Technologies for expanding the reach of evidence-based interventions: Preliminary results for promoting social-emotional development in early childhood

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Echoing more than three decades of research, a recent report on the impact of early childhood intervention programs underscores the consensus that children who are nurtured from their earliest stages of development have the best chances of achieving school-readiness and life-long success (Isaacs, 2008). Lifelong cycles of disadvantage established in early infancy can be driven by general risks such as poverty as well as by specific individual risks including early biological vulnerability (e.g., low birth weight or disability) and exposure to environments characterized by harsh, insensitive, and non-responsive caregiving (Aber, Jones, & Cohen, 2000; Bradley, Whitehead, & Mundfrom, 1994; Yoshikawa, 1994). Our best chance at optimizing children's developmental trajectories, and the associated probabilities of school readiness, is by intervening early and consistently throughout early childhood with evidence-based interventions demonstrated to support social-emotional development through nurturing, responsive interactions with caregivers. Substantial evidence indicates that consistent, high quality interactions with caregivers beginning in infancy and continuing throughout early childhood makes a profound difference in children's developmental outcomes as well as in long-term savings in human cost and social expenditures (see Isaacs, 2008; Kagan & Neuman, 2000; Landry et al., 2001; Lyons-Ruth, Melnick, 2004; Smith, Landry, & Swank, 2006).

To date, intervention efforts focused on positive behavior support as a mechanism for fostering social-emotional development in early intervention settings tend to begin in the preschool years at the earliest. However, for the most vulnerable at-risk infants and toddlers, the achievement gap often emerges long before they reach the preschool door (Melmed, 2008). The role of high quality, responsive caregiving in early infancy been identified as a crucial precursor of school readiness in recent research (Landry et al., 2001). Furthermore, it is a relatively recent phenomenon of Part C (infant/toddler) special education to recognize impairments in social-emotional development as one of the five domains of developmental disability. As measures improve and programs become more proficient at identifying social-emotional disabilities, the demand for appropriate intervention will likely continue to grow. Currently, the Office of

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Special Education Program's (OSEP) policies mandate that states report the annual progress of children and families receiving Part C special education services with respect to child outcomes, which include positive social-emotional skills and relationships, as well as family outcomes such as the family's ability to help children learn and develop (Regional Resource & Federal Center Network, 2006). Also recognizing the importance of early social relationships, Early Head Start standards require that programs promote parent-child bonding and nurturing parent-child relationships (Administration for Children and Families, 1996). Recent national projections indicate that the number of infants and family members receiving Early Head Start services will nearly double within the next year, allowing the program to serve approximately 75,000 participants (Health and Human Services, 2009). Though these expansions point to the growing demand for interventions to support infant social-emotional development, knowledge among early intervention providers about evidence-based interventions for doing so is extremely limited. This is likely due to the fact that the evidence base for effective intervention is quite new and that systemic barriers have historically tended to prohibit broad scale infusion of evidence-based interventions into practice (Walker, 2006).

Early intervention efforts have only recently begun to focus on infant social-emotional development relative to setting the stage for school readiness (Landry, 2001; Lyons-Ruth & Melnick, 2006; Webster-Stratton, 2008). These efforts build on research, conducted over the past three decades, which has consistently supported the importance of warm, sensitive, and responsive caregiver behavior as the basis for infant attachment (George & Man, 1979; Sroufe, Carlson, & Schulman, 1993; Solomon & George, 1999; Zeanah & Zeanah, 2001) and, more recently, infant social-emotional development (Landry et al., 2001; van den Boom, 1994; van den Boom, 1995). A constellation of behaviors that reflect sensitivity and responsiveness have a strong empirical basis in predicting child social-emotional behavior. For example: (a) studies driven by attachment and behavioral theory, have shown that high levels of caregiver acceptance and warmth predict child positive feedback and pro-social behavior (George & Main, 1979; Zanolli, Paden, & Cox 1997); (b) behaviorally and socio-culturally driven studies have shown that rich descriptive language, especially when linked to children's interests (i.e., following children's lead) predicts children's engagement and expressive communication (Hart & Risley, 1995; Tamis-LeMonda et al. 2001); (c) maintaining children's interest has been shown to promote joint attention and follow-through (Landry et al. 2001; Landry et al. 2006); and (d) caregiver support to reduce child distress has been associated with active child engagement and less avoidant and withdrawn behavior (Field, 1994; George & Main, 1979). Moreover, while the caregiver behaviors described above facilitate positive child social-emotional behavior and thus promote school readiness (Landry et al. 2001; Landry et al., 2006; Van IJzendoorn et al, 2006; Van den Boom, 1995), adverse caregiver behaviors predict poor social-emotional outcomes. In particular, (a) harsh, critical behavior has been linked with both externalizing and internalizing problem (Bean et al., 2006; Lyons-Ruth et al., 1997); (b) as predicted by psychological control theory, highly restrictive and intrusive behavior has been linked to child internalizing problems (Barber 2002); and (c) as hypothesized by attachment theorists, rejecting behavior predicts child withdrawal (George & Main, 1979).

