratives (e.g., Klinger & Dawson, 1992; Stone, Ousley, Yoder, Hogan, & Hepburn, 1997). This may be particularly true for children who use communication behaviors frequently used to convey proto-declaratives which also can be used to request the maintenance of play routines (e.g., vocalizations, gaze to adult's face coordinated with attention to object of interest). Second, particularly in the context of play routines, using communication behaviors for proto-imperative purposes frequently results in the pairing of functional rewards (e.g., the continuation of the routine) and social rewards (e.g., adult's laugh and attention). Such pairing may increase the probability that social consequences will become more reinforcing (see Bijou & Baer, 1965; Halle, Reichle, Drasgow, & Reinhoehl, 1995). Because the natural consequences of proto-declaratives are social (e.g., laughs, attention), as social consequences become more reinforcing, proto-declaratives may become more frequent.

We know of only two studies using an AB design (each with 1 participant) in which implementing an intervention was associated with changes in proto-declaratives. Klinger and Dawson (1992) found that imitating the play of a child with autism was associated with increases in generalized proto-declaratives. Warren and Yoder et al. (1993) found that a child with developmental delay without autism increased the number of proto-declaratives used during PMT intervention sessions when compared to baseline levels. A group experimental design would increase the confidence with which we can infer that the treatments facilitated proto-declaratives because the effect on generalized proto-declaratives may be delayed many months after the onset

of the treatment phase. The Yoder (1998a) experiment is such a study.

Given Yoder and Warren's (1993) results, we expected the effect size for proto-imperatives and proto-declaratives to be specific, more beneficial treatment for children with pre-treatment maternal responsiveness. In statistical terms, we predicted a significant interaction between pre-treatment maternal responsiveness and treatment predicting proto-imperatives and proto-declaratives. Specifically, we expected PMT to facilitate proto-imperatives and proto-declaratives at the post-treatment and 6-month follow-up periods in children of mothers who were relatively responsive to their children's communication. In contrast, we expected PMT to facilitate proto-imperatives and proto-declaratives at the post-treatment and 6-month follow-up periods in children who were relatively unresponsive before treatment began.

## METHOD

### Participants

Children were recruited through intervention programs for children with developmental disabilities. The ages of participants ranged from 17 months to 36 months. None of the children used more than 2 words in their classrooms, according to reports from their parents. During three communication sessions (i.e., a total of at least 45 minutes of communication), only six children used more than 2 words. Two children used 2 words and four used only 1 word. The remaining children used no words in the communication sessions. Therefore, this sample of children was considered "prelinguistic." All children were below the 10th percentile on the expressive vocabulary of the Communication Development Inventory, a frequently used vocabulary measure (Fenson et al., 1991).

The hypotheses were tested on children with disabilities and their primary caregivers. Table 1 presents descriptive statistics for the predictor variables, pre-treatment maternal responsiveness, and the outcome variables, and other child and parental variables. Nin-

**Table 1.***Means and Standard Deviations on Selected Pre-treatment Variables Within the Treatment Groups*

Variables	PMT <sup>a</sup> ( <i>n</i> = 28)		RSG <sup>a</sup> ( <i>n</i> = 30)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Children's Variables				
Chronological age in mos.	22	4	23	4
Mental age in mos. <sup>b</sup>	15	2	15	2
Mental Development Index (MDI) <sup>b</sup>	55	13	53	12
Parental report of words understood <sup>c</sup>	127	101	113	90
Number of self-initiated proto-imperatives <sup>d*</sup>	17	11	11	10
Proportion of acts that are self-initiated Proto-imperatives <sup>d*</sup>	.62	.22	.41	.28
Number of self-initiated proto-declaratives <sup>d</sup>	10	10.5	12	10.5
Proportion of acts that are self-initiating proto-declaratives <sup>d*</sup>	.30	.22	.47	.29
Family Variables				
Parental tendency to interpret nonverbal behavior <sup>e*</sup>	100	8	93	15
Proportion of acts to which mothers responded <sup>f</sup>	.48	.17	.53	.15

<sup>a</sup>PMT = Prelinguistic Milieu Teaching; RSG = Responsive Small Group. <sup>b</sup>Bayley Infant Scales of Development, 2nd Ed.; <sup>c</sup>Communication Development Inventory/Infant scale; <sup>d</sup>Experimenter-child interaction session, <sup>e</sup>General Tendency to Attribute Communication, <sup>f</sup>Mother-child interaction session.

\**p* < .05.

(i.e., 52) of the caretakers were the children's mothers; the rest were fathers (4) and grandmothers (2). The children's cognitive scores were estimated using the Bayley Scales of Infant Development, 2nd ed. (Bayley, 1993). Mental development indices were derived using extrapolated norms similar to those Naglieri (1981) derived for the 1969 version of the Bayley (McCathren & Yoder, 1994). Using the Uzgiris-Hunt Means-End Scale (Uzgiris & Hunt, 1975), 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 males.

