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A Responsive Parenting Intervention: The Optimal Timing Across Early Childhood For Impacting Maternal Behaviors And Child Outcomes

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Abstract

This study examined the optimal timing (infancy, toddler–preschool, or both) for facilitating responsive parenting and the intervention effects on maternal behaviors and child social and communication skills for children who vary in biological risk. The intervention during infancy, Playing and Learning Strategies (PALS I), showed strong changes in maternal affective–emotional and cognitively responsive behaviors and infants' development. However, it was hypothesized that a 2nd intervention dose in the toddler–preschool period was needed for optimal results. Families from the PALS I phase were rerandomized into either the PALS II, the toddler–preschool phase, or a Developmental Assessment Sessions condition, resulting in 4 groups. Facilitation of maternal warmth occurred best with the PALS I intervention, while cognitive responsive behaviors were best supported with the PALS II intervention. Behaviors that required responsiveness to the child's changing signals (contingent responsiveness, redirecting) required the intervention across both the early and later periods.

Keywords

parenting; responsiveness; early intervention; child outcomes

Responsive parenting described from different theoretical frameworks (e.g., attachment) emphasizes an affective–emotional style with positive affection and high levels of warmth and nurturance (Darling & Steinberg, 1993), responses that are contingently linked to children's signals, and acceptance of children as unique individuals (Ainsworth, Blehar, Waters, & Wall, 1978; Bornstein, 1985). From a sociocultural framework, the behaviors that fit into this style have been expanded to include cognitively responsive behaviors such as maintaining children's focus of interest (Akhtar, Dunham, & Dunham, 1991; Tomasello & Farrar, 1986) and the use of rich verbal input that is responsive to children's signals (Smith, Landry, & Swank, 2000; Tamis-LeMonda, Bornstein, & Baumwell, 2001). These frameworks describe responsive

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parenting as critically important for its role in providing a strong foundation for children to develop optimally (Ainsworth et al., 1978; Bornstein, 1985). Through repeated experiences of responsive interactions with parents that incorporate these behaviors, children are thought to internalize and generalize their learning to new experiences (e.g., Ainsworth et al., 1978; Bornstein & Tamis-LeMonda, 1989; Grusec & Goodnow, 1994). It also has been documented that parents can be supported through interventions to increase this aspect of parenting that, in turn, has facilitated a range of children's outcomes (Juffer, Hoksbergen, Riksen-Walraven, & Kohnstamm, 1997; Landry, Smith, & Swank, 2006; Van Zeigl, Mesman, Van IJzendoorn, Bakermans-Kranenburg, & Juffer, 2006).

What is less well understood is whether there are developmental periods during which the influence of this parenting style is particularly important or whether consistency in responsive parenting is needed. For example, some theories identify responsive parenting during infancy as most critical, while others describe the importance of consistency in responsive parenting across early childhood development (Bornstein & Tamis-LeMonda, 1989; Landry, Smith, Swank, Assel, & Vellet, 2001). In a descriptive study, the importance of consistency in responsive parenting across both infancy and early childhood for optimal cognitive and social development was demonstrated (Landry et al., 2001). In fact, when responsive parenting was at higher levels only across the first year of life, children's development during toddlerhood was comparable to that of children who had received poorer parenting in infancy and only moderate responsiveness in the toddler–preschool period.

These findings raise two important research questions that will be addressed in this study regarding an intervention to facilitate responsive parenting. These include determining (a) the optimal timing for intervention implementation (e.g., across infancy vs. the early childhood period vs. both) and (b) the effect of such an intervention on positive change in maternal behaviors and child outcomes for children who vary in biological risk status (i.e., term vs. very low birth weight [VLBW]). The objective of the present study was to address these two questions.

Responsive Parenting Interventions

Over the past 2 decades, the effect of responsive parenting has been examined in early intervention programs for developmentally at-risk young children, including those who were born prematurely (e.g., Patteson & Barnard, 1990), adopted (e.g., Juffer et al., 1997), maltreated and/or involved in foster care (Linares, Montalto, Li, & Oza, 2006; Toth, Maughan, Manly, Spagnola, & Cicchetti, 2002), parented by depressed mothers (Toth, Rogosch, Manly, & Cicchetti, 2006), and/or from lower socioeconomic backgrounds (e.g., Royce, Darlington, & Murray, 1983). Some programs have documented at least short-term increases in children's cognitive, behavioral, and language skills; changes in certain types of maternal behavior (e.g., amount of positive verbal stimulation); and/or positive changes in the home environment (Beckwith, 1988; Bromwich, 1981; Patteson & Barnard, 1990; Resnick, Armstrong, & Carter, 1988). Also, the importance of responsive parenting for social–emotional development (e.g., attachment security) has been supported through a meta-analysis (Bakermans-Kranenburg, van IJzendoorn, & Juffer, 2003) and from findings of more recent interventions targeting specific aspects of social behavioral development (e.g., Van Zeigl et al., 2006). While age sometimes has been examined as a predictor of intervention effectiveness in studies including infants and young children (e.g., Van Zeigl et al., 2006), child age has not been included as a design factor. Without examining the effects of an intervention that occurs during only infancy versus the toddler–preschool period versus one that occurs during both periods, it is not possible to determine the optimal timing of an intervention for promoting young children's development.

Obstacles to Consistency in Responsive Parenting

Descriptive studies suggest the importance of being consistently responsive across both infancy and the toddler–preschool period in order to foster cognitive and social development. If so, this may require parental understanding of children's changing developmental needs, a complex and demanding process that may be difficult to achieve for some parents. This may be particularly true for parents with specific risk factors such as lower economic resources or those parenting children with special needs. For example, poverty is often associated with lower levels of parental affective expression, sensitivity, and more frequent use of power-assertive control techniques (Hess, 1970; McLoyd & Wilson, 1990; Samerof, Seifer, & Zax, 1982) as well as less rich verbal stimulation (Hart & Risley, 1995). Parents of lower economic backgrounds are more likely to have attitudes that assume they have less impact on their children's outcomes and to place greater value on compliance than on child autonomy (McLoyd, 1990). As toddlers seek greater independence, such attitudes may be detrimental to their children's changing needs. Parents with more restricted attributions about why children make increased demands may be more likely to respond with inflexibility and rejection of children's needs. Descriptive support for this idea comes from a low socioeconomic status sample where only about 25% of the mothers showed relatively high levels of responsiveness consistently across both infancy and the toddler– preschool period (Landry et al., 2001). Another 25% who were highly responsive during infancy showed dramatic decreases in responsiveness in the toddler–preschool period that were predicted in part by power-assertive parenting beliefs.

Parenting children with special needs also has been associated with less responsive parenting including inappropriate pacing of interactions (e.g., Brachfeld, Goldberg, & Sloman, 1980) due, in part, to developmentally high-risk children's difficulty in providing clear signals about their needs. One group of high-risk children that may be challenging to parent are those born at VLBW, given their problems with language and behavioral regulation (Landry, Smith, Swank, & Miller-Loncar, 2000). These children may not learn as effectively from interactions with their parents without specialized support, as they show difficulty in independently organizing their behavior to show appropriate cognitive and social responses (Brachfeld et al., 1980), greater passivity in social interactions (Garner, Landry, & Richardson, 1991; Plunkett & Meisels, 1989), and difficulty understanding contingencies (Landry, Leslie, Fletcher, & Francis, 1985). Thus, it seems important to include high-risk children when examining the question of when best to intervene as parents of children born at VLBW may require more support than those parenting children born term without increased developmental risk.

A Playing and Learning Strategies Intervention

In a previous report, we showed how an intervention could support parents to use higher levels of responsive parenting behaviors from an affective–emotional style as well as those that are cognitively responsive when interacting with their infants (Landry et al., 2006). This was demonstrated in a random assignment intervention with lower income families across their infants' first year of life. Inclusion of infants born term and at VLBW allowed for the determination of whether there was a differential influence of maternal responsiveness for children who varied in birth status. By incorporating theories regarding effective adult learning, we delivered a 10-session curriculum that targeted each of the four aspects of a responsive parenting style. Delivery included using educational videotapes featuring mothers with similar backgrounds, facilitator coaching of parents' use of key behaviors during videotaped interactions with their infants, supporting mothers to critique their videotaped practiced behaviors, and planning for how to use the target behaviors across the week. This Playing and Learning Strategies (PALS I) infant intervention program was compared to an attention control condition where families received the same number of home visits with information provided

about their infants' development (Developmental Assessment Sessions [DAS I]). Briefly, these results demonstrated that mothers receiving PALS I showed dramatic increases in affective–emotional and cognitively responsive behaviors. These maternal behavior changes, in turn, mediated the influence of the intervention on increases in infants' social and cognitive skills, providing some of the first support for a causal role of responsive parenting for promoting children's cognitive and social development. For example, mothers' increases in maintaining their infants' attentional interest and provision of rich verbal input mediated the influence of the intervention on infants' greater increases in their use of words. In addition, contingent responsiveness, verbal encouragement, and decreased restrictiveness mediated the intervention's influence on infant cooperation. Similar PALS I findings for the term and VLBW infant groups confirmed our hypothesis that the process by which responsiveness supports children's development was due, in part, to its specialized support for children's individual needs.

The Present Study

While the results of the PALS I intervention remained apparent at the 3-month follow-up assessment time point, an important question that remained was whether the support provided across infancy would be enough to promote optimal child outcomes into the preschool period or whether it would be necessary to provide additional support in this later developmental period. To address this question, we adapted the PALS I curriculum for the toddler–preschool period and delivered it in a second randomized intervention phase, PALS II. Thus, mothers who received PALS I were randomly assigned to receive either PALS II or the comparison condition, DAS II, for the toddler–preschool period. Similarly, mothers who received DAS I were randomized into these two conditions. With this design, we were able to examine whether mothers' use of the responsive behaviors required a second phase of the intervention and whether children's outcomes were further enhanced by their mothers receiving both an early and a later intervention. We also were interested in examining whether particular maternal responsive behaviors mediated the intervention's influence on specific child communication and social skills.

Mechanism of Action for the PALS II Intervention

Evidence for the effectiveness of the PALS interventions was expected to be seen in differences between the PALS and DAS groups (hereafter PALS and DAS without a roman numeral refer to both time points) for the level (intercept) of mother and child behaviors at the end of the intervention (posttest) and/or the rate of change in behaviors across the study period (slope). This was proposed due to the close match between the targeted maternal behaviors and children's learning needs. Examination of group differences at the end of the intervention was proposed as they would demonstrate PALS was effective in supporting mothers' greater use of responsive behaviors and, in turn, higher levels of child skills. Examination of differences in rates of increases that includes scores from assessments across the study provides additional information about how the intervention groups varied in their patterns of change in targeted behaviors.

Building on already established skills from PALS I was thought to enhance mothers' abilities to adapt these behaviors to the needs of their toddlers–preschoolers. Responsive parenting is hypothesized to be effective because it is a "three-term chain of events": The child shows an action, the mother responds promptly to that action, and the child experiences a supportive consequence (Bornstein & Tamis-LeMonda, 1989). Mothers' responses are contingently linked to children's signals while acknowledging their individuality and needs (Ainsworth et al., 1978). Children then experience that their needs and interests are important and that signaling them will result in a predictable, positive response. The mutual accommodation of a

responsive style is thought to facilitate children's cognitive development because it promotes an understanding of cause and effect and assists in motivating children to attempt new learning activities as they experience success with parental support (Maccoby & Martin, 1983). It is theorized to facilitate social development as it alters how open children are to parental socialization practices, leading children to make appropriate choices and responses at later ages (Grusec & Goodnow, 1994).