Recently, interventions, aimed at improving parent sensitivity and responsiveness during interactions with their children have been demonstrated to alter the key aspects of parent sensitivity and responsiveness highlighted above, and thereby improve infant social-emotional behavior and development outcomes (Landry, 2008; Lyons-Ruth, & Melnick, 2004; Van den Boom, 1995). Moreover, interventions targeting sensitive and responsive parenting appear to promote social development similarly in children with identified disabilities, children at-risk for disabilities, and children who are typically developing (Landry et al., 2008).

Lack of Successful Translation of Evidence-Based Intervention: Barriers that Impede Progress

Though evidence-based interventions exist for supporting infant social-emotional development through sensitive, responsive interactions with caregivers, such interventions have by and large not yet reached children and families through general early intervention service delivery systems such as Part-C or Early Head Start. Sadly, history has shown that moving evidence-based (EB) interventions into usual practice is more easily said than done (Carnine, 1997; Kazdin, 1991). Several barriers, as noted below, have contributed to a significant, 20-year, lag time between the availability of EB practices and their effective use in usual education and community practice (Walker, 2006). There has been an accumulation of literature, across disciplines, demonstrating remarkable similarity in factors potentially responsible for this lag (Corrigan, Steiner, McCracken, Blaser, & Barr, 2001; Glasgow, Marcus, Bull, & Wilson, 2004; Sanders, 2003; Turner & Sanders, 2006; Walker, 2006). The barriers most often mentioned include lack of perceived relevancy, efficiency, accessibility and affordability. More specifically, (a) providers may lack knowledge of the importance of EB practices in general or for specific service delivery or may be unconvinced about the added benefit these practices would bring, and (b) actual or perceived lack of lack time or resources for direct service staff to deliver the intervention, receive training, or participate in ongoing supervision and professional development necessary to implement the intervention with fidelity (e.g, Friedrichsen & Stamm, 2003; Gale & Deprez, 2003;Nordal, Copans & Stamm, 2003).

Internet-Based Technologies

In light of the above barriers, a prominent challenge facing the early intervention field is to identify mechanisms to facilitate the speedy implementation of evidence-based interventions for promoting social-emotional development in educational practice settings. The rise of Internet use, paired with the many recent advances in computer networking and multimedia technology, has created potential new avenues for intervention delivery. (Feil, Baggett, Davis, Sheeber, Landry, & Carta, 2008; Feil, Baggett, Davis, Sheeber, Landry, & Carta 2009). Computer-mediated interventions and assessments, including those that are delivered in part or entirely online, have become feasible due to the wide penetration of Internet access. In 2008, estimates indicated that more than 70% of the adult population in the U.S. used the Internet, with similar rates of use reported for men and women (i.e., 73% and 75% respectively; Madden, 2006). Moreover, Internet use is rapidly crossing key demographic thresholds. While a digital divide continues to exist for those who are poor and of non-majority status, evidence suggests that this divide is shrinking (Madden, 2006). In a study examining propensity for Internet-delivered intervention in a state that contains many miles of rural and remote areas, data from 2006, showed that statewide, 77 % of early intervention centers and 80 percent of homes had Internet access with a regional range of 64% to 91% (Washington State Department of Early Learning, 2008). Due to the rapid increase in Internet penetration over the past three years, these numbers may reflect an underestimate for the current year.