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

were diagnosed as having "pervasive developmental delay," one had macrocephaly, and one had microcephaly. One had Duane's syndrome, one had neonatal meningitis, one had fetal alcohol syndrome, and one had tuberous sclerosis. 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 (three from each treatment group) scored between 26 and 50 dB at one or more of the three frequencies. Hearing level did not covary with treatment group, proposed outcomes, or proposed predictor of treatment effects (i.e., maternal responsivity).

At the beginning of the study, parents completed a demographic questionnaire about



their employment and education level. From the parents' responses, staff members identified the parents' occupational title and occupational status (Stevens & Cho, 1985; International Standard Classification of Occupations, 1986). The occupational status of U.S. population averages 34.5 (SD = 18; Stevens & Cho). The median occupational status of our sample was 23 (SD = 22) and the distribution was positively skewed (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. Parents also completed a questionnaire to measure the degree to which they perceived family resources to be adequate (i.e. the Family Resource Scale). On this measure, groups were comparable before treatments began ( $p > .25$ ).

The formal education of the mothers averaged high school graduation and ranged from one year of school to post-graduate school training. 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 three years of graduate school or post-graduate training. Thirty-five percent (20) of the parents were African American, 3% were Asian. This racial composition and level of formal education is not representative of the 1980 U.S. census data (Zill & Schoenborn, 1990), but was equally distributed across the two treatment groups ( $p > .25$ ).

### **Design**

Treatment effects were evaluated through a randomized group experiment. Children were randomly assigned using a computer program to one of two groups. Each group received one of two educational treatments. We elected to use a contrast treatment group, instead of a no-treatment control group, because we wanted to control for the "Hawthorne effect," differential attrition, and amount of attention

from a responsive adult. 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).* At the pre-treatment, post-treatment, and 6-month follow-up periods, the Communication Temptations and Book Sharing sections of the CSBS (Wetherby & Prizant, 1993) were administered to derive estimates of child communication rate. An experienced examiner who was not the child's trainer during the intervention conducted these assessments. The Communication Temptations and Sharing Books are procedures designed to entice a variety of child-initiated communicative acts in different contexts that vary in the degree of structure provided by the examiner. Communication Temptations consist of structured communication-eliciting situations. Sharing Books provides a less structured sampling context.

*Experimenter-child interaction session (ECX).* At the pre-treatment, post-treatment, and follow-up 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. ECX sessions lasted 15 minutes. Toys in this session were a baby doll, two baby bottles, baby spoon, doll hairbrush, rattle, blanket, teapot with 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 also was instructed to avoid directives for action or communication and to avoid modeling levels of play higher than the child used during the session.

*Mother-child interaction session (MCX).* At the pre-treatment period, mothers were asked to play with their children for a total of

15 minutes (three 5-minute segments). 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.* At 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; Leet & Dunst, 1988).* The FRS is a questionnaire in which mothers rate the adequacy of their time, money, and energy to meet 30 different needs. At the pre-treatment period, all mothers completed the FRS. 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).* At 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 trained to at least 85% summary-level reliability before coding data to be analyzed.

The CSBS was coded to describe children's communication before the treatment. Prior research found that the treatments did not have an effect on estimates of child communication from the CSBS (Yoder & Warren, 1998a), but estimates from the CSBS were used to compare groups before the treatment phase. The descriptive variables derived from the CSBS were the rate of communication, rate of proto-imperatives, and rate of proto-declaratives. Definitions and examples are in Table 2.

The ECX sessions at all three measurement periods also were coded for communication acts and then categorized into proto-imperatives, proto-declaratives, and others. Our dependent variables were derived from this measurement context. In addition to pragmatic distinctions, we distinguished communication acts into self-initiated and prompted acts. By "self-initiated" communication acts, we mean communication acts that do not occur immediately after an adult's prompt for such acts. Prompted acts were those that occurred immediately after and were conceptually related to the meaning of an adult question or outstretched palm. We were particularly interested in *self-initiated* proto-imperatives and proto-declaratives because the pragmatic function of these acts is less ambiguous than prompted acts. For example, one can reasonably argue that instances in which the child hands a jar to an adult in response to the adult's upturned and extended palm represents compliance or evidence of receptive communication, not proto-imperative behavior (McCathren et al., 1999). Because two children at the 6-month follow-up had ECX sessions that lasted 11 and