Thus, the present study focused on the impact of providing additional intervention during the late toddler–early preschool period and allowed us to address questions related to the timing of intervention to support positive change in maternal behaviors and child outcomes, the impact on children who vary in biological risk status, and additive versus synergistic effects of the intervention over time.

Study Hypotheses

Hypothesis 1—Effects on Maternal Behaviors

Given that the intervention was developed to facilitate mothers' use of responsive behaviors that were sensitive to children's individual developmental needs, the following two hypotheses were proposed and tested to determine whether they were supported for mothers of term versus VLBW born children:

1. Mothers who received PALS I and II would show higher levels (intercept) at the posttest and/or greater rates of increases (slope) in three affective–emotional and two cognitively responsive behaviors as compared to mothers in all other groups. The affective–emotional behaviors targeted in the intervention and analyses were (a) contingent responsiveness (i.e., sensitive and prompt responses to child signals), (b) positive affect, and (c) warm sensitivity. The two aspects of cognitively responsive behaviors were (a) support of child focus of interest including maintaining and avoidance of redirecting and (b) quality of language input including verbal scaffolding and verbal encouragement.
2. Mothers who received either PALS I or PALS II would show higher levels (intercept) at posttest and/or greater rates of increases (slope) in these same affective–emotional and cognitively responsive behaviors that mothers who did not receive the intervention at either time point (i.e., DAS I and II).

Hypothesis 2—Effects on Child Outcomes

As responsive parenting has been shown in descriptive and intervention studies to provide the type of caregiving environment that allows biologically at-risk children to develop in comparable ways to those born healthy and at term (e.g., Landry et al., 2001), the following hypotheses were proposed and tested for the term and VLBW groups of children.

1. The children of mothers who received both PALS I and II were expected to show higher levels (intercept) at posttest and/or greater rates of increases (slope) in social and communication skills when interacting with their mothers and on standardized measures of language development. The communication behaviors were (a) use of words and (b) coordinating attention with word use. The social behaviors were (a) cooperation, (b) social engagement, and (c) positive affect.
2. The children of mothers who received either PALS I or PALS II would show higher levels (intercept) at posttest and/or greater rates of increases (slope) in social and communication skills when interacting with their mothers and on standardized measures of language development compared to children who did not receive the intervention at either time point (i.e., DAS I and II).

Mediation of Intervention Influence on Children's Outcomes

It also was of interest to determine whether different aspects of maternal responsiveness mediated the impact of the intervention on different child skill domains and whether this was moderated by biological risk status (i.e., VLBW vs. term born). Based on results from the infancy phase of the intervention, we hypothesized that responsive behaviors across both an attachment (i.e., affective–emotional) and a sociocultural (i.e., support of focus of attention, rich language input) framework together would explain the intervention effect on social and communication outcomes.

Method

Participants

Study groups—Two groups of children were included who varied in biological risk for problems in later development as it allowed for examination of the effectiveness of the intervention across risk levels. Children born term (n = 80) had a gestational age at birth of > 36 weeks, Apgar scores > 8, and a normal maternal pregnancy history. Children born at VLBW (n = 86) had a gestational age at birth of ≤ 36 weeks, a birth weight of ≤ 1,600 g (3.5 lb), and they ranged in severity of medical complications known to predict risk for developmental difficulties (e.g., respiratory disorders, intracranial insults). Infants with the most severe types of intracranial insults (i.e., intraventricular hemorrhage, Grade 4, periventricular leukomalacia) were not recruited due to the high incidence of severe neurological difficulties for which this intervention was not expected to have a positive impact.

Recruitment of sample—A medical record review approved by the Institutional Review Board was used to determine eligibility and contact information. The cohort was recruited from clinics in three hospitals serving families from lower income backgrounds in the greater Houston and Galveston, Texas, areas. Telephone calls and letters were used to invite families to participate. Infants were excluded if the mother had a history of drug abuse, severe mental illness, or if she was less than 18 years of age. Of families contacted, 35% declined participation in the infant intervention, with no differences on a range of demographic and medical factors (e.g., gender, birth weight) found between those that agreed versus declined to participate. In the first phase of funding (1997–2000), we targeted the special needs of VLBW infants in designing the PALS I curriculum and implemented this parenting intervention (or an attention-control program) with 264 infants (term, n = 95; VLBW, n = 169). Of these, 242 completed the study with no differential attrition across the risk groups (Landry et al., 2006).

Children were recruited for PALS II if they were between the ages of 24 and 28 months at the time of recruitment; 222 families of the original sample were eligible for recruitment. In the process of obtaining funding for the second study phase, 20 of the 242 families that completed the PALS I study were used to collect pilot data for the development of the new intervention (PALS II). Of the 222 eligible families, 166, or 75%, agreed to participate. Those that declined tended to do so because of not having time to meet on a weekly basis or because of our inability to locate them. No significant differences in demographic or medical factors were found between those who continued to participate and those who did not.

Randomization procedures—Mother–child pairs were randomly assigned to the PALS II for the toddler–preschool period or to the DAS II condition in the following manner in order to balance the four study groups based on the child's biological risk status. Two envelopes were used for the term versus VLBW groups, with each envelope including an equal number of study group markers (i.e., PALS II, DAS II). After the preassessment, one "marker" was drawn from the appropriate envelope to determine the family study condition. Markers were drawn without replacement. Analysis of the rerandomized groups showed that mother and child

variables were comparable at the pretest. The rerandomization resulted in four study groups; PALS I/PALS II, $n = 34$; PALS I/DAS H, $n = 33$; DAS I/PALS II, $n = 50$; DAS I/DAS II, $n = 49$. When we used a similar study attrition criteria to that in PALS I (i.e., not completing all home visits; Landry et al., 2006), 90% of study families had a posttest assessment and 88% a follow-up assessment.

Characteristics of the four study groups—Table 1 summarizes the children's medical and demographic information for the four study groups with no expected differences found. Table 2 summarizes the demographic information for the children's mothers and the family structure, and only a significant difference for maternal age was found. Overall, the socioeconomic status (Hollingshead, 1975) of our sample was in the upper lower class to lower middle-class range, which is consistent with a high school education and clerical or semiskilled occupations.

Procedures

Home visiting—The PALS II and DAS II study conditions required families to meet with a facilitator in their homes for 11 visits that lasted about 1.5 hr and occurred on a weekly basis. Three toys (i.e., book, puzzle, medium-sized ball) were provided to study families across all four conditions as not all families had access to developmentally appropriate toys.

Assessment design—Four assessments, conducted by staff masked to study condition, were completed on mothers and children in order to evaluate the intervention effectiveness. At each assessment mother–child interactions were videotaped for 15 min in a naturalistic living room situation where mothers were requested to do what they would typically do with their children. Items found in a living room (e.g., toys, magazines) were provided as described previously (Landry et al., 2006). Assessment of language skills using standardized measures also occurred. Assessments occurred at the following time points: (a) pretest, 2 weeks prior to Home Visit 1, mean age = 30.2 months, $SD = 2.5$; (b) interim test, after Home Visit 5, mean age = 33.0 months, $SD = 2.7$; (c) posttest, 1 month after the final Home Visit 11, mean age = 36.0 months, $SD = 3.0$; and (d) follow-up test, about 3 months later, mean age = 38.2 months, $SD = 3.1$. In order to be assessed at the posttest and follow-up evaluations, each family had to complete all 11 home visits. Thus, each family was seen for 15 visits.

Rationale and description for the PALS condition—The PALS II condition was adapted from the PALS I curriculum to target similar responsive behaviors for the toddler period plus an additional session targeting behavioral guidance. As in PALS I, the PALS II intervention incorporated factors known to impact intervention efficacy (e.g., short term, clearly defined focus, linking intervention goals to theory; Bakermans-Kranenburg et al., 2003). It continued to acknowledge the importance of including the family's social context into the intervention, supporting facilitators to accept the role of change agent, and involving mothers via active construction of knowledge and practice. Table 3 summarizes session topics for both PALS I and II. The PALS II home visits were guided by a detailed curriculum that included behaviors linked to the four aspects of responsiveness supported by the literature. Each session format included: (a) asking the mother to review her experiences across the last week related to her efforts to try the targeted behaviors, (b) describing the targeted behavior for the current visit, (c) watching and discussing with the mother the educational videotape of mothers from similar backgrounds demonstrating the target skills, (d) videotaping coached interactions between the mother and her child in situations selected by the mother (e.g., toy play, feeding, bathing), (e) supporting the mother to critique her behaviors and her child's responses during the videotaped practice, and (f) planning how to integrate responsive behaviors into everyday activities throughout the coming week. Colorful magnets defining the behavior and its importance were provided at each session to support practice. Separate

educational videotapes of the same topics were developed for English- and Spanish-speaking mothers, and the sessions were delivered in the mother's primary language.

Description of the comparison condition—The DAS II also were similar to those used in PALS I. Research staff made the same number of home visits on a similar schedule to PALS II where staff talked with mothers about new child skills observed during the previous week, screened a range of child skills, and provided feedback. Questions about child skill levels were answered and handouts were provided on common issues (e.g., sleep, feeding) that PALS II mothers also received. Questions regarding how to facilitate development were answered by encouraging mothers to talk with their health care providers.

Systematic training of facilitators and fidelity assessment—Similar to PALS I, an intense and systematic approach to training and supervision of facilitators and assessment staff to ensure fidelity of the intervention implementation was used (Landry et al., 2006). Training included review of sessions, practice with coaching by the supervisor, and discussion of the type of information provided in each condition. A stringent monitoring system ensured that fidelity of implementation by facilitators remained at high levels via (a) supervisor accompanying facilitator on home visits with a fidelity checklist and (b) monthly 3-hr group meetings with the supervisor that included review of videotaped home visits and discussion of problems.

Another aspect of fidelity, the extent to which mothers were engaged in the intervention, was documented with a checklist in Sessions 5 and 10 as mothers taught key target behaviors to an "alternative caregiver." Similar to PALS I, each mother chose a close family member or friend to support her use of the target behaviors. This was considered a fidelity check as ratings were made of each mother's understanding of key target behaviors. This procedure also provided the facilitators with guidance about behaviors that needed further discussion and modeling. In Session 5, three key behavioral areas were assessed (i.e., reading children's signals, use of warm responsiveness behaviors in a contingent manner, and behavioral guidance), and in Session 10, three behaviors were assessed (i.e., maintaining vs. redirecting, verbal scaffolding including labeling objects–actions, using targeted behaviors together in a coordinated style). Items within each area were scored 1 = *no prompting needed*, 2 = *minimal prompting*, or 3 = *coach had to provide much of the information.* Items were averaged within each behavioral area to obtain a score. For the seven areas, mean scores ranged from 1.31 (*SD* = 0.44) for reading signals to 1.54 (*SD* = 0.66) for verbal scaffolding, demonstrating a high degree of maternal knowledge and skill from engagement in the intervention.