The Internet offers many advantages over traditional home- and clinic-based approaches to delivering behavior change programs (Ondersma, Martin, & Chaffin, 2008; Taylor, et al., 2008). One of the foremost advantages of technology-based delivery mechanisms, as compared to traditional approaches, is that they dramatically increase the potential to reach individuals for whom the intervention was intended. This is a particularly important advantage given compelling evidence from public health research that wide penetration of delivery can lead to powerful impact, even when effect sizes are small (Abrams, 2007). Factors likely to contribute to improved reach of Internet-based interventions include the following: (a) accessibility; (b) cost efficiency, (c) amenability to and flexibility of individual implementation, and (d) more structured intervention integrity (Ondersma et al., 2008). With regard to accessibility, Internet-based interventions facilitate 24-hour use, enable access from various settings (e.g., homes and

early intervention centers), and have potential for delivery in multiple languages, improving accessibility for linguistically diverse populations. In terms of cost-efficiency, Internet-based interventions eliminate monetary and time costs associated with travel to and from service settings, a significant savings over home-visiting approaches, especially in rural and remote locations. Internet-based intervention programs also allow for relative ease of, and flexibility in, individualizing program implementation to address the needs of various users (e.g., customization of audio and visual text displays; completion of sessions at times convenient to the individual). With regard to direct service intervention integrity, Internet-based formats are structured and consistent in their presentation, thus helping to ensure accuracy and completeness of program content presentation and avoiding implementation fidelity problems that often ensue due to lack of interventionist adherence to intervention protocols with traditional home-or clinic-based delivery.

The Present Study

In an effort to address common barriers that interfere with evidence-based interventions reaching children and their families, we examined an Internet-based adaptation of an evidence-based intervention, the Play and Learning Strategies program (PALS; Landry & Smith, 1996). This approach was designed to harness both the existing advantages of an established evidence-based intervention and the unique delivery advantages that may be possible via the Internet as described above. We selected this particular intervention based on several considerations (see Feil et al., 2008), which included the following: (a) it has demonstrated effectiveness in increasing sensitive and responsive parenting behaviors as well as in improving child social-emotional behavior and developmental outcomes (Landry, et al. 2008; Akai, et al., 2008); (b) it makes use of educational and therapeutic strategies that have been shown consistently to promote behavioral effectiveness, including skills instruction and direct coaching of behavioral skills, active engagement of parents in personal behavior reflection, and between-session skills practice (see Kaminski. Valle, Filene, & Boyle, 2007); and (c) Intervention and assessment materials were developed and available, including parent training videos, highly detailed and specific coaching guides for session content, measures of implementation fidelity, parent engagement, parent knowledge acquisition, parent responsiveness and child behavioral engagement based on direct observation were developed and available (Feil et al., 2008).

Research questions—Through a randomized-control trial, as described in the Method section to follow, we tested the effects of the Infant-Net system with regard to the following research questions: (a) Would parents engage in an Internet-delivered intervention designed to support their infant's social-emotional development; (b) Would the intervention promote sensitive and responsive interactions and, thereby, yield improvements in infant social outcomes; (c) Would the intervention function protectively to buffer against maternal depressive symptoms; and (d) Would mothers perceive the intervention to be easy and satisfying to use?

Method

Participants

Participants included 40 infants and their mothers living in Lane County Oregon and income-eligible for Early Head Start and the Women Infants and Children program (WIC) as defined by an annual gross income at or below 185 percent of the U.S. Poverty Income Guidelines. Families were recruited from flyers posted in public and community service settings such as WIC clinics, pediatric clinics, and libraries. At the time of enrollment, infants ranged in age from three to eight months and on average were four months of age. Among the 40 families enrolled in the study, two dropped out. One family had been assigned to the treatment condition

and the other to the control condition. Both families dropped out immediately following pre-assessment. One family reported a major change in life events which she believed would interfere with participation in the study and the other could not be reached. Descriptive information is provided for the 38 families who remained in the study. Fifteen percent of the mothers were Hispanic/Latina, 2.5% were American Indian, 5% were African American, 82.5% were White, 7.5% reported more than one race category, and 2.5% did not report race or ethnicity. Mothers evidenced a wide range of educational attainment; 8% did not complete high school, 22% obtained a high school degree, 44% attended some college and 28% graduated from college. Based on mothers' report, infants were 45% female, 25% Hispanic/Latino, 5% were American Indian, 2.5% Asian, 5% were African American, 65% were White, and 22.5% reported more than one race category.