**Table 2.****Definitions, and Examples of Communication and Responsivity Variables**

Variables and Definitions	Examples
<b>Child's Communication</b>	
Gesture & vocalization, vocalization & attention to the adult, or symbol & attention to the adult or symbol with attention to the adult. The list of gestures used is indicated in the CSBS scoring manual.	<ol style="list-style-type: none"> <li>1. Handing object to adult.</li> <li>2. Point to object and looking at adult.</li> <li>3. Saying "uhoh" and looking at adult.</li> </ol>
<b>Child's Proto-imperatives</b>	
Communication acts for the purposes of requesting an object, action, or event.	<ol style="list-style-type: none"> <li>1. Reach to object and vocalization</li> <li>2. Peek-a-boo routine interrupted and child vocalizes to adult and points to blanket while smiling.</li> <li>3. Child reaches up to the adult to be picked up.</li> </ol>
<b>Child Proto-declaratives</b>	
Child communication act that requests adult to attend to an object or event or attempts to share affect or experience about an object or event without trying to get the adult to do anything.	<ol style="list-style-type: none"> <li>1. Child points in the direction of a noise in the hall. After adult acknowledges the noise, child goes back to playing.</li> <li>2. Adult hands 5 blocks to child who is putting blocks in a box. Adult hands a Snoopy dog to the child. Child shows Snoopy dog to adult and vocalizes and smiles.</li> </ol>
<b>Maternal Response</b>	
Complying with the presumed meaning of the immediately prior child's 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> </ol>
Imitating some component of the immediately prior child's 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>
Attempt to clarify the meaning of the preceding utterance.	<ol style="list-style-type: none"> <li>1. Child reaches for ball, then stops and vocalizes. Adult asks, "Do you want the ball?"</li> </ol>
Utterance that includes a verb, noun, or function word implicit in the immediately preceding child act.	<ol style="list-style-type: none"> <li>1. Child points to a toy bird. Mother says "That's a bird!"</li> </ol>

14.25 minutes instead of the usual 15 minutes, the 6-month follow-up variables were divided by the duration of the session to yield rate variables.

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 mother responded as our measure of maternal responsivity. We expected this variable to interact statistically with treatment group to predict the outcomes. We used a proportion variable at the pre-treatment period because we wanted

an index that was not dependent on the number of times the child communicated with the mother.

**Treatments**

The assigned treatment sessions were made available to the children four times a week for 6 months. Each session lasted 20 minutes. If a child was absent from a session, no make-up session was provided. Children in both groups attended early intervention centers in addition to the treatments that we provided. Random assignment to treatments was successful in equally distributing children in each

treatment group across the early intervention classrooms. Therefore, any effect the early intervention classes may have had on the outcomes of this study would not explain group differences or interactions with group that predict the outcomes.

*Prelinguistic milieu teaching (PMT).* PMT was specifically designed to facilitate prelinguistic communication in children with mental retardation (Warren et al., 1993; Warren & Yoder, 1998; Yoder et al., 1994; Yoder & Warren, 1993). A primary trainer worked with the child 3 days a week, while a secondary trainer worked with the child 1 day a week. Specific behavioral targets were selected for each child based on his or her current performance in the three communication samples (i.e., CSBS, ECX, 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.

During PMT sessions, the trainer first attempted to increase the probability of establishing one or more play routines. Play routines were defined as turn-taking sequences around a central theme (e.g., peek-a-boo, ball rolling). Communication prompts for proto-imperatives were used when a child was involved in a routine, or was highly motivated to communicate. The least intrusive, but effective, prompt method was used and later faded. Once proto-imperatives were used more frequently, PMT teachers attempted to stimulate proto-declaratives through modeling. More description on PMT can be found in Warren and Yoder (1998) or Yoder and Warren (1999b).

*Responsive small group (RSG).* The research design required that we construct a contrast group that would not inhibit the children's development. We selected a responsive small group to accomplish this goal because there is evidence that responsivity may facilitate, certainly not inhibit, development of prelinguistic communication skills (Wilcox, 1992). One trainer and three children engaged in parallel play during the RSG sessions. The trainer was instructed to respond to the chil-

dren's communication but not to make any demands on them (i.e., either communicative or otherwise). The trainers were also instructed not to imitate the children's motor or nonword vocal behavior, as this was a primary method of building routines used in the PMT method. We do not claim to be comparing a complete version of a responsivity treatment with PMT because in many responsivity treatments, imitations are encouraged and some types of questions (e.g., those to which the adult does not know the answer) are allowed (MacDonald, 1989; Wilcox, 1992).

### *Fidelity of Treatment and Coding for Treatment Description*

Once a week, on a rotating basis, a supervisor observed each trainer to provide assistance in implementing the training model. During months 3, 4, and 5, supervisors videotaped one training session for each trainer-child pair. Videotaped sessions were coded in detail to describe how the sessions differed between treatment groups. Shown in Table 3 are categories that were coded, their definitions and examples.