Measures

Maternal observed behaviors—Observational measures were quantified using frequencies or global ratings to evaluate changes in maternal behaviors, as these types of measures are sensitive to variability in maternal interactive behaviors and predict later developmental outcomes (Landry et al., 2006). The use of frequencies and ratings together is thought to capture the most information about parenting behaviors (Darling & Steinberg; 1993). Ratings are an effective means of assessing behaviors that reflect a disposition that permeates all of a mother's interactive behaviors (e.g., contingent responsiveness), while frequency counts capture aspects of maternal behavior where quantity is important (e.g., verbal scaffolding; Bakeman & Brown, 1980). Mother–child interactions were quantified using rules separating them into events on verbal and nonverbal behaviors and the amount of time that elapsed between the behaviors (i.e., 3 s) using procedures previously described (Landry et al., 2006). Frequency data were obtained from behaviors that occurred within each event (e.g., maintaining attention). Global ratings using a 5-point scale were used to quantify other maternal

behaviors (e.g., contingent responsiveness). Definitions for coding of the observed behaviors are provided in Table 4.

Targeted behaviors were conceptualized into two areas: (a) affective–emotional and (b) cognitively responsive, based on theoretical frameworks and empirical support from our previous report (Landry et al., 2006). Within the affective–emotional area, three behaviors were included: (a) contingent responsiveness, (b) warm sensitivity, and (c) positive affect. Cognitively responsive behaviors included those related to supporting children's focus of interest (i.e., maintaining, redirecting) and those providing support of communication (i.e., verbal scaffolding, verbal encouragement). Factor analysis has demonstrated support for these targeted behaviors measuring related but distinct aspects of a responsive parenting style (Landry et al., 2006).

Child behaviors with mothers—Behaviors were coded as responses if they followed within 3 s of a maternal attention- directing event and as initiations if they occurred outside of this time interval. For the communication domain, across responses and initiations, the use of words and joint attention behaviors were coded. For the social domain, child cooperation with requests, positive affect, and quality of social engagement were coded. Definitions for all child behaviors are included in Table 5.

Coding procedures and interrater reliability—The coding staff (n = 6) was trained by an expert senior coder under the direction of Susan H. Landry. Initial training involved each member achieving interrater agreements ≥ 80% per variable. To guard against observer drift, monthly meetings were conducted where videotapes were coded as a team, and interrater agreements were checked to assure that they continued to meet the criterion of ≥ 80% per variable. For the mother and child behaviors, one of the three 5-min segments was randomly chosen for coding.

A second rater coded 15% of the videotapes, and generalizability coefficients using repeated measures analyses of variance were calculated (Fleiss, 1986). This method is recommended for studies using continuous, behavioral observational data and has the advantage of evaluating both the consistency across participants for each rater (absolute) and the rater variance within participants (relative) for those variables used in the analyses (Frick & Semmel, 1978). Coefficients above .50 indicate adequate reliability (Mitchell, 1979). Generalizability coefficients for the maternal and child behaviors are included in Tables 4 and 5.

Standardized language measures—Because of our interest in examining the intervention's influence on growth in language skills, raw, rather than standard, scores were used in data analyses. Standard scores are used to compare skills at a specific time point to same age peers.

Peabody Picture Vocabulary Test—The Peabody Picture Vocabulary Test—Third Edition (PPVT-III; Dunn, Dunn, & Dunn, 1997) in English and the Test de Vocabulario en Imagenes Peabody (Dunn, Padilla, Lugo, & Dunn, 1986) in Spanish are individually administered, norm-referenced, one-word receptive language tests for ages 2 through adulthood. Testing takes about 5 min for children in our age range, and test–retest reliability (1 month) has been documented as 0.92 (Dunn et al., 1997). Derived scores include raw scores, standard scores, stanines, language ages, and percentile ranks. In light of the fact that some children started the intervention below the normative age, raw scores were used in data analyses.

Preschool Language Scale—3rd Edition—This scale (Zimmerman, Steiner, & Pond, 1992) is a measure of receptive and expressive language development for children from infancy

through 6 years of age that evaluates aspects of semantic and syntactic language abilities. It is a widely used tool in clinical and research settings, and scores can be obtained for Auditory Comprehension, Expressive Communication, and Total Language. Test–retest reliability (2 days to 2 wks) for preschool age children has been reported in the 0.90 range for both subscales and the Total Language score (Zimmerman et al., 1992).

Data Analyses

To evaluate the effect and timing of the intervention on differences in level (intercept) and rates of change (slope) in maternal behaviors and child outcomes, growth curve modeling procedures were used. This approach was chosen as it yields individual growth curves, unlike traditional repeated measures approaches that are based on group means, as well as an overall or average trajectory, This is similar to the random coefficient models of Cook and Ware (1983) with multiple growth parameters estimated. An additional advantage is that unlike traditional repeated measures, using growth curve modeling allows for the inclusion of data for all families who had at least two assessments, variability in age of assessment, and examination of predictors for individual patterns of growth (see Appendix A for model equation).

Growth curve modeling requires centering at a specific time point. Because of our objective to evaluate the intervention effectiveness, we centered time at the posttest age (i.e., intercept). This approach allows for evaluation of treatment effects (e.g., PALS vs. DAS) for mother and child behaviors at the posttest (intercept). Intervention effects for the slope allow for evaluation of treatment effects among the intervention groups with respect to the rate of change (slope). In the models, the slope effect is fixed when there is not significant variability across participants. For the following maternal behaviors, the slope was entered as a random effect, contingent responsiveness, maintaining, redirecting, and verbal scaffolding. The slope effects for the remaining variables were entered as fixed effects. For the child variables, all the slopes were entered as fixed effects with the exception of the model analyzing intervention effects on the composite expressive language scores. Although curvature (i.e., quadratic, cubic) was necessary to characterize growth in the models, these were not a study focus and are not reported.

An advantage to the use of factorial models is that it allows for testing of multiple interventions (i.e., PALS I vs. DAS I and PALS II vs. DAS II) as well as for the potential synergistic effect of having both interventions (i.e., effect of PALS I in the presence of PALS II vs. effect of PALS I in the presence of DAS II). In our 2 (PALS I vs. DAS I) × 2 (PALS II vs. DAS II) × 2 (term vs. VLBW) factorial design, we used an orthogonal approach to test all possible effects, which accounts for all variance in the means. In a 2 × 2 × 2 design, there are seven degrees of freedom that can be used to test the three main effects and the four possible interactions (e.g., PALS I × Risk Level) with each requiring one degree of freedom. These test the independent hypotheses that are inherent in the design. The orthogonal approach is used to examine for intervention effects on the intercept and the slope in the same model. When interaction effects are nonsignificant, these are dropped and the model is rerun to avoid biasing the remaining effects.

Although a significant difference was found between the study conditions for maternal age, inclusion of this as a covariate did not change the model results in any case. Thus, significant results without these covariates are reported. In addition, lower order interactions (e.g., Slope × PALS 1) are not interpreted when higher order interactions (Slope × PALS I × Risk Group) are significant. To further evaluate the significant results, effect sizes for the intercept effects were based on the difference between expected means divided by the estimated standard deviation. For the slope effects, we determined expected means at pretest and posttest and then divided this difference by the estimated standard deviation. The clinical significance of the

intercept findings are provided based on Cohen's *d* (small effect, *d* = .2; moderate effect, *d* = .5; and large effect, *d* = ,8; Cohen, 1988). Summaries of the parameter estimates (*SE*), degrees of freedom, *F* tests, and related *p* values for all factors included in the final model for each analysis are provided for maternal behaviors in Table 6 and for child outcomes in Table 7. In Appendix B, a summary of means and standard deviations by study condition for each of the maternal and child outcomes at the four assessment time points is included for additional information. However, it is important to recognize that the results are based on analyses conducted on the individual growth parameter estimate for each subject and not the means.

Matching analyses to distribution of variables—In order to determine the most appropriate growth curve model analysis to use, an examination of the distribution of each maternal and child behavior was conducted. When the data were normally distributed, a linear mixed model was used, and when it was positively skewed, a nonlinear mixed model was used (SAS Version 9.0; SAS Institute, 2004). For the maternal behaviors, a linear mixed model analysis was used to examine intervention effects on contingent responsiveness, warm sensitivity, and positive affect. All other maternal variables were analyzed with a nonlinear mixed model. All child outcomes were analyzed using linear mixed model approach with the exception of the PPVT-III data, which required a nonlinear analysis. The following child variables were scaled using a Rasch modeling approach: words and coordinating attention and use of words, In the Results section, means for the significant variables analyzed using the nonlinear mixed model are transformed back into the original units for ease of interpretation.

Results

Hypothesis 1—Effects on Mothers' Responsive Behaviors

Mothers' behaviors across the study groups were examined for differences in levels (intercept) at posttest and in rates of change (slope) across the study period. Higher intercept scores and/or faster rates of increases (slope effects) for the PALS conditions demonstrate the intervention effectiveness on maternal targeted behaviors. Behaviors within three responsiveness areas were examined: affective–emotional, support of focus of interest, and rich verbal input.

Affective–Emotional Supportive Behaviors

Contingent responsiveness—A significant PALS I × PALS II interaction was found for level (i.e., intercept) of contingent responsiveness, $F(1, 269) = 5.17$, $p = .024$. Mothers who received both PALS interventions used higher levels of this behavior at posttest than those in the other three groups, regardless of their child's birth history ($d = .51$).

Warm sensitivity—There was an overall intercept effect of PALS I for warm sensitivity for mothers of both term and VLBW infants, $F(1, 406) = 5.40$, $p = .021$. Mothers who received PALS I displayed greater warmth at the posttest compared with mothers who did not receive PALS I regardless of the intervention condition during the toddler–preschool period ($d = .29$). A significant slope effect for the PALS I × Risk Group interaction also was found, $F(1, 406) = 6.92$, $p = .009$. Mothers of VLBW children showed faster rates of increases (slope) in this behavior if they received PALS I as compared to DAS I ($d = .48$).

Positive affect—A significant slope effect for the PALS I × Risk Group interaction also was found for changes in mothers' positive affect, $F(1, 403) = 13.65$, $p = .0003$. For mothers parenting VLBW children, participation in PALS I resulted in faster rates of increase in this behavior when compared to those in DAS I ($d = .46$). In contrast, PALS I mothers parenting children born at term showed a greater decrease in positive affect compared to those in DAS I.

Cognitively Responsive Behaviors: Support for Focus of Interest

Maintaining—A significant intercept effect of PALS I for mothers' maintaining at posttest (intercept) was found $F(1, 249) = 4.33$, $p = .038$. Mothers of children across both risk groups who received PALS I, with or without PALS II; more frequently maintained their children's focus of interest than mothers in the other groups ($d = .32$).

Redirecting—A significant intercept effect for the PALS I × PALS II interaction, $F(1, 248) = 7.16$, $p = .008$, revealed that mothers who participated in both interventions had lower levels of redirecting, and this was evident for both risk groups ($d = .39$). Also, with both PALS I and PALS II mothers showed the fastest rates of decreases (slope) in this negative behavior when compared to mothers in all other groups, $F(1, 248) = 13.10$, $p = .0004$, $d = .16$. A significant slope effect for the PALS I × Risk Group interaction, $F(1, 248) = 3.85$, $p = .050$, indicated that mothers of term children showed faster rates of decreases if they were in PALS I as compared to DAS I ($d = .39$). A significant slope effect also was found for the PALS II × Risk Group interaction, $F(1, 248) = 8.63$, $p = .004$, and this also demonstrated that mothers of term children showed faster rates of decreases if in PALS II as compared to DAS II ($d = .73$).

Cognitively Responsive Behaviors: Rich Verbal Input

Verbal scaffolding—A significant slope effect for the PALS I × PALS II × Risk Group interaction for maternal use of rich language was found, $F(1, 256) = 4.62$, $p = .032$. Mothers of term children showed faster rates of increase if they had the intervention during the toddler period when compared to mothers parenting term children in all other groups ($d = .52$).