The sample reflected a high prevalence of significant maternal depressive symptoms. Thirteen mothers (31%) obtained scores on the Post-Partum Depression Screening Scale (PDSS) indicating significant postpartum depression symptoms. Three mothers (6%) obtained scores indicating the need for immediate treatment referral due to high risk for Major Post-Postpartum Depression.

Intervention and Study Procedures

After completing baseline assessments, comprised of demographic interview, questionnaires and direct observation, participants were randomized to either the Experimental (Infant-Net) or Control (computer/Internet only) condition.

Prior to intervention, both groups were provided with an instructional manual for the computer. Written at approximately a third-grade reading level, the manual featured screen shots illustrating how to use the laptop computer and access the Internet. The instructional manual was reviewed with each mother immediately following the pre-intervention assessment by the home-visiting assessor. During the 30-minute instruction, mothers followed the instructional guide to use their laptop. In addition, mothers in the intervention group received brief instruction in using the Infant-Net program. Training consisted of an instructional manual written at approximately a third grade level and featuring screen shots illustrating functionality of the program. During an approximately 15-minute practice, mothers navigated through each key step of using the system with the support of the manual in the presence of the research assistant who provided support as needed.

Computer-control condition—This condition was designed to control for the potentially confounding effect of introducing computer and Internet technology into the homes of families. Mothers randomized to this condition received a computer and Internet connection for 6 months; the computer had word processing software as well as links to infant development and parenting resources on the Internet.

Infant-Net condition—Mothers randomized to this condition received a computer and Internet connection for 6 months as well as the Infant-Net program (the Internet-adapted PALS program). In the traditional PALS program format, sessions are implemented by trained facilitators (coaches), who build supportive one-on-one relationships with the child's caregiver and use videos to demonstrate key principles and behaviors. The PALS program consists of 10 home-based sessions, lasting about 90 minutes each and targeting parents' ability to read infant signals, respond with warm and sensitive behaviors, maintain infants' focus of attention, watch for opportunities to introduce an object or social game, and use of rich verbal content in combination with physical demonstrations, and incorporate this constellation of behaviors in everyday activities such as dressing, feeding, and playing. In addition to these 10 sessions, another session, reading with babies (Read to Me, Inc.;

http://www.readtomeprogram.org/index.html), was included in 2003 to enhance very early pre-literacy development. The PALS and Infant-Net intervention content, including video models, is the same. The relative alignment of intervention process between PALS and Infant-Net is presented in Figure 1.

In order to provide the same content and learning opportunities within the Internet-facilitated adaptation of PALS, the Infant-Net program included the following: (a) a multi-media, instructional presentation of concepts, behaviors, and skills via video examples featuring parents and infants diverse in race, ethnicity, and age; this presentation adhered to principles found in the literature to be associated with the effective design of teacher-led classroom instructional materials (Kameenui & Carnine, 1998) as well as the principles more recently found to be associated with effective distance learning (Clark, 2002); (b) check-in questions dispersed throughout each session, with answers recorded to a data base for review by both parent and coach after each session's self-directed learning period; (c) a summary of key session concepts; (d) daily activities (homework) based on skills taught in each session; (e) the creation of a 5-minute computer-collected video of mother-infant interactions implementing session skills for later remote co-review by coach and parent; and (f) a weekly telephone coach call to co-review mother-infant computer-administered video and session content and provide individualized support in skill practice and acquisition. In earlier testing, we found that session completion time for the self-directed portion of the Infant-Net program (components a–e above; see Figures 2–4 for sample Internet pages) required 25 to 35 minutes. Following the self-directed portion of each session parents were asked about their experience and satisfaction with the session (see Feil, Baggett, Davis, et al., 2008 for detailed discussion of Infant-Net creation).