### *Reliability*

Reliability checks were conducted on every 5th coded session for a total of at least 20% of the data. Interobserver agreement was estimated for the coded variables. Test-retest reliability was estimated for the variables derived from parent reports. Reliability was estimated by generalizability (g) coefficients (Cronbach, Glaser, Norda, & Rajaratnam, 1972). The g coefficient was used to quantify the extent to which these observations were reliable across observers or time because they reflect the between-subject variability, as well as the between-coder or between-time variability across subjects. An index of reliability that includes information about both of these sources of variability informs the investigator whether the observed amount of between-coder or between-test-periods disagreement will obscure individual differences between subjects (Cronbach et al.). Conceptually, a g coefficient is the proportion of variance in scores due to subjects divided by the total variance

**Table 3.**  
*Definitions and Examples of Treatment Description Variables*

Variable	Definition	Examples
Trainer's prompts for child proto-imperatives	Verbal, gestural, or nonverbal communication conveying an expectation the child communicate or use a particular communicative behavior for a proto-imperative function.	1. "What do you want?" 2. "Look at me." 3. Upturned and extended palm. 4. Withholding a turn in a routine and looking expectantly at the child.
Trainer's vocal imitations	Exact, reduced, or expanded imitation of immediately preceding child's vocalization	1. C: "Aba"; A: "Aba" 2. C: "Aba"; A: "Abada".
Trainer's specific acknowledgment of the child's act	With a display of positive affect, saying what the child did that the trainer was targeting.	1. C: Looks at adult and reaches. A: "You looked at me!"
Trainer's compliance with child's communication act*	Complying with the apparent request conveyed by the preceding child's communication act.	1. C: Reaches for out-of-reach bubbles. A: Gives bubbles to child. 2. C: Points in direction of plane noise. A: (Look at plane) and says, "Yeah."
Trainer's linguistic mapping of the child's act	Saying the noun, main verb, or function word implied in the preceding child's acts.	1. C: Reaches for the ball and looks at adult. A: "Ball".
Trainer's talk to the child	Trainer says verbal utterance to the child. These include verbal prompts, verbal responses, and verbal descriptions of child's and adult's activities. (Not mutually exclusive with aforementioned prompts and responses)	1. "You are playing with the doll!" 2. "What do you want?" 3. "You looked at me."

**Child Communication\***

\*Child communication defined in Table 2.

in scores, which is composed of between-coder, between-subject variance, and other sources of error (Cronbach et al.). These were one-facet G studies with observer or time as the facet that was fully crossed with 20% of the participants.

The test-retest *g* coefficients were .95, .95, and .70 for the comprehension scale of the CDI, the FRS, and the GTAC, respectively. 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 proto-imperatives in the 3rd month of treatment) and averaged .91 (SD = .12). Table 4 contains the *g* coefficients

for the coded variables analyzed to test the hypotheses.

**RESULTS**

In this section, we present the results of the analyses for (a) pre-treatment group differences, (b) differences in what the children experienced during the treatment sessions, (c) growth in use of self-initiated proto-imperatives and self-initiated proto-declaratives, and (d) the expected statistical interactions between pre-treatment responsiveness and treatment group when predicting the outcomes. The last set of analyses provides a test of treatment effects on post-treatment and 6-

**Table 4.**  
*g-Coefficients for Variables Used in the Primary Analyses*

Variable label	Measurement Period	Procedure <sup>a</sup>	g
Responsive interaction style	Pre-treatment	MCX	.85
Number of self-initiated proto-imperatives	Pre-treatment	ECX	.97
	Post-treatment	ECX	.99
	6-mo. Follow-up	ECX	.94
Number of self-initiated proto-declaratives	Pre-treatment	ECX	.98
	Post-treatment	ECX	.97
	6-mo. Follow-up	ECX	.95

<sup>a</sup>MCX = Mother-child interaction session; ECX = Experimenter-child interaction session.

month follow-up proto-imperatives and proto-declaratives within the predicted subsamples defined by maternal responsivity. In all of these analyses, we used a two-tailed .05 alpha level.