Verbal encouragement—A significant intercept effect was found for PALS II mothers' use of verbal encouragement, $F(1, 386) = 6.21$, $p = .013$. Mothers of all children who received PALS II demonstrated the highest level of this behavior at the posttest (intercept; $d = .25$). A significant intercept effect for the PALS I × Risk Group interaction also was found, $F(1, 386) = 4.07$, $p = .044$. Mothers of term born children who received PALS I, irrespective of whether they had PALS II, showed higher levels of verbal encouragement at the intercept (posttest) than those in DAS I ($d = .38$). Finally, a significant slope effect for the PALS I × PALS II × Risk Group interaction was found, $F(1, 386) = 18.11$, $p = .0001$. While their levels of verbal encouragement were lower, mothers of term children in the DAS I–DAS II group were increasing at faster rates than mothers of term children in the other groups.

Hypothesis 2—Effects on Child Outcomes

Children's behaviors when interacting with their mothers were examined for differences in levels at posttest (intercept) and in rates of change (slope) across two developmental domains: social skills and communication. Differences in levels and rates of change on standardized measures of language development also were examined. Similar to maternal behaviors, no differences across groups on child outcomes at pretest were found for the rerandomized groups. Thus, higher levels at posttest (intercept) for children whose mothers were in the PALS conditions would demonstrate the effectiveness of the intervention.

Social Skills With Mother

Cooperation—There was a significant intercept effect of PALS II on children's cooperative behaviors across all risk groups, $F(1, 352) = 4.10$, $p = .044$. Children whose mothers received PALS II showed greater cooperation with maternal requests at posttest than those whose mothers received DAS II ($d = .30$).

Social engagement—A significant intercept effect for PALS II was found for children's engagement when interacting with their mothers, $F(1, 420) = 7.73$, $p = .006$. Irrespective of

risk group, children displayed higher ratings of eye gaze, positive affect, and communication with their mothers at posttest (intercept) than those who had not received PALS II (d = .32). A significant slope effect for PALS I, $F(1, 420) = 4.14$, $p = .043$, revealed that faster rates of increase were found for children whose mothers also received PALS I as compared to DAS I (d = .28).

Positive affect—Only trends toward significance were seen for children's level and rates of increases in positive affect.

Communication Skills With Mother

Use of words—A significant effect for PALS II intercept, $F(1, 256) = 7.82$, $p = .006$, revealed that children in both risk groups whose mothers were in the PALS II condition used words more frequently when interacting with their mothers than those whose mothers received the DAS II condition (d = .37).

Coordinating attention and use of words—Significant intercept effects were found for the PALS I × Risk Group interaction, $F(1, 378) = 5.70$, $p = .018$, and the PALS II × Risk Group interaction, $F(1, 378) = 4.05$, $p = .045$. Term born children whose mothers had either PALS I (d = .68) or PALS II d = .57) showed higher levels in joint attention in combination with use of words than those in the DAS conditions. However, a significant slope effect for the PALS I × PALS II × Risk Group interaction, $F(1, 378) = 5.36$, $p = .021$, showed that mothers of term born children who received both interventions had children growing at faster rates than term born children of mothers in all other conditions (d = .68).

Standardized Language Measures

Receptive vocabulary—A significant intercept for PALS II was found for vocabulary skills, $F(1, 420) = 5.31$, $p = .022$. All children whose mothers received PALS II showed higher levels of vocabulary comprehension on the PPVT-III at posttest compared to scores for children whose mothers received DAS II (d = .36). There also was an intercept effect for PALS I, but this varied by risk group, $F(1, 420) = 4.38$, $p = .037$. Children born term whose mothers received PALS at least in the early period showed higher receptive vocabulary scores than those with mothers in DAS I. A significant slope effect for PALS II also was found, $F(1, 420) = 9.45$, $p = .002$. Although children with mothers in the PALS II group showed higher vocabulary scores than those with mothers in DAS II at the end of the intervention, children whose mothers received DAS II showed faster increases.

Composite language skills—For composite receptive language skills, a significant slope effect for PALS II × Risk Group was found, $F(1, 422) = 5.27$, $p = .022$. Children born at term whose mothers received PALS II, irrespective of whether they received PALS I, showed faster rates of increases in composite language comprehension skills than those whose mothers received DAS II (d = .38). For composite expressive language, a similar PALS II slope effect was found for increases that again varied by risk group, $F(1, 281) = 19.65$, $p = .0001$. As with receptive skills, those children born term whose mothers received PALS II showed faster rates of increases in expressive skills compared to children in the other groups (d = .38).

Evidence for Mediation in Multilevel Models

To show mediation, the effect of the intervention on the mediator and the effect of the mediator on the outcome is examined. Potential mediation is indicated when the product of the effect of the intervention to the mediator (a), and the mediator to the outcome effect (b), is significantly different from zero (Preacher & Hayes, 2004). This product is usually tested by the Sobel test (Sobel, 1982). We report the Sobel test as well as the Asymptotic Confident Interval (ACI)

method as the latter has some advantages for the types of complex models conducted for this study (MacKinnon, Lockwood, Hoffman, West & Sheets, 2002; Pituch, Whittaker, & Stapleton, 2005). Drawbacks of the Sobel test include the assumption that the product of the two parameter estimates follows a normal distribution, which is often not the case and it also has been shown to have poorer power than the ACI method (MacKinnon et al., 2002). A bootstrapping approach described by Preacher and Hayes (2004) also was considered. However, as there is currently not agreement on what the unit of analysis should be in a multilevel model, this approach was not used (K. Preacher, personal communication, May 5, 2008).

The ACI method makes use of tables developed by Meeker, Cornwell, and Aroian (1981) that give asymmetric critical values for the product of two normally distributed variables based on ratios of the parameters to their standard errors and correlations between parameter. As a first step it is important to determine the nature of the mediation since in multilevel models the mediator being examined can be at Level 1 or 2 as can the treatment effects being mediated. This gives rise to the possibility that the estimated parameters may be random. In our study the variable being mediated (PALS intervention effects) occurs at Level 2 (mother–child level), whereas the mediator (maternal behavior) occurs at Level 1 (time points) as each maternal behavior is measured at the same times as the child outcomes. Thus, the effect of the intervention on the mediator can be considered as fixed and, therefore, independent of the effect of the mediator on the child outcome. We estimated the parameters from the mixed models and used critical values from the tables of Meeker et al. (1981) and these values are included in Table 8 under the headings of *Lower CV* and *Upper CV*. Assuming the correlation between the parameters was zero, we next determined the 95% confidence intervals about the estimated mediation effect. When the interval failed to contain zero, there is evidence for mediation. All mediation models conducted are in summarized in Table 8. Of the 38 models examined, 24 were significant (63%).

Social skills with mother—For children's cooperation with mother, the product of three different intervention effects (column 1) with two different maternal responsiveness behaviors, warm sensitivity and contingent responsiveness (column 2), met the criteria that the product between the intervention effect and the maternal behavior was significantly different from zero (column 3; standard error of each product, column 4). These two maternal behaviors significantly mediated the effects of the intervention on children's cooperation, and this is evident by the fact that the ACI confidence interval (ACI lower value, column 7; ACI upper value, column 8) and/or the Sobel confidence interval (Sobel lower value, column 9; Sobel upper value, column 10) do not contain 0. Thus, the influence of the PALS I intervention on this social skill was mediated by both of these behaviors. The influence of the interaction between PALS I and II as well as PALS II on cooperation also was mediated by mothers' use of contingent responsiveness.

Maternal behaviors from both the attachment and social–cultural framework significantly mediated the intervention effects on children's social engagement. As with cooperation, the influence of the PALS I intervention on this social skill was mediated by mothers' displays of warm sensitivity and contingent responsiveness. Contingent responsiveness also significantly mediated the influence of the interaction between PALS I and II and the PALS II main effect on this social outcome. In addition, mothers' redirecting mediated the influence of the interaction between PALS I and II on children's social engagement.

Maternal affect, warm sensitivity, and contingent responsiveness all mediated intervention influences on children's display of affect. The influence of the interaction of PALS I and II on children's affect was mediated by both warm sensitivity and contingent responsiveness, while the influence of PALS I was mediated by warm sensitivity. The influence of PALS I on changes

in children's affect for those born preterm was mediated by their mothers' displays of smiles and facial animation.

Communication skills with mother—Evidence of mediation was found for both aspects of children's communication skills evaluated. Although maintaining as a function of PALS I also was correlated with children's word use, only contingent responsiveness and warm sensitivity were the significant mediators of the intervention on word use. The influence of the interaction of PALS I and II and the PALS I main effect on children's use of words was mediated by both of these maternal variables. The influence of PALS II on use of words also was mediated by contingent responsiveness.

The intervention effects on children's coordination of attention and word use was mediated by mothers' contingent responsiveness, affect, and avoidance of redirecting. The effect of the interaction of PALS I and II on this complex skill was mediated by contingent responsiveness, while the influence of PALS I was mediated by this maternal behavior and avoidance of redirecting. Avoidance of redirecting also mediated the influence of PALS II on this communication skill. Greater increases in this skill were influenced by PALS I and this was mediated by maternal affect, particularly for those born preterm.

Standardized language tests—Although significant intervention effects were found for vocabulary and complex language skills, mediation only was evident for children's vocabulary (i.e., PPVT-III). Although maternal use of verbal scaffolding and maintaining were significantly related to children's vocabulary skills, contingent responsiveness was the only significant mediator. The interaction of PALS I and II on children's vocabulary skills was mediated by contingent responsiveness.

Discussion

Hypothesis 1—Changes in Maternal Responsiveness Behaviors

The findings of this experimental study demonstrate that the PALS interventions influenced higher levels and/or increases in maternal responsiveness across three behaviors from an affective emotional style (contingent responsiveness, warm sensitivity, positive affect) and two behaviors from a cognitively responsive style (attention to child focus of attention, rich verbal input). However, determination of the optimal timing of PALS (only early, only later, early and later) for responsiveness depended on factors such as the type of support a behavior provided to a child and the child's biological risk status. Responsiveness behaviors best facilitated by PALS I tended to be those that provided warmth and nurturance, whether or not mothers also received the intervention during the toddler–preschool period. Warmth is described in the attachment framework as critically important across the first year of life for establishing a secure and trusting relationship between a mother and her infant (e.g., Ainsworth et al., 1978). When high levels of warm sensitivity occur across this early period, a lasting positive influence on multiple aspects of the child's development is hypothesized. Our results suggest that there is a unique salience about the early developmental period for an intervention to support mothers' expressions of warmth that extends beyond the first year of life.

The unique salience of the early developmental period for maternal behaviors from an attachment framework was particularly apparent for mothers of children born at VLBW. Although mothers of term and VLBW children who received PALS I showed higher levels of warmth than mothers receiving DAS I, only mothers of the VLBW children who received PALS during infancy showed faster rates of increases. This same unique PALS I effect for mothers of VLBW children also was apparent for mothers' increases in the expression of positive affect. Positive affect indicates pleasure in a mother's relationship with her infant and is another responsiveness behavior described in the attachment framework as critically

important during the first year of life. One focus of PALS I was to help mothers appreciate and receive pleasure in their infants' efforts. This focus may be particularly helpful for mothers of children at VLBW because of the greater vulnerability of VLBW infants for difficulty learning new behaviors and their mothers' greater concerns about their development. A facilitator assisting mothers in this early period to respond sensitively to their infants' needs and to take pleasure in their attempts to interact appears to promote a greater bond and acceptance of their child's behavior in spite of their child's risk status.