In addition to the self-directed program and ongoing contact with a coach, the Infant-Net intervention also included a mechanism for online parenting support and information-sharing via a Bulletin board. The bulletin board took advantage of the Internet technology to approximate the group support thought to be an integral component of traditional parenting groups (Taylor et al., 2008). Through peer and professional contact, participants are able to tell success stories, address questions or issues, and participate in discussions about general community support opportunities.

The Infant-Net program allowed administrative staff to monitor and track, online, each participant's activities and responses during self-directed learning activities as well as their online involvement during the coach call (see Figure 5). This information allowed the coach to make maximum use of program information during coach calls to support mothers' progression through the program. In addition, this information was electronically stored for summary and analysis of information such as the amount of time participants spent using the program (e.g. the amount of time spent in each session and in each activity component within sessions), degree of program completion within and across sessions, accuracy of responses to check-in questions, ease of use, and satisfaction. In the current study, the coach was a masters-level individual at the University of Kansas, certified as a facilitator for the original PALS parenting program.

Assessments Procedures and Measures

All families participated in pre-assessment prior to randomization as well as a post-assessment, conducted six months after pre-assessment. Assessments were conducted by a research assistant in each family home. Assessments at both time points consisted of questionnaires regarding maternal and infant functioning as well as direct observation of mother-infant interaction, which was video recorded. In addition, a parent satisfaction questionnaire was administered at post-assessment.

Mother-infant interaction—The Landry Parent-Child Interaction Scales (Landry, et al, 1998) were used to code observed mother-infant interactions. The Landry Scales were designed to assess naturalistic parent-child interaction. The Landry Rating Scales were completed following a 30-minute free-play observation, in which mothers were encouraged to interact with their infants as they typically do at home. Items pertaining to caregiver behavior include positive affect, warmth, flexibility, and positive verbal content, physical intrusiveness as well as verbal and affective negativity. Items pertaining to infant behavior include attention/arousal, warmth-seeking, and behavioral regulation. Each item was rated on a five- to seven-point Likert-type scale. The Landry Scales have been used in a series of federally-funded longitudinal and intervention studies over the past twelve years, yielding evidence of adequate reliability and predictive validity with regard to child social-emotional outcomes (see Landry et al., 2001; Landry et al., 2008).

Videos of mother-infant interactions were coded independently by coders at the University of Texas, who were trained to criterion prior to coding, and who were blind to treatment condition and time point (pre-/post- intervention). Fifteen percent of videos were independently coded by a second coder, yielding an inter-rater correlation of .88 for mother and infant behavior ratings.

Postpartum depression—The Postpartum Depression Screening Scale (PDSS; Beck & Gable, 2003) is a self-report instrument designed to identify women at high risk for postpartum depression. It consists of 35 items rated on a 5-point scale ranging from "strongly disagree" to "strongly agree". Written at a third grade reading level, it takes approximately 10 minutes to complete. The test yields an overall severity score falling into one of three ranges: (a) Normal adjustment, (b) Significant symptoms of postpartum depression, or (c) Positive screen for major postpartum depression. In addition, norms are provided for seven symptom areas. Reliability is adequate and with regard to predictive validity, it demonstrates superior sensitivity in detecting depression for women post-partum as compared to the Beck Depression Scale (Beck & Gable, 2003).

Program engagement, ease of use and satisfaction—Parent engagement in the program was measured via electronic tracking of the following: degree of program and session completion, amount of time parents spent in each session, and amount of time spent in activity components of each session. Measures of ease of use and parent satisfaction were collected electronically via parent report at the end of each session based on questions with a three-point response scale. In addition, a satisfaction questionnaire, containing seven items with a five point-response scale, was administered at post-assessment.

Results

Prior to addressing the research questions, preliminary analyses were conducted to examine whether randomization to condition did in fact result in group equivalence. As shown in Table 1, no significant differences were found between groups at pre-assessment with regard to demographic data, parent-reported Internet access, comfort with computer use, or mother-infant interaction behavior variables. It should be noted that two times as many families in the control condition, as compared to the intervention condition, were receiving Early Head Start (EHS) services. Though this difference in enrollment in Early Head Start services is not statistically significant, the higher number of families receiving (EHS) services in the control group provided a more stringent test of our intervention condition. That is to say, an equal playing field between the treatment and control groups, with regard to receipt of community support in the form of EHS services, was not in place. Rather, the intervention group was at a disadvantage with only half as many families receiving EHS services, despite no between-group differences in EHS eligibility. Hence, this comparison provided a stronger test of

intervention than if both groups had the same number of families receiving community support of EHS services.