#### ***Pre-Treatment Group Equivalence***

The children and families in the PMT group were not statistically significantly different from those in the RSG group on over 20 child and maternal pre-treatment variables. For a subset of these variables, see Table 1. There were four exceptions to this general pattern. 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,  $t(57) = -2.55, p = .05$ , using adjusted degrees of freedom due to unequal variances. The PMT children tended to use more frequent and proportionally more self-initiated proto-imperatives,  $t(57) = -2.19, p = .03$ ;  $t(57) = -3.05, p = .004$ , respectively, and proportionally fewer self-initiated proto-declaratives  $t(57) = 2.61, p = .01$ , than did RSG children in the ECX procedure. The proportion of communication acts that were proto-declaratives at the pre-treatment period was positively related to the number of self-initiated proto-declaratives at the post-treatment ( $r = .35, p = .007$ ) and 6-month follow-up periods ( $r = .28, p = .03$ ). No other pre-treatment variables on which there were group differences were correlated with any of the outcomes presented in the current study. Therefore, analyses testing

the predicted statistical interactions between pre-treatment maternal responsivity and treatment group predicting the number of self-initiated proto-declaratives outcome variables were conducted on the residuals of this variable after controlling for pre-treatment proportion of communication acts that were proto-declaratives in the ECX at the pre-treatment period.

#### ***Results of Treatment Description Coding***

Group difference in session attendance was not statistically significant,  $t(57) < 1.0, p > .05$ . Table 5 indicates the results of the coding for the monthly taped training session. PMT trainers used more prompts for proto-imperatives and more instances of vocal imitation. PMT children used more communication acts. Therefore, it is not surprising that PMT trainers had more responses to children's communication acts. When the children did communicate, PMT trainers also were more likely to respond to children's communication acts with compliance and specific acknowledgment than were RSG trainers. All of these results reflect the intended differences between the treatments. In contrast, RSG trainers linguistically mapped a greater proportion of the children's acts and talked more often than PMT trainers. Informal observation indicates that the vast majority of the adult utterances described what the child was doing.

Theoretically, proto-declaratives are not directly elicited. PMT may affect proto-declar-

**Table 5.**

*Means and Standard Deviations of Treatment Description Variables Averaged Across the 3rd, 4th, and 5th Months of Treatment*

Variables	PMT <sup>a</sup>		RSG <sup>a</sup>	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Trainer's prompts for child proto-imperatives**	73	22	4	3
Trainer's vocal imitations of child's vocalizations**	25	16	.62	.97
Child's communication acts**	67	31	30	20
Child acts to which the trainer complies**	53	28	19	14
Percentage of child acts to which the trainer complies.**	78%	14	61%	1
Child acts trainer linguistically maps.**	30	16	12	9
Percentage of child acts trainer linguistically maps**	24%	12	32%	08
Child acts trainer specifically acknowledges**	6	5	.29	.47
Percentage child acts trainer specifically acknowledges**	10%	10	2%	5
Trainer utterances**	203	61	350	96

<sup>a</sup>PMT = Prelinguistic Milieu Teaching; RSG = Responsive Small Group.

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

atives in part because building routines increases the children's attention to and motivation to communicate with the adult for social purposes. Vocal imitation and compliance were used to build turn-taking routines.

#### ***Growth in Self-initiated Proto-imperatives and Proto-declaratives in the ECX***

We determined that there was a statistically significant increase in children's use of self-initiated proto-declaratives from the pre-treatment ( $M = 11$ ,  $SD = 10.5$ ) to the post-treatment ( $M = 16.5$ ,  $SD = 15.7$ ;  $F(1,56) = 7.62$ ,  $p = .008$ ) but no statistically significant increase from post-treatment to the 6-month follow-up ( $M = 17.7$ ,  $SD = 16.13$ ;  $F(1,56) = .36$ ,  $p = .55$ ). Similarly, the children also grew in their use of self-initiated proto-imperatives from the pre-treatment ( $M = 13.7$ ,  $SD = 11$ ) to the post-treatment ( $M = 21$ ,  $SD = 16.45$ ;  $F(1,56) = 8.48$ ,  $p = .005$ ) periods and began to level off at the 6-month follow-up ( $M = 24$ ,  $SD = 17.6$ ;  $F(1,56) = 2.22$ ,  $p = .14$ ). For these comparisons, rate variables at the 6-month follow-up period were multiplied by 15 (i.e., the ECX session was 15 minutes for all but 2 children). This prorating procedure produced the same metric for 6-month follow-up periods as were used at the pre- and post-treatment periods.

#### ***Treatment Effects on Self-initiated Proto-declaratives and Proto-imperatives***

*Testing for main effects of treatments.* In the context of a mixed ANOVA, a main effect for the treatment is an interaction between time and group in which the group difference only occurs at the post-treatment (or follow-up) period. No statistically significant interactions occurred between treatment group and time for either self-initiated proto-declaratives or self-initiated proto-imperatives at the post-treatment,  $F(1,56) = 2.82$ ,  $p = .10$ ;  $F(1,56) = .52$ ,  $p = .48$ , respectively, or 6-month follow-up periods,  $F(1,56) = .14$ ,  $p = .70$ ;  $F(1,56) = .08$ ,  $p = .78$ , respectively. Given the Yoder and Warren's (1998a) finding of no main effects for treatment, these null findings were expected.