Contingent responsiveness is a more complex behavior than warmth and positive affect, as it requires the caregiver to notice and respond to the child's signals promptly, sensitively, and contingently related to what the child signaled. Thus, a parent needs to appreciate the child as an individual with needs and requests that may be different from those of the parent. Contingent responsiveness was significantly influenced by the intervention but required PALS at both the early and later periods for mothers of all children to show the optimal levels. We expected that the demands of the toddler–preschool child would make it more difficult for mothers to attend consistently to the child's signals in a contingent manner. Thus, PALS II was expected to support mothers in adapting to the child's changing needs rather than seeing them as more demanding, and this hypothesis was supported. This finding suggests that when designing parent responsiveness interventions for the toddler–preschool period, behaviors that require mothers to adjust a great deal to their children's changing developmental needs should receive more attention than those that provide more basic nurturance.

Support of children's attentional focus through maintaining rather than redirecting was an additional aspect of responsiveness targeted by PALS. Sociocultural frameworks highlight the specialized scaffolding that maintaining provides for young children's immature cognitive and attention skills, in contrast to the greater demands that redirecting places on them (Tomasello & Farrar, 1986). Higher levels of maintaining were found for mothers who received PALS I as compared to those who received DAS I. However, avoidance of redirecting was best facilitated if mothers in both risk groups received PALS during both developmental periods. Similar to contingent responsiveness, avoidance of redirecting requires a caregiver to carefully monitor and respond to a child's signals, but the focus is on attending to signals involving the child's interest in objects and activities. Thus, it may be that a second "dose" is needed to sustain lower levels and faster decreases in this intrusive interactive behavior across a time when children are increasing their exploratory activities and their need for caregivers' attention to their interests.

Mothers' quality of language input (i.e., verbal scaffolding and encouragement) was impacted mainly by participation in PALS II. Provision of verbal input such as (a) providing labels and explanations and (b) highlighting links between objects and actions was best supported for mothers receiving the intervention during the later developmental period. The faster rates of gain in verbal scaffolding, however, were seen for mothers of term born children and not for those parenting children born at greater biological risk. Verbal scaffolding requires mothers to adapt and alter their behaviors to match their children's gestural and verbal signals and to provide verbal input that is aligned with and supports the child's level of understanding and use of words. The advantage of PALS II for mothers of term born children may be best understood by considering the term children's more mature levels of communication and signals that they provide for their mothers. This, in turn, allows mothers greater opportunities to use the verbal scaffolding techniques they have been facilitated to learn through the PALS II intervention. It may be that as the children born VLBW reach higher levels of communication skills, their mothers with PALS support will begin to respond with this type of rich verbal input.

Higher levels of verbal encouragement also occurred if mothers received the intervention at least during the later developmental period, but the benefit of PALS II was seen for mothers of term and VLBW children. As children are more active and independently engaged with their environments as toddlers and preschoolers, PALS facilitated mothers to respond positively to this engagement with positive encouragement. Thus, the importance of PALS II for mothers' use of this form of verbal input may be due to greater opportunities for it to occur as children increased in age. Exposure to PALS during the early period also supported mothers of term children to use more verbal encouragement. Again, the specific developmental needs of the child may help researchers understand these findings. Term born children may have been more developmentally ready in infancy for this form of responsive verbal input, while those born at VLBW became ready later.

Hypothesis 2—Effects on Child Outcomes

Communication and social behaviors with mothers—As with the findings for mothers' behaviors, the optimal timing of the intervention for children's development was dependent, in part, on the skill complexity and the age at which the skills would naturally be emerging. Intervention effects were found for all language and social areas, but the timing varied depending on the skill being assessed. For example, greater use of multiword utterances, a skill that begins in the toddler period, was best facilitated when mothers received PALS II, and this was found for children in both risk groups. One of the more complicated outcomes examined was word use in combination with coordination of joint attention. For children to show better development of this more complex communication skill, their mothers needed to receive multiple doses of the intervention, and only the term born children of mothers receiving both PALS interventions showed the higher levels and greatest increases in this behavior. Joint attention skills begin to develop across the first year of life and are supported by responsive interactive behaviors such as maintaining versus redirecting infants' attentional focus (e.g., Akhtar et al., 1991). Coordinating this behavior with word use develops later. Such coordination may benefit from both intervention phases because mothers initially learn to engage their children with objects and activities, and later build on this foundation by requesting verbalizations from their child during joint attention activities.

Children's social development was impacted by the interventions in similar ways for children born term and those born at VLBW. Cooperation and social engagement were at higher levels for all children when their mothers had received PALS II. An additional benefit for greater increases in social engagement was found for those whose mothers received PALS I, suggesting that for children to develop a range of social skills, PALS I and II were required. Given the challenges of guiding toddlers' behavior and the need to avoid highly punitive discipline to facilitate development, PALS II included one session specifically focused on strategies to help children cooperate (e.g., giving choices, praising positive behaviors while ignoring negative behaviors). However, the positive effect of PALS II on children's cooperation was unlikely due to this session alone but rather to the curriculum's general focus on parent–child engagement and responsiveness to children's signals. This is consistent with other studies demonstrating that toddlers are more motivated to cooperate with highly engaged and responsive parents (Parpal & Maccoby, 1985). The need for both interventions for optimal social engagement indicates an additive effect, such that the later intervention promoted higher skill levels, but the early intervention supported greater increases. As social skills begin to develop in infancy, mothers who were facilitated to show greater warmth and responsiveness in early interactions seem to be laying a foundation for their children's social development. Children's skills, in turn, were further facilitated as mothers continued to learn effective responsive behaviors across the toddler–preschool period.

Effect on children's standardized language scores—The strength of the intervention results are enhanced by the effects on standardized assessments of language development in addition to children's use of language and social skills when interacting with their mothers. In general, PALS II was most important for the development of vocabulary for all children. Although children of mothers who received DAS were showing faster rates of increase, the children whose mothers received PALS II had the highest levels of vocabulary at the posttest. PALS II also was most influential for composite language skills, but this advantage was only seen for term born children. These results demonstrate that the influence of mothers' responsiveness on children's development extends to children's language competence in situations quite removed from interacting with their mothers. As language skills in the preschool period are one of the three critical predictors of school-age reading competence (National Institute for Literacy, 2006), this finding suggests that one approach to supporting early literacy is through a parent responsiveness intervention that targets the use of rich language input.

Mediation of Intervention Effects—The use of a randomized design provides evidence that changes in children's behavior were due to changes in their mothers' behavior. Further support for this was found in analyses demonstrating that the influence of the intervention on children's outcomes was mediated by changes in parenting behaviors. Mediation effects emerged for the impact of the intervention on all of the children's social skills (i.e., cooperation, social engagement, affect). Models showed that warm sensitivity was a significant mediator of all three social behaviors and that contingent responsiveness was a mediator for children's gains in cooperation and social engagement. Both of these maternal behaviors are described from an attachment framework as critically important aspects of a caregiver's affective–emotional style that should explain children's ability to develop social and emotional competence (e.g., Bornstein & Tamis-LeMonda, 1989).

The avoidance of redirecting children's attentional interests was also important for their social competence as it mediated the intervention effect on social engagement. Redirecting is often associated with a sociocultural theoretical framework as avoidance of this strategy provides specialized support for children's immature attentional skills. For children to be socially engaged, they need to attend to the cues of others and mothers' avoidance of redirecting appears to support their ability to use their attentional resources.

The importance of contingent responsiveness as a mediator of the effect of the intervention also was seen for children's language development. This was found for word use, coordination of attention with use of words, and standardized vocabulary scores. Other mediators of gains in language development were mothers' avoidance of redirecting, their warmth, and for children born at VLBW, mothers' positive affect. Thus, as with social competence, mothers' expression of warmth, pleasure, and responsiveness to signals help explain how the intervention supported young children's language development. It is not clear why mothers' verbal input (e.g., verbal scaffolding and encouragement) was not a mediator of language development. As verbal scaffolding only showed intervention effects for mothers of term born children, the impact of this verbal strategy may not have been strong enough to influence gains in language. Also, high ratings of contingent responsiveness in our coding system included promptness and appropriateness of mothers' reactions to child signals with "reactions" being characterized, in part, by language input that was sensitively responsive. Thus, the strong influence of contingent responsiveness on language skills goes beyond providing language input to also include the manner in which the input is provided.

Summary

Our findings provide implications regarding the optimal timing of interventions for promoting maternal responsiveness and, in turn, children's social and communication development. Optimal timing was found to depend, in large part, on the specific targeted behavior and on the degree to which the behaviors were linked to a child's changing developmental needs. These results provide support for the causal influence on children's development of a responsive style that includes behaviors from attachment and sociocultural frameworks. The benefit of this integrated approach was highlighted by the mediation models, where behaviors such as contingent responsiveness and warmth, together with support for children's attention skills, provided the best explanation of the intervention's effect on both social and communication skills. Finally, the intervention effects on maternal and child behaviors showed many similarities for mothers of children term born and VLBW. However, mothers with VLBW children received a particular benefit of the early intervention for warmth and pleasure with their infants. This may have occurred as these infants are more developmentally vulnerable in infancy and behaviors such as warmth facilitate a bond between a mother and infant that, in turn, supports the infant's early development. In contrast, when mothers of term born children received an added benefit of the intervention, it was in the area of rich language input, a scaffolding behavior often associated with the sociocultural framework. The particular benefit of the intervention for these mothers' rich language input may be due, in part, to a greater developmental readiness of the term born children for verbal stimulation. Positive effects on children's social and language outcomes generally were the same across risk groups with a few exceptions that showed a greater benefit for those children born term (e.g., composite language skills). Also, as groups were balanced with respect to ethnicity and primary home language, results indicate that the interventions were effective for families with a range of characteristics.

Limitations of the present study include the extent to which the results would generalize to parents from a broader economic range, given that study families were lower middle and lower socioeconomic status. While infants born VLBW were included as the higher risk group, it is not known if results would generalize to other infant groups who are known to have developmental problems (e.g., Spina Bifida, Down's Syndrome). In addition, the extent to which positive gains in maternal responsiveness behaviors and children's outcomes persist beyond the 3-month follow-up period remains a question.

The findings have logistically important and clinically meaningful implications for decisions regarding bringing parenting interventions to a larger scale. First, they demonstrate that if a parent intervention is only implemented in the infancy or the toddler–preschool period, the facilitation of some aspects of parent responsiveness and child social and communication development will be compromised. Second, the findings can provide guidance for determining the scope of an early versus later intervention in order to maximize the effectiveness of each phase for supporting a comprehensive responsiveness style. A natural next step would be to design and evaluate the combined influence of a staged curriculum model that begins with intervention sessions during the infancy period and strongly focuses on aspects of warmth and contingent responsiveness (i.e., maintaining attention and interpreting signals). A second stage during toddlerhood would then build on this supportive foundation with targeted emphasis on rich language stimulation, using responsive behaviors to promote cooperation and independence, and modifying expectations to adapt to children's changing needs. It also would be valuable to determine the extent to which the positive effects of the PALS curriculum extend into childhood, and whether additional intervention "boosters" beyond the toddler–early preschool period would enhance these effects.