The results presented herein revolve around answering the four main questions: (a) Would parents engage in an Internet-delivered intervention designed to support their infant's social-emotional development; (b) Would the intervention promote sensitive and responsive interactions and, thereby, yield improvements in infant social outcomes? (c) Would the intervention function protectively to buffer against maternal depressive symptoms; and (d) Would mothers perceive the intervention to be easy and satisfying to use?

Q1: Engagement

Electronic tracking of sessions completed, hours spent in the Infant-Net program overall, as well as hours spent in each program activity were calculated to provide a descriptive overview of how mothers connected utilized the Infant-Net program. Results indicated that, for the 19 mothers in the Infant-Net condition, completion rates were very high. 84% (16/19) of mothers completed all 11 sessions, with 1 mother (5%) completing through session 9 (i.e., through all skills teaching sessions), 1 mother (5%) completing through session 5, and 1 mother (5%) completing through session 3.

On average, Infant-Net mothers who completed the program spent 22.7 hours (range = 11.6 to 46.1 hours; sd = 12.14) logged into the Infant-Net program. This overall time estimate involved not only time spent in self-directed learning, weekly coach support, and other social support activities but also review time because mothers were allowed to re-enter sessions to view past videos and material at any time of their choosing. Data on how time was distributed for mothers over self-directed learning aspects of the program and in coach contact indicated that, on average, 40% of mothers' time was spent in the Infant-Net self-directed instructional pages; 33% of their time was spent in video pages, making and viewing their mother-infant interactions; 12% of time was spent in the coach call pages of sessions; 7% of their time was spent on daily activities pages (learning about homework) and check-in questions; and 1% of time was spent on session summary pages. The remaining 7% of their time was spent using the social support bulletin board function. Most program use for mothers (80% of time spent) occurred during the day (5 am – 5 pm), with 19% of time spent occurring between 5 pm – midnight and 1% occurring from midnight to 5 am.

Q2 & 3: Mother and Infant Outcomes

We conducted 2 (time) × 2 (condition) repeated measures ANOVAs on infant and mother positive behaviors as observed during mother-infant interactions as well as on maternal depression (see Figures 6, 7, and 8, respectively). With regard to infant functioning, results indicated a significant time × condition interaction ($F = 4.3$; $p = .045$; $\eta^2 = .107$, associated with a moderate to large effect size), with infants in the Infant-Net condition improving significantly more than those within the control condition (i.e., Infant-Net pre-post mean change from 3.5 to 4.1 and sd = .67; Control pre-post mean change from 3.7 to 3.8 and sd = .69). In respect to maternal functioning, results of the time X condition interaction indicated a trend toward significance for both maternal positive behavior in interaction with their infant (time × condition $F = 1.86$; $p = .18$), associated with a moderate effect size ($\eta^2 = .05$), as well as maternal depression (time × condition $F = 2.71$; $p = .10$) associated with a medium to large effect size ($\eta^2 = .07$). To further examine intervention effects on maternal and infant observed behavior, pre-post change scores for both behavioral outcomes were calculated across both conditions and a correlational analysis was conducted to determine the relation between the changes observed. Results indicated a significant correlation ($r = .47$; $p < .01$). Frequency analysis on change scores by condition indicated that the average change score for Infant-Net mothers and infants was x = .15 (sd = .62) and x = .62 (sd = .75), respectively and x = −.19 (sd

= .68) and x = .13 (sd = .72) for Control mothers and infants, respectively. Finally, we would note that because of the high level of Infant-Net engagement and program completion, lack of variability in these indicants precluded the conduct of analyses to examine dosage effects.