*Analysis used to test the interaction.* For a detailed description of the analysis method used to test for and interpret the predicted statistical interactions, see Yoder and Warren (1998a). Briefly, we conducted a multiple regression analysis in which pre-treatment maternal responsivity was entered first, dummy-coded treatment group was entered second, and the product term for the interaction of pre-treatment responsivity and group was entered last. The number of self-initiated proto-declaratives (or proto-imperatives) at the post-

**Table 6.**

*The Interaction Between the Pre-treatment Maternal Responsivity and Treatment Predicting Proto-imperatives and Proto-declaratives at Post-treatment and 6-month Follow-up Periods*

Prediction	R <sup>2</sup>	t	p	xU <sup>a</sup>	xL <sup>b</sup>
Number of self-initiating Proto-imperatives @ Post-treatment	.13	2.8	.007	.58	.35
Number of self-initiating proto-declaratives @ post-treatment	.08	2.14	.04	.47	NA
Rate of self-initiating proto-imperatives @ 6-month follow-up	.25	4.46	.0001	.5	.36
Rate of self-initiating proto-declaratives @ 6-month follow-up	.08	2.14	.03	.6	.29

*Note.* A value in the xU or xL columns indicates more than 1 participant in each treatment group in that region of significance.

<sup>a</sup>xUpper = the responsivity score above which PMT is superior to RSG. <sup>b</sup>xLower = the responsivity score below which RSG is superior to PMT. <sup>c</sup>NA = This part of the interaction was not interpretable because no participants fell in this region of significance.

treatment and at the 6-month follow-up periods was the criterion variable in four separate analyses. Regions of statistical significance were computed using the method described in Pedhazur (1982). Only regions of significance that had more than one child in each group were interpreted (Aiken & West, 1991). The statistical assumptions were checked for all regressions. Unless otherwise indicated, the following regression results met these statistical assumptions. R<sup>2</sup> and the standardized difference in predicted outcome are presented to aid readers in interpreting the clinical significance of the effects.

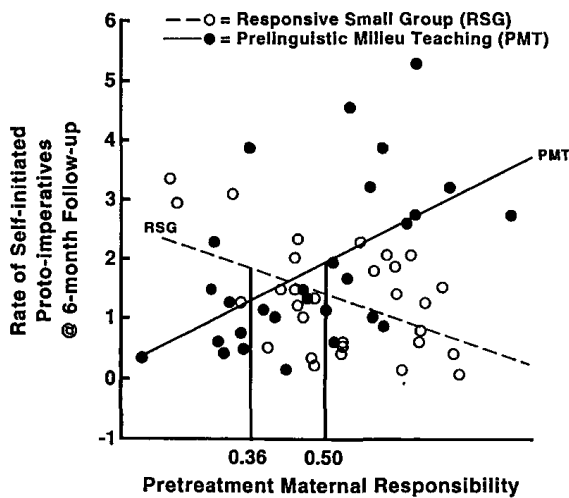
*Treatment effects on the post-treatment outcomes varied by pre-treatment responsivity.* In children whose mothers were relatively high responders before the treatment began, the PMT group used statistically significantly more self-initiated proto-imperatives than the RSG group (Table 6). The standardized between-treatment difference in predicted self-initiated proto-imperatives for the children of mothers with pre-treatment responsivity of 58% (the upper cut-off score) and 86% (the maximum in the sample) was .51 and 1.33, respectively. In children whose mothers were relatively unresponsive at the pre-treatment period, the RSG group used statistically significantly more self-initiated proto-imperatives than the PMT group. The standardized between-treatment difference in predicted

self-initiated proto-imperatives for the children of mothers with pre-treatment responsivity of 35% (the lower cut-off score) and 19% (the minimum responsivity in the sample) was .53 and 1.47, respectively.

For self-initiated proto-declaratives, only the upper region of statistical significance had more than one child per treatment group. In children whose mothers responded to at least 47% of the children's communication acts at the pre-treatment period, the PMT group used statistically significantly more self-initiated proto-declaratives than the RSG group. The standardized between-treatment difference in predicted self-initiated proto-declaratives for the children of mothers with pre-treatment responsivity of 47% and 86% (the maximum in the sample) was .51 and 1.56, respectively.