APPENDIX A

General Equation Used in Examining the Models

Level 1 Model

$$Y_{ij} = \beta_{0i} + \beta_{1i}(\text{Time}) + \beta_{2i}(\text{Time} \times \text{Time}) + \beta_{3i}(\text{Time} \times \text{Time} \times \text{Time}) + e_{ij}$$

Where Y_{ij} is the observation for subject *i* at time *j*, the (βs are the growth parameters for the model.

Level 2 Models

$$\begin{aligned}\beta_{0i} = {} & \gamma_{00} + \gamma_{01}(\text{Pals1}_i) + \gamma_{02}(\text{Pals2}_i) \\ & + \gamma_{03}(\text{Pals1}_i \times \text{Pals2}_i) + \gamma_{04}(\text{risk}_i) \\ & + \gamma_{05}(\text{Risk}_i \times \text{Pals1}_i) + \gamma_{06}(\text{Risk}_i \times \text{Pals2}_i) \\ & + \gamma_{07}(\text{Risk}_i \times \text{Pals1}_i \times \text{Pals2}_i) + u_{0i}\end{aligned}$$

$$\begin{aligned}\beta_{1i} = {} & \gamma_{10} + \gamma_{11}(\text{Pals1}_i) + \gamma_{12}(\text{Pals2}_i) \\ & + \gamma_{13}(\text{Pals1}_i \times \text{Pals2}_i) + \gamma_{14}(\text{risk}_i) \\ & + \gamma_{15}(\text{Risk}_i \times \text{Pals1}_i) + \gamma_{16}(\text{Risk}_i \times \text{Pals2}_i) \\ & + \gamma_{17}(\text{Risk}_i \times \text{Pals1}_i \times \text{Pals2}_i) + u_{1i}\end{aligned}$$

$$\begin{aligned}\beta_{2i} = {} & \gamma_{20} + \gamma_{21}(\text{Pals1}_i) + \gamma_{22}(\text{Pals2}_i) \\ & + \gamma_{23}(\text{Pals1}_i \times \text{Pals2}_i) + \gamma_{24}(\text{risk}_i) \\ & + \gamma_{25}(\text{Risk}_i \times \text{Pals1}_i) + \gamma_{26}(\text{Risk}_i \times \text{Pals2}_i) \\ & + \gamma_{27}(\text{Risk}_i \times \text{Pals1}_i \times \text{Pals2}_i)\end{aligned}$$

$$\begin{aligned}\beta_{3i} = {} & \gamma_{30} + \gamma_{31}(\text{Pals1}_i) + \gamma_{32}(\text{Pals2}_i) \\ & + \gamma_{33}(\text{Pals1}_i \times \text{Pals2}_i) + \gamma_{34}(\text{risk}_i) \\ & + \gamma_{35}(\text{Risk}_i \times \text{Pals1}_i) + \gamma_{36}(\text{Risk}_i \times \text{Pals2}_i) \\ & + \gamma_{37}(\text{Risk}_i \times \text{Pals1}_i \times \text{Pals2}_i)\end{aligned}$$

Where Pals1 and Pals2 are the conditions and Risk is the birth status of the child. Typically the first two parameters (intercept and slope) are random, unless the model indicates that there is no random variance for that term. In our models, many of the slopes showed no random variance, and these were entered as fixed effects as described in the *Data Analyses.*

APPENDIX B

Descriptive Statistics for Maternal Responsiveness Behaviors and Children's Outcomes by Study Group for Each Assessment Point

	PALS I											
	PALS II				DAS II				PALS II			
Maternal behavior	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	
						Maternal behaviors						
Contingent Responsiveness'[a]	3.1	3.7	3.3	3.4	2.7	2.9	2.7	2.7	2.6	3.1	2.9	2.
	.9	1.1	.9	1.1	.9	1.0	.8	1.0	.8	.9	.8	.
Warm sensitivity[a]	3.0	3.7	3.1	3.0	2.9	2.9	2.9	2.6	2.5	3.1	2.7	2.
	1.0	1.2	.8	1.1	1.1	1.1	1.0	1.1	1.0	1.1	.9	1.
Positive affect	2.4	2.9	2.7	2.6	2.8	2.5	2.4	2.6	2.5	2.4	2.5	2.

	PALS I											
	PALS II				DAS II				PALS II			
Maternal behavior	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	
	1.0	1.3	1.3	1.1	1.3	1.2	1.1	1.1	1.0	1.0	1.1	1.
Maintaining	75.9	76.8	83.9	86.1	76.9	80.1	80.0	79.1	68.0	74.0	78.1	77.
	22.2	21.4	13.9	15.2	22.4	17.9	17.4	15.4	19.0	17.7	15.5	17.
Redirecting	15.4	14.9	12.3	7.1	15.9	15.4	14.0	14.1	24.4	18.6	16.8	16.
	17.5	18.7	12.1	9.7	16.8	15.9	14.9	13.9	18.0	14.8	12.3	12.
Verbal scaffolding	.9	1.3	1.3	.9	.9	1.4	1.2	1.5	1.5	2.0	1.1	1.
	1.4	1.9	1.6	1.2	1.1	2.7	1.9	2.2	1.9	2.4	1.6	2.
Verbal encouragement	11.8	17.4	8.7	14.0	14.3	10.9	10.4	9.0	10.9	13.2	12.9	12.
	13.2	16.4	9.2	16.5	15.7	12.2	12.5	14.1	13.3	11.2	14.6	14.
	Children's outcomes with mother											
Cooperation	.4	.6	.5	.4	−.5	.2	.2	.2	.1	.6	.58	.5
	.9	1.0	1.1	1.1	1.1	1.0	1.2	1.1	.9	1.0	.84	.7
Social engagement[a]	2.9	3.6	3.5	3.7	2.7	2.9	3.1	3.4	2.8	3.6	3.2	3.
	1.0	1.1	1.1	1.1	1.2	.9	1.0	.9	1.0	1.0	.89	1.
Positive affect[b]	−4.0	−4.2	−3.8	−4.0	−3.8	−4.0	−4.2	−4.1	−3.9	−4.2	−3.8	−4.
	1.4	1.1	1.4	1.4	1.7	1.3	1.3	1.3	1.3	1.1	1.4	1.
Use of words[b]	.5	1.0	.8	1.1	−.0	.6	.7	.8	.4	.9	.80	1.
	1.0	1.4	1.0	1.0	1.3	1.0	.8	1.0	1.0	.9	.86	.6
Coordinating attention and words[b]	−1.8	−1.6	−1.5	−1.7	−1.2	−1.9	−1.9	−1.4	−1.9	−1.7	−1.6	−1.
	.7	1.0	.8	1.0	1.0	1.1	.9	.9	.9	1.0	.9	1.
	Children's standardized language test outcomes											
Receptive vocabulary[c]	13.7	19.7	22.2	25.6	10.8	15.3	18.5	23.6	14.0	17.4	22.7	24.
	10.2	12.1	10.8	14.6	9.8	15.4	12.8	16.5	9.4	9.8	11.7	11.
Composite receptive language[c]	20.9	24.2	26.0	28.0	21.2	22.7	25.4	26.3	21.8	23.4	26.3	27.
	5.6	6.3	6.3	5.0	6.1	6.5	6.6	6.5	4.7	6.6	5.4	5.
Composite expressive language[c]	21.0	23.0	23.2	24.4	19.9	21.1	23.6	24.2	21.0	23.3	25.1	25.
	5.1	4.0	4.1	5.0	4.1	5.0	4.9	5.7	3.3	4.0	4.0	4.

Note. The mean for each variable at each time point is the top number; the standard deviation is the bottom number. Assessment time points: 1 = pretest; 2 = interim; 3 = posttest; 4 = follow-up.

[a] Variable is based on a 5-point rating; higher scores are more positive.

[b] Variable is a scaled score using a Rasch modeling approach; less negative numbers are more positive.

[c] Variable is a raw score.

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Table 1

Child Medical and Demographic Characteristics by Intervention Group

Characteristic	PALS I-II		PALS I-DAS II		DAS I-PALS II		DAS I-II	
	Term	VLBW	Term	VLBW	Term	VLBW	Term	VLBW
Mean birth weight in grams	3,444 (326)	992 (337)	3,274 (381)	994 (320)	3,326 (383)	1,203 (501)	3,305 (371)	1,177 (388)
Mean gestational age in weeks	39.9 (0.3)	28.7 (2.3)	39.9 (0.2)	28.7 (2.2)	40.0 (0.0)	30.2 (3.2)	40.0 (0.0)	29.5 (2.9)
Risk status (%)	44	66	58	42	45	55	47	53
Female (%)	57	43	60	40	44	55	48	52
n	15	19	19	14	23	28	23	26

Note. Values in parentheses represent the group standard deviation. PALS = Playing and Learning Strategies; DAS = Developmental Assessment Screening; I = intervention in infancy; II = intervention in toddler–preschool period; VLBW = very low birth weight.

Table 2

Maternal and Family Demographic Characteristics by Intervention Group

Characteristic	PALS I-II	PALS I-DAS II	DAS I-PALS II	DAS I-II
Mean age in years	31.2 (6.1)[a]	29.4 (6.0)[a]	28.9 (6.7)[b]	28.3 (5.5)[b]
Mean education in years	11.9 (3.3)	12.8 (2.4)	12.2 (2.2)	12.6 (2.5)
Mean SES	35.3 (19.3)	33.0 (16.8)	31.6 (14.6)	34.4 (13.3)
Mean siblings	1.6 (0.3)	0.8 (0.6)	1.1 (0.3)	0.9 (0.3)
Marital status (%)	62	51	49	52
Ethnicity (%)				
African American	25	42	35	33
Hispanic	47	39	32	39
Caucasian	28	19	27	24
Other	0	0	6	4
n	34	33	50	49

Note. Values in parentheses represent the group standard deviation. PALS = Playing and Learning Strategies; DAS = Developmental Assessment Screening; I = intervention in infancy; II = intervention in toddler-preschool period; SES = socioeconomic status based on Hollingshead (1975) Four Factor Scale; Siblings = number of siblings in the home; marital status = percentage of mothers who were married. Means having the same subscript are not significantly different.

Table 3

Comparison of PALS I and II Sessions

Session	PALS I (Infancy)	PALS II (Toddler-Preschool)
Session 1	Learning the child and family routine (e.g., sleep, feeding patterns, demands on mother's time) and maternal expectations and beliefs regarding her role in promoting development.	
Session 2	Recognizing-understanding the intent of positive and negative signals as a means of child communication and how this changes from infancy to the toddler-preschool period.	
Session 3	Contingently responding to infant and child signals in warm and sensitive ways and, for PALS II, how to use such behaviors even when requests are denied.	
Session 4	Review with alternative caregiver.	Behavioral guidance with an emphasis on helping children learn to cooperate through sharing control when possible, providing choices, and other strategies (e.g., praise, ignore, transitions).
Session 5	How to attend to infant focus of attention and maintain and build interest rather than redirect	Review with alternative caregiver
Session 6	Continue to develop skills in maintaining attention and when to introduce interactions, social games, and objects.	How to attend to child focus of attention (objects, conversation) maintain and build on interest rather than redirect.
Session 7	Using rich language while maintaining attention and introducing interactions, social games, and objects with an emphasis on use of labels of objects and actions.	
Session 8	Review with alternative caregiver	Using rich language with an emphasis on verbal scaffolding (e.g., hints, prompts offered that provide conceptual links between objects, actions, persons, activities, functions, or prior experiences).
Session 9	Integrating use of responsive interactive behaviors together in everyday situations (e.g., bath, meals, dressing)	
Session 10	Continued practice with integrating use of responsive behaviors	Review with alternative caregiver
Session 11		Integrating use of responsive interactive behaviors together in everyday situations

Note. Sessions 1, 2, 3, 7, and 9 had similar topics for both PALS I and II, so one description is provided. PALS = Playing and Learning Strategies; I = intervention in infancy; II = intervention in toddler-preschool period.