Q4: Ease and Satisfaction

With regard to ease of use questions, rated on a 5-point Likert scale, 95% of Infant-Net mothers reported that it was somewhat (4) or very (5) easy to find information on the program website, use the website to complete the skills-training sessions, understand the audio and text information presented, and use the camera function to videotape interactions with their infant. We defined satisfaction as perceived helpfulness as well as maternal sense of connection to the program. Relative to helpfulness, 95% of mothers reported the in-session skills-modeling video vignettes as "probably" to "definitely" helpful to them in learning the Infant-Net skills. Moreover, 95% to 100% of mothers found the coach phone calls, viewing their own video with their infant along with the coach, discussions with the coach, and coach feedback to them as "somewhat" to "very" helpful in learning the Infant-Net skills. As regards maternal connection to the Infant-Net program, 90% of mothers felt their remote coach was interested in them; 85% felt their coach understood them and their baby, and 85% of mothers would recommend this program to their friends.

Discussion

Results of this study provided preliminary support for an Internet-based intervention aimed at promoting infant social-emotional behavior through sensitive, responsive interactions with mothers. Furthermore it provides evidence that interventions delivered via remote technologies such as the Internet, though commonly viewed as static and impersonal, can be interactive, dynamic, easy to use, and can contribute to parents' sense of connection, as indicated by parent report of high satisfaction and sense of connection with a remote coach. These results counter commonly held myths such as that Internet-delivered interventions are too complicated and too expensive for use by individuals affected by poverty.

With respect to parent engagement in intervention, the completion rate was much higher than that typically found in home-visiting programs (Gomby, Culross, & Behrman, 1999). The high completion rate may be due, in part, to the Infant-Net program's structure (i.e., remote, non-threatening, 'around-the-clock' availability of the self-directed and bulletin-board components) that enabled mothers to access services in a manner that could fit easily into their busy lives and could reduce emotional (e.g., shame; embarrassment) or practical barriers (e.g., transportation; work schedules) that can interfere with participation in services (Thompson, Flood, & Goodwin, 2006).

Not only did parents engage in the intervention, but infants whose mothers received the intervention showed significantly more social engagement with their mothers as well as engagement with the environment during interactions with their mothers as compared to infants in the control group. Although the between group difference in change in mothers' interactional behavior with their infants was not statistically significant within this extremely small study sample with restricted power, trends toward significance, reflecting a medium effect size, indicate the potential of the intervention and suggest that it warrants further investigation within an adequately-powered study.

Results with regard to intervention effects on maternal depressive symptom, while also not statistically significant, were encouraging in light of the medium to large effect size obtained. Though the PALS intervention is not aimed at reducing maternal depression per se, we examined it as an outcome for several reasons. First, rates of maternal depressive symptoms were high in our relatively rural sample, affecting nearly one-third of mothers. Second, prior

investigation has shown that parent perceptions of social support predicts greater improvement in parent responsiveness for families receiving PALS intervention as compared to those who are not (Guttentag, Pedrosa-Josic, C., Landry, S., Smith, K., Swank, P. 2006). Though the mechanism for this relationship is unclear, it is possible that high quality PALS coaching may serve as a social support that actively fosters parent attention to and reflection on parents own positive behaviors as well as the positive impact that such behavior has on their child's behavior. This process could conceivably help to mitigate symptoms of depression, which are known to interfere with responsive parenting. Third, it is also possible that as mothers become more skilled in interactions with their infants, the interactions become more rewarding and contribute to reductions in depressive symptoms. As mothers become more competent in reading their infants' signals and framing their infants' behavior in terms of developmental phenomenon as compared to personalizing their infant's negative signals, these positive reframing skills could counter depressive symptoms.

A notable aspect of our findings was that mothers in the control condition showed greater impairment with regard to both interactional behavior and depressive symptoms at the post-assessment relative to the pre-assessment, while mothers in the treatment group demonstrated improved functioning. These finding are consistent with both descriptive and experimental studies, which have shown that among high-risk dyads (in particular those at risk due to low family income and low infant birth weight), maternal responsiveness decreases over time in the absence of intervention (Guttentag, et al., 2006; Landry et al., 2001; Landry et al., 2008). It is possible that mothers in high-risk dyads found it increasingly difficult to respond in a sensitive and responsive manner as demands for care changed with infant development. This could lead to less satisfaction in their relationship with their infants, and potentially greater levels of depressive symptoms. Alternatively, the prevalence of post-partum depression increases at around 4 months post-birth (Beck & Gable, 2003), and increasing depressive symptoms may contribute to reductions in sensitive and responsive parenting behavior. In either case, this pattern of results suggests that the intervention may function to buffer mothers against a downward spiral characterized by deteriorating mood and parenting behavior. Further research is needed to examine the nature of the relationship between indicants of parent-child interaction and those of maternal symptoms of depression in response to interventions aimed at enhancing maternal sensitivity and responsiveness.

Study Limitations

Though the results provide preliminary support for the Infant-Net intervention as a potentially engaging and effective program for mothers and their infants, the present study had several limitations that deserve mention. First, the current study was a small, intervention-development project that included a small-sample pilot RCT evaluation. The small sample size likely contributed to the absence of statistically significant results with regard to intervention effects on maternal functioning. Further investigation on larger samples is quite clearly needed. Second, the pilot evaluation sample also included a relatively homogeneous sample as regards race and ethnicity, consisting primarily of non-Hispanic, Caucasian mothers. This sample composition clearly limits the generalizability of the results to mothers of other cultures and races, and studies with more diverse samples are warranted. In our current efforts, we are seeking funding to overlay a Spanish language version of the PALS program onto the Infant-Net remote-delivery platform such that future samples can include greater diversity, including mono-lingual Spanish speakers. Third, the preliminary nature of this evaluation limited the scope of maternal and infant outcomes to be investigated. We focused on direct observations of mother and infant positive behavior, which were independently collected and coded from those observations that served as part of the Infant-Net intervention protocol, as our primary between-group outcomes, and included a secondary outcome focus on maternal report of depressive symptoms. The use of single-indicant outcomes does not provide the most stable

estimate of intervention effects. Thus, future evaluations should involve examination of a more diverse set of multi-agent/multi-method outcomes in order to allow for greater confidence in the results. Finally, in this small and initial exploratory study, we used a traditional control group rather than a strong attention-control condition. That is, while we provided the control group with laptop computers and Internet access to control for the introduction of the Internet and computers into family homes, control families did not create interaction videos nor were we able to provide equivalent time for coaches to interact with control families via phone calls. Also, we did not electronically monitor the time that families in both the treatment and control group spent on the Internet outside of the intervention.

Implications

In light of the promising results of the current study as well as its limitations, implications for future research include the need to conduct larger randomized control trials to test the effects of the Infant-Net intervention. Future studies should focus on inclusion of racially and ethnically diverse participants. Measures of dosage should include time spent in active as well as passive engagement while in the program. Future research efforts should also include an attention-control condition to control for possible effects video recording interaction and for coach time spent with families. Finally, monitoring and analysis of Internet use by parents in both the treatment and control group could provide useful information about effects of the intervention apart from any potential effect of Internet use alone.

The potential impact of Internet-based intervention programs to overcome barriers to evidence-based intervention service delivery is great. Such technologies present advantages to reaching families, as well as professionals, who, respectively, may not otherwise be able to receive direct evidence-based intervention services or individualized training and ongoing support for implementing them. Though limitations exist in terms of access to the Internet, these limitations have decreased substantially within the past few years and are projected to continue to decrease. In addition, emerging technologies, such as wireless laptops, Internet appliances, web TV, and voice recognition, as well as the convergence of these technologies, are creating further opportunity and sophistication for applications and delivery of Internet-based intervention. Consequently, research on these applications and their effects represents an important area of inquiry in general.

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Intervention Features	PALS Program	Infant Net Program
Adult learning focus	All sessions	All sessions
	Judicious review and reflection with coach	Reflects principles of instructional design and e-learning
Coach relationship	In person	Phone, email, web
Video modeling	Every Session	Every Session
Session skill practice	Every session	Every Session
Video reflection of skill practice	Conducted with active coach support Conducted immediately following practice	Video-recorded and viewed remotely by coach Conducted within the week of practice; All session videos are stored in cue for easy retrieval and review by the parent and coach at any time
Homework	Every Session	Every Session
	Assigned by coach	Assigned online; Supplemented as needed by coach
Homework review	Sessions 2-10	Sessions 2-10
Involvement of alternate caregiver	In-person At least 2 sessions	Phone call At least 2 sessions