*Treatment effects on 6-month follow-up outcomes varied by pre-treatment responsivity.* The interaction predicting self-initiated proto-imperatives at the 6-month follow-up (see Figure 1, Table 6) accounted for almost twice the variance accounted for by the same interaction at the post-treatment period. As was seen at the post-treatment period, both the upper and the lower regions of statistical significance in this interaction were interpretable. In the children whose mothers were relatively unresponsive at the pre-treatment period, the RSG group had statistically significantly more self-initiated proto-imperatives than the PMT





**Figure 1.**  
The statistical interaction between treatment group and pre-treatment maternal responsibility predicting post-treatment generalized proto-imperatives.

group. The standardized between-treatment difference in predicted self-initiated proto-imperatives for the children of mothers with pre-treatment responsivity of 35% and 19% was .53 and 1.47, respectively. In children whose mothers were relatively high responders before the treatment began, the PMT group had statistically significantly more self-initiated proto-imperatives than the RSG group. The standardized between-treatment difference in predicted self-initiated proto-imperatives for the children of mothers with pre-treatment responsivity of 60% and 86% was .45 and 2.10, respectively.

The analysis indicated the interaction that predicted self-initiated proto-imperatives at the 6-month follow-up violated a statistical assumption (multivariate normality). The results, however, were the same after transforming rate of self-initiated proto-imperatives at the 6-month follow-up using a square root transformation (Tabachnick & Fidell, 1989;  $R^2$  change for the interaction term = .26;  $t$  for the interaction = 4.5;  $p = .00001$ ). After transformation, no assumptions for multiple regression were violated.

For self-initiated proto-declaratives, both regions of statistical significance had more than one child per treatment group. The lower

region of significance was just within this criterion. There were 3 children in the PMT group (11% of the group) and 2 children in the RSG group (7% of the group) in the region of significance in which RSG was superior. RSG was superior in facilitating self-initiated proto-declaratives in children of mothers who responded to between 19 and 29% of their children's communication before treatment. The standardized between-treatment difference in predicted self-initiated proto-declaratives for the children of mothers with pre-treatment responsivity of 29% and 19% was .59 and .94, respectively. There were 7 children in the PMT group (25% of the group) and 11 children in the RSG group (37% of the group) in the region of statistical significance in which PMT was superior. PMT was superior in facilitating self-initiated proto-declaratives in children of mothers who responded to between 60% and 86% (the maximum) of their children's communication. The standardized between-treatment difference in predicted self-initiated proto-declaratives for the children of mothers with pre-treatment responsivity of 60% and 86% was .54 and 1.13, respectively.

## DISCUSSION

This study was a re-analysis and extension of a previously presented study (Yoder & Warren, 1998a) to demonstrate that staff-implemented prelinguistic communication intervention facilitated self-initiated proto-imperatives and proto-declaratives at both the post-treatment and 6-month follow-up periods. Because the staff members that administered the measurement of the outcome variables (i.e., ECX) were not the children's trainers and because the materials used in the ECX were not used during intervention sessions, these findings represent a strong test of generalized use of these types of communication acts. As occurred in the Yoder and Warren study, the specific intervention that was superior varied by pretreatment maternal responsibility.

Statistical significance does not tell us whether these or any treatment effects are clinically important. In this case, the interac-

tions between treatment group and pretreatment maternal responsivity accounted for 8–25% of the variance in the outcome variables. These effect sizes are equal to, or greater, than those in other studies finding a treatment by pre-treatment characteristic interaction (Cole, Mills, Dale, & Jenkins, 1991; Mills, Cole, Jenkins, & Dale, 1998; Yoder, 1992; Yoder, Kaiser, & Alpert, 1991).

Although rigorous in that it controlled for many possible threats to internal validity (including maturation, history, exposure to the testing conditions, parental expectations), the current study did not test the extent to which either treatment *can* be effective. In an effort to conduct a highly controlled experiment, we implemented a restricted version of the treatments. For example, we administered PMT and RSG only 20 minutes a day. Parents and teachers were purposefully kept naive to 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, although it is encouraged in typical responsivity models (e.g., Wilcox, 1992). Additionally, the current study compared treatments that each used techniques long thought to facilitate communication development (Warren & Yoder, 1998a; Wilcox). In fact, the results show 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. Therefore, the current study probably represents a conservative estimate of the effect of either treatment. Future implementations of the PMT may be more effective if parents are supported to be more responsive to their children's communication. Implementations of responsivity treatment models may be more effective than RSG if they are implemented by parents (as well as teachers) and if they include imitative responses of children's behavior (Wilcox).

There is evidence that PMT facilitated proto-declaratives at both measurement periods. PMT may be particularly well suited to facilitating proto-declaratives for several reasons. First, PMT teachers were told to model proto-declaratives at the child's developmental level. Second, the frequent elicitation of proto-imperatives during treatment provides many opportunities to pair functional (e.g., compliance) with social (e.g., smiles, attention, affection) consequences, possibly increasing the reinforcing value of social consequences (Bijou & Baer, 1965; Halle et al., 1995). Proto-declaratives are used to acquire social consequences. This type of pairing is particularly probable in the context of turn-taking routines (Rollins, Wambacq, Dowell, Mathews, & Reese, 1998). One weakness of this study, however, is that we had no direct measure of teacher modeling of proto-declaratives nor of children's engagement in routines. Therefore, we cannot be sure how often these events occurred. Future studies would be strengthened by such measures.