Table 4

Definitions of Maternal Interactive Behaviors

Behavior	Definition
Affective-emotional responsive	
Contingent responsiveness[a]	Degree of responsiveness to child cues including promptness and appropriateness of maternal reactions to child's needs, appropriate input and pace that fits child's (r = .74).
Warm sensitivity[a]	Degree of sensitivity to child cues including acceptance of interests and needs, amount of physical affection, enthusiasm in activities, positive tone of voice, and avoidance of negative comments (r = .74).
Positive affect[b]	Degree to which mother displays smiling, laughing, and facial animation (r = .74).
Cognitively responsive	
Maintaining[b]	Maternal interactive behavior that relates to the activity or object in which the child is currently visually and physically engaged (e.g., while child manipulating toys, mother provides name of toy and/or action that can be done with toy), or is in direct response to the child's attempts to attract mother's attention to an object or activity (e.g., "Do you want to throw the ball to me?" while child is holding ball in hand; r = .81).
Redirecting[b]	Maternal interactive behavior that is unrelated to the child's focus of visual and physical attention in an attempt to shift child's attention (r = -77).
Verbal scaffolding[b]	Verbal hints-prompts offered that provide conceptual links between objects, persons, activities, or functions that may occur in relation to objects, activities, and topics of conversation (r = 64).
Verbal encouragement[b]	Statements that involve praising child's efforts (e.g., "Way to go") or serve to encourage their activity involving objects or toys or child's verbalizations ("You're making the car go," "Yes, car"; r = .78).

Note. Values in parentheses are generalizability coefficients *(r)* for interrater reliability.

[a] Coded using a 5-point rating scale.

[b] Coded as a frequency.

Table 5

Definition of Child Behaviors Observed With Mother and Generalizability Coefficients (*r*)

Behavior	Definition
Social behaviors	
Cooperation[b]	Behaviors used in response to a maternal request for information (e.g., Mother asks, "What is the name of that picture?" while pointing to picture in book, and child attempts to follow mother's request with behavior or words; *r* = .62).
Social engagement[a]	Degree to which child positively engaged mother through use of affect, eye gaze, gestures, joint attention, and verbal-nonverbal communication demonstrating an interest in the interaction (*r* = .65).
Positive affect[b]	Displays of smiles and laughs (*r* = .85).
Communication behaviors use of words[b]	Six levels were coded for each attention directing event; single utterance sound, babbling with sentence like intonation, word approximation-single words, two- to three-word phrases, four- to five-word phrases, and > six words (*r* = .68).
Coordination of attention and use of words[b]	Frequency with which children were able to coordinate joint attention between their mother and objects in combination with using words (*r* = .68).

Note. Values in parentheses are generalizability coefficients (*r*) for interrater reliability.

[a] Coded using a 5-point rating scale.

[b] Coded as a frequency.

Table 6

Intervention Effects at Posttest (Intercept) and for Rate of Change (Slope) in Maternal Responsive Behaviors

Model variable	Parameter estimate (*SE*)	*F*	Parameter estimate (*SE*)	*F*	Parameter estimate (*SE*)	*F*
	Affective-emotional behaviors					
	Contingent responsiveness[a]		Warm sensitivity[b]		Positive affect[c]	
Intercept	3.36 (0.15)	21.82^{++}	3.21 (0.20)	16.26^{++}	2.64 (0.20)	13.36^{++}
PALS I	−0.51 (0.20)	2.06	−0.35 (0.24)	5.40*	−0.34 (0.24)	1.48
PALS II	−0.52 (0.21)	2.41	−0.37 (0.26)	1.30	0.15 (0.27)	0.08
Risk	—	—	0.03 (0.27)	0.99	0.08 (0.27)	0.66
PALS I × PALS II	0.64 (0.27)	5.17*	0.34 (0.28)	1.44	0.26 (0.28)	0.87
PALS I × Risk	—	—	−0.32 (0.30)	1.19	0.07 (0.28)	0.06
PALS II × Risk	—	—	0.08 (0.27)	0.10	−0.48 (0.30)	2.65
Slope	−0.03 (0.04)	6.15*	−0.03 (0.04)	17.44^{++}	0.05 (0.05)	2.33
Slope × PALS I	−0.03 (0.05)	1.43	−0.12 (0.06)	1.16	−0.12 (0.07)	0.02
Slope × PALS II	−0.00 (0.06)	0.18	0.07 (0.06)	0.93	−0.03 (0.08)	0.16
Slope × Risk	—	—	−0.14 (0.06)	0.48	−0.24 (0.08)	0.20
Slope × PALS I × Pals II	−0.03 (0.07)	0.22	−0.07 (0.08)	0.77	−0.08 (0.15)	0.81
Slope × PALS I × Risk	—	—	0.22 (0.08)	6.92**	0.34 (0.15)	13.65^{+}
Slope × PALS II × Risk	—	—	—	—	0.17 (0.09)	3.37
	Cognitively responsive behaviors: Focus of attention					
	Maintaining[d]		Redirecting[c]			
Intercept	4.40 (0.03)	131.64^{++}	2.13 (0.21)	10.29^{++}		
PALS I	−0.06 (0.04)	4.33*	0.52 (0.27)	4.82*		
PALS II	−0.03 (0.05)	0.96	0.42 (0.30)	3.79		
Risk status	—	—	−0.51 (0.32)	1.60		
PALS I × PALS II	0.00 (0.06)	0.00	−0.61 (0.37)	7.16**		
PALS I × Risk Status	—	—	0.34 (0.40)	0.43		
PALS II × Risk Status	—	—	0.48 (0.42)	1.34		
PALS I × PALS II × Risk	—	—	−0.30 (0.53)	0.32		
Slope	0.02 (0.01)	5.05*	−1.57 (0.62)	25.98^{++}		
Slope × PALS I	−0.01 (0.02)	0.15	1.18 (0.77)	0.68		
Slope × PALS II	−0.01 (0.02)	0.00	0.51 (0.86)	0.12		
Slope × Risk	−0.01 (0.02)	5.65*	−1.55 (0.91)	2.55		
Slope × PALS I × Pals II	−0.03 (0.02)	2.63	−3.45 (0.95)	13.10^{+}		
Slope PALS I × Risk	−0.00 (0.02)	0.06	1.88 (0.96)	3.85*		
Slope × PALS II × Risk	−0.02 (0.02)	1.07	2.75 (0.94)	8.63**		
	Cognitively responsive behaviors: Rich verbal input					
	Verbal scaffolding[f]		Verbal encouragement[g]			
Intercept	−0.15 (0.31)	−0.48	1.66 (0.31)	5.35^{+}		
PALS I	0.10 (0.40)	0.50	0.60 (0.40)	0.48		
PALS II	−0.13 (0.46)	0.22	−0.41 (0.46)	6.21*		
Risk status	0.28 (0.45)	0.18	0.79 (0.46)	4.04*		
PALS I × PALS II	0.06 (0.58)	0.08	−0.08 (0.58)	0.59		
PALS I × Risk Status	−0.39 (0.60)	1.81	−0.60 (0.60)	4.07*		
PALS II × Risk Status	0.17 (0.63)	0.00	0.10 (0.64)	0.12		

Model variable	Parameter estimate (*SE*)	*F*	Parameter estimate (*SE*)	*F*	Parameter estimate (*SE*)	*F*
PALS I × PALS II × Risk	−0.34 (0.83)	0.17	−0.48 (0.83)	0.34		
Slope	−1.42 (1.07)	11.90^{+}	−0.10 (0.04)	24.49^{++}		
Slope × PALS I	−2.68 (1.36)	0.27	0.02 (0.05)	0.01		
Slope × PALS II	0.20 (1.51)	0.95	0.08 (0.06)	5.95*		
Slope × Risk	−0.15 (1.63)	2.55	0.07 (0.05)	3.09		
Slope × PALS I × Pals II	4.66 (2.06)	0.00	0.38 (0.09)	3.01^{++}		
Slope PALS I × Risk	−6.10 (2.84)	1.35	−0.12 (0.06)	2.72		
Slope × PALS II × Risk	1.00 (2.15)	2.17	−0.14 (0.07)	1.20		
Slope × PALS I × PALS II × Risk	3.02 (1.93)	4.62*	−0.11 (0.07)	18.11^{++}		

Note. Intercept is set at the posttest assessment. Parameter estimates in analyses for the intervention were coded as DAS = 1, PALS = 0; for risk, term = 0, very low birth weight = 1. *F* values are Type 3 tests of fixed effects. Dashes indicate that the effect was not included in the final model. PALS = Playing and Learning Strategies; DAS = Developmental Assessment Screening; I = intervention in infancy; II = intervention in toddler-preschool period.

[a] *dfs* for intercept and slope = 1, 142; all others = 1, 269.

[b] *dfs* = 1, 406.

[c] *dfs* = 1, 403.

[d] *dfs* = 1, 249.

[e] *dfs* for intercept and slope = 1, 139; all others = 1, 249.

[f] *dfs* for intercept = 1, 139; all others = 1, 248.

[g] *dfs* = 1, 256.

$^{*}p < .05$.

$^{**}p < .01$.

$^{+}p < .001$.

$^{++}p < .0001$.

Table 7

Intervention Effects at Posttest (Intercept) and for Rate of Change (Slope) in Child Outcomes

Model variable	Parameter estimate (*SE*)	*F*	Parameter estimate (*SE*)	*F*	Parameter estimate (*SE*)	*F*
	Social skills with mother					
	Cooperation[a]		Social engagement[b]		Positive affect[c]	
Intercept	−0.67 (0.76)	−0.88	3.50 (0.14)	24.76^{++}	−3.38 (0.94)	−3.58^{+}
Child age	0.44 (0.28)	2.35	—	—	−0.31 (0.35)	0.82
PALS I	0.09 (0.19)	2.05	−0.18 (0.17)	0.20	0.18 (0.28)	0.17
PALS II	−0.38 (0.21)	4.10*	−0.44 (0.18)	7.73**	0.17 (0.33)	0.00
Risk	0.14 (0.13)	1.29	0.18 (0.11)	2.63	0.67 (0.34)	0.85
PALS I × PALS II	0.21 (0.27)	0.62	0.25 (0.23)	1.22	0.19 (0.42)	0.72
PALS I × Risk	—	—	—	—	−0.50 (0.44)	1.93
PALS II × Risk	—	—	—	—	−0.61 (0.47)	3.15
PALS I × PALS II × Risk	—	—	—	—	0.14 (0.61)	0.05
Slope	−0.10 (0.05)	0.85	0.09 (0.02)	32.41^{++}	−0.07 (0.08)	0.22
Slope × PALS I	0.11 (0.06)	1.80	−0.04 (0.02)	4.14*	0.04 (0.10)	0.03
Slope × PALS II	0.13 (0.07)	2.71	—	—	0.18 (0.13)	0.01
Slope × Risk	0.06 (0.03)	5.28*	—	—	0.14 (0.14)	0.14
Slope × PALS I × Pals II	−0.09 (0.10)	0.91	—	—	−0.17 (0.16)	0.28
Slope PALS I × Risk	—	—	—	—	−0.12 (0.17)	0.84
Slope × PALS II × Risk	—	—	—	—	−0.45 (0.20)	2.75
Slope × PALS I × PALS II × Risk	—	—	—	—	0.48 (0.25)	3.67
	Communication skills with mother					
	Use of Words[d]		Coordinating attention and word use[e]			
Intercept	−0.04 (0.79)	−0.06	−2.42 (0.66)	−3.69^{+}		
Child Age	0.33 (0.30)	1.25	0.19 (0.24)	0.63		
PALS I	−0.08 (0.17)	0.00	0.26 (0.21)	0.46		
PALS II	−0.42 (0.19)	7.82**	0.09 (0.25)	3.20		
Risk Status	0.30 (0.12)	5.65*	0.93 (0.26)	2.38		
PALS I × PALS II	0.15 (0.24)	0.40	−0.13 (0.32)	1.74		
PALS I × Risk Status	—	—	−1.00 (0.33)	5.70*		
PALS II × Risk Status	—	—	−0.91 (0.36)	4.05*		
PALS I × PALS II × Risk	—	—	0.88 (0.47)	3.46		
Slope	0.02 (0.04)	4.32*	−0.05 (0.05)	2.59		
Slope × PALS I	0.04 (0.05)	0.13	0.08 (0.08)	0.81		
Slope × PALS II	0.03 (0.06)	0.00	0.28 (0.10)	3.74		
Slope × Risk	—	—	0.07 (0.11)	0.08		
Slope × PALS I × Pals II	−0.05 (0.08)	0.44	−0.34 (0.13)	1.28		
Slope PALS I × Risk	—	—	−0.13 (0.14)	0.99		
Slope × PALS II × Risk	—	—	−0.27 (0.15)	0.17		
Slope × PALS I × PALS II × Risk	—	—	0.45 (0.20)	5.36*		
	Standardized language tests					
	PPVT-III[f]		PLS: Auditory Comprehension[g]		PLS: Expressive Comprehension[h]	
Intercept	1.76 (0.62)	2.83**	13.73 (5.71)	2.41*	13.05 (4.51)	3.15**

Model variable	Parameter estimate (*SE*)	*F*	Parameter estimate (*SE*)	*F*	Parameter estimate (*SE*)	*F*
Child Age	0.04 (0.02)	3.07	0.39 (0.19)	4.01*	0.33 (0.14)	5.64*
PALS I	0.18 (0.17)	1.17	−0.12 (1.33)	0.13	1.21 (1.00)	2.26
PALS II	−0.37 (0.16)	5.31*	−1.56 (1.72)	1.82	−0.92 (1.30)	2.09
Risk	0.40 (0.15)	3.43	2.30 (1.32)	5.16*	1.42 (0.99)	4.32*
PALS I × PALS II	0.28 (0.20)	1.91	0.94 (1.87)	0.25	−0.30 (1.40)	0.05
PALS I × Risk	−0.42 (0.20)	4.38*	—	—	—	—
PALS II × Risk	—	—	−0.35 (1.83)	0.04	0.08 (1.38)	0.00
Slope	0.04 (0.02)	99.00++	0.63 (0.16)	110.87++	0.17 (0.12)	99.70++
Slope × PALS I	0.04 (0.02)	0.15	0.22 (0.18)	1.17	0.19 (0.14)	0.01
Slope × PALS II	0.07 (0.03)	9.45**	0.17 (0.24)	0.40	0.71 (0.18)	5.06*
Slope × Risk	0.01 (0.02)	0.29	0.12 (0.11)	0.66	0.27 (0.09)	0.18
Slope × PALS I × Pals II	−0.04 (0.03)	1.39	−0.14 (0.28)	0.24	−0.36 (0.21)	3.01
Slope PALS I × Risk	−0.04 (0.02)	3.29	—	—	—	—
Slope × PALS II × Risk	—	—	−0.38 (0.16)	5.27*	−0.60 (0.13)	19.65++

Note. Intercept is set at the posttest assessment. Child age is at the pretest assessment. Parameter estimates in analyses for the intervention were coded as DAS = 1, PALS = 0; for risk group, term = 0, very low birth weight = 1, *F* values are Type 3 tests of fixed effects. Dashes indicate that the effect was not included in the final model. PALS = Playing and Learning Strategies; DAS = Developmental Assessment Screening; I = intervention in infancy; n = intervention in toddler-preschool period; PPVT-in = Peabody Picture Vocabulary Test–Third Edition; PLS = Preschool Language Scale–3rd Edition.

[a] *dfs* = 1,352.

[b] *dfs* = 1,420.

[c] *dfs* = 1,388.

[d] *dfs* = 1,256.

[e] *dfs* = 1,378.

[f] *dfs* = 1,420.

[g] *dfs* = 1,422.

[h] *dfs* = 1,288.

* $p < .05$.

** $p < .01$.

+ $p < .001$.

++ $p < .0001$.

Table 8

Summary of All Mediation Analyses Conducted

Intervention effect	Maternal behavior	a × b	*SE*	Lower CV	Upper CV	ACI lower value	ACI upper value	ACI *p*	Sobel lower value	Sobel upper value	Sobel *P*
					Children 's cooperation with mother						
PALS I	Warm, sensitivity	−0.06	0.032	−1.61	2.26	−0.11	0.01	*ns*	−0.12	−0.01	<.05
PALS I	Contingent responsiveness	−0.11	0.040	−1.69	2.20	−0.17	−0.02	<.05	−0.18	−0.03	<.05
PALS I × PALS II	Contingent responsiveness	−0.09	0.040	−1.63	2.24	−0.15	−0.00	*ns*	−0.17	−0.01	<.05
PALS II	Contingent responsiveness	−0.11	0.040	−1.69	2.20	−0.17	−0.02	<.05	−0.18	−0.03	<.05
					Children's social engagement with mother						
PALS I	Warm sensitivity	−0.23	0.07	−1.78	2.12	−0.35	−0.09	<.05	−0.36	−0.10	<.05
PALS I	Contingent responsiveness	−0.30	0.07	−1.80	2.10	−0.43	−0.15	<.05	−0.44	−0.16	<.05
PALS I × PALS II	Contingent responsiveness	0.29	0.09	−1.74	2.15	0.13	0.49	<.05	0.11	0.47	<.05
PALS II	Contingent responsiveness	−0.32	0.07	−1.80	2.10	−0.45	−0.17	<.05	−0.46	−0.18	<.05
PALS I × PALS II	Redirect[a]	1.26	0.76	−1.54	2.31	0.09	3.00	<.05	−0.23	2.74	*ns*
PALS I	Maintain	−0.03	0.02	−1.51	2.32	−0.07	0.016	*ns*	−0.08	0.01	*ns*
PALS I × PALS II	Redirect	0.04	0.02	−1.49	2.34	−0.00	0.10	*ns*	−0.01	0.09	*ns*
Slope × PALS I	Verbal scaffolding[a]	−0.02	0.01	−1.48	2.34	−0.04	0.01	*ns*	−0.05	0.01	*ns*
Slope × PALS I	Verbal scaffolding	−0.01	0.01	−1.55	2.29	−0.01	0.00	*ns*	−0.02	0.00	*ns*
					Children's affect with mother						
PALS I × PALS II	Warm sensitivity	0.13	0.07	−1.58	2.29	0.02	0.29	<.05	−0.01	0.27	*ns*
PALS I × PALS II	Contingent responsiveness	0.10	0.06	−1.55	2.30	0.01	0.24	<.05	−0.01	0.22	*ns*
PALS I	Warm sensitivity	−0.12	0.06	−1.64	2.24	−0.21	0.00	*ns*	−0.23	−0.01	<.05
Slope × PALS I × Risk Group	Affect	0.13	0.07	−1.20	2.50	0.05	0.31	<.05	−0.01	0.27	*ns*
PALS I	Contingent responsiveness	−0.10	0.05	−1.63	2.24	−0.18	0.02	*ns*	−0.19	0.00	*ns*
PALS II	Contingent responsiveness	−0.09	0.05	−1.57	2.29	−0.17	0.03	*ns*	−0.18	0.01	*ns*
PALS II	Warm sensitivity	−0.11	0.06	−1.58	2.29	−0.20	0.02	*ns*	−0.22	0.00	*ns*
					Children's use of words with mother						
PALS I × PALS II	Contingent responsiveness	0.12	0.05	−1.68	2.21	0.04	0.22	<.05	0.02	0.21	<.05
PALS I × PALS II	Warm sensitivity	0.06	0.04	−1.57	2.30	0.01	0.15	<.05	−0.01	0.13	*ns*
PALS I	Contingent responsiveness	−0.11	0.04	−1.71	2.18	−0.17	−0.02	<.05	−0.18	−0.03	<.05
PALS I	Warm sensitivity	−0.08	0.03	−1.66	2.22	−0.13	−0.01	<.05	−0.14	−0.01	<.05
PALS II	Contingent responsiveness	−0.11	0.04	−1.71	2.18	−0.18	−0.02	<.05	−0.19	−0.03	<.05
PALS I	Maintain[a]	−2.63	1.50	−1.55	2.30	−4.95	0.81	*ns*	−5.56	0.30	*ns*
					Children's coordination of attention and word use with mother						
PALS I × PALS II	Contingent responsiveness	0.09	0.06	−0.83	2.51	0.04	0.24	<.05	−0.03	0.21	*ns*
PALS I	Contingent responsiveness	−0.09	0.04	−1.55	2.29	−0.16	0.01	*ns*	−0.18	−0.01	<.05
PALS II	Redirect[a]	0.78	0.83	−0.81	2.56	0.11	2.91	<.05	−0.85	2.41	*ns*
PALS I	Redirect	0.07	0.06	−0.77	2.74	0.02	0.24	<.05	−0.06	0.19	*ns*
Slope × PALS I × Risk Group	Affect	0.06	0.04	−1.10	2.43	0.02	0.15	<.05	−0.02	0.13	*ns*
PALS I	Warm sensitivity	−0.08	0.04	−1.45	2.31	−0.15	0.02	*ns*	−0.17	0.00	*ns*
					One word receptive vocabulary (PPVT)						
PALS I × PALS II	Contingent responsiveness	0.64	0.38	−1.64	2.24	0.02	1.50	<.05	−0.10	1.39	*ns*
PALS I	Maintain[a]	−0.40	9.27	−1.62	2.32	−25.42	11.07	*ns*	−28.57	7.77	*ns*
PALS I	Contingent responsiveness	−0.61	0.34	−1.74	2.18	−1.21	0.13	*ns*	−1.29	0.06	*ns*
PALS II	Contingent responsiveness	−0.64	0.36	−1.74	2.18	−1.26	0.14	*ns*	−1.34	0.06	*ns*
Slope × PALS I	Contingent responsiveness	−0.08	0.05	−1.47	2.35	−0.16	0.05	*ns*	−0.18	0.03	*ns*
Slope × PALS I	Verbal scaffolding	−0.08	0.08	−0.68	3.44	−0.13	0.19	*ns*	−0.23	0.08	*ns*

Note. Negative effects are due to coding of treatment effects as DAS = 1, PALS = 0 so that this does not indicate that the mediation is a negative relation. PALS = Playing and Learning Strategies; DAS = Developmental Assessment Screening; I = intervention in infancy; II = intervention in toddler-preschool period; a × b = Product of the two effects; *SE* = Standard error of the product of the two effects; Lower CV and Upper CV = critical values from Meeker's (1981) tables; ACI = Asymptotic confidence interval value; *ns* = not significant.

[a]Variable is log transformed.