There are many instances, however, of children learning from interventionists skills not explicitly elicited by adults. Perhaps the most probable explanation for PMT's effect on proto-declaratives is that PMT facilitated communicative behaviors first used in proto-imperatives and later generalized to proto-declaratives. A familiar principle in the language acquisition literature is that children use "old forms to express new functions" (Slobin, 1973). Currently, we hypothesize that coordinated attention to the adult message recipient and to the object or event being communicated with a vocalization (i.e., a voiced phoneme) are frequently the "form" children use to convey early proto-declaratives. Future research is necessary to determine whether PMT facilitates these communicative behaviors and subsequent generalization to proto-declaratives better than RSG in children of highly responsive mothers.

The evidence supporting the notion that PMT facilitates self-initiated proto-declaratives is stronger than evidence supporting an RSG effect on proto-declaratives. In fact, there were no children in the region of statis-

tical significance in which RSG was superior when predicting proto-declaratives at the post-treatment period. Replication studies especially are needed to determine whether a more complete version of the responsivity model can facilitate proto-declaratives.

Anytime an intervention study is among the first to demonstrate treatment effects on a particular outcome, replication studies are needed before we can be confident that the effects will replicate with similar families. Some readers may feel particularly strong about the need to replicate treatment effects that are conditional on some pre-treatment characteristic (e.g., pre-treatment responsivity). Historically, pre-treatment characteristic by treatment interactions (i.e., aptitude by treatment interactions, ATIs) have not replicated very often (Speece, 1990). Fortunately, more recent ATI studies have been replicated (Cole et al., 1991; Mills et al., 1998; Yoder et al., 1991; Yoder, 1992). Additionally, when one predicts before the analysis which pretreatment variable will interact with treatment group on the basis of theory and past empirical work, we can have relatively more confidence that the interaction will replicate.

If future studies replicate the finding that PMT can facilitate proto-declaratives in children of high responders, we can use PMT in future research to test several important research questions. For example, one could test whether the positive association between early use of proto-declaratives and later expressive vocabulary in children with disabilities is a causal relationship. If so, it may be wise to use PMT to facilitate proto-declaratives, and other pragmatic functions, in children who are not yet talking. Once children begin to talk, interventionists could change the intervention goal to early vocabulary. Theoretically, intervention might focus on proto-declaratives before focusing on vocabulary development. A primary motivation for learning to talk may be to share more precisely one's experience of the world with significant others (Bloom, 1993). We could test whether facilitating proto-declaratives and other aspects of prelinguistic communication to accelerate the child's readiness for linguistic intervention is

superior to waiting and teaching children vocabulary after the child becomes "ready" for linguistic interventions on their own. Because proto-declaratives are used to attain only social consequences (e.g., smiles, laughs, attention, verbal comments, etc.), it is not surprising that children whose primary disability is social (e.g., autism) have especially large deficits in proto-declaratives. An important research question is whether PMT can be effective in facilitating proto-declaratives in such children and what characteristics of the children mitigate or enhance the treatment effects.

The strong internal validity of this randomized group experiment, replication of the PMT effect on proto-imperatives with a new sample, and demonstration that the effect maintains 6 months after the end of treatment adds to the evidence that PMT facilitates proto-imperatives. These data also indicate for the first time that responsivity models, even a stripped down version like we used, can facilitate proto-imperatives. Future research of a more complete instantiation of the responsivity treatment model needs to replicate the effect on proto-imperatives (Girolametto, 1988; Wilcox, 1992).

It is also noteworthy that the effect size on proto-imperatives nearly doubled (from 13% to 25% of the accounted for variance) from post-treatment to 6 months after the end of treatment. This unusual pattern may have occurred because increasing intentional communication elicits maternal responses (Yoder & Warren, 1999b) that may, in turn, facilitate further development of proto-imperatives. This suggests another example of a transactional process in which children affect parents in ways that affect future child development (Yoder & Warren, 1993).

In summary, the present study demonstrated that PMT facilitates self-initiated proto-declaratives in children of highly responsive mothers, even though the children had developmental disabilities. The fact that the treatment effects on proto-imperatives doubled from post-treatment to the 6-month follow-up suggests the treatments tapped into a transactional process that occurs between parents and their children with disabilities during the

prelinguistic period. That is, increasing prelinguistic communication, even if through clinic-based treatments, elicits maternal responses (even when mothers are kept naïve to the treatment methods and hypotheses), which in turn facilitates further development of proto-imperatives.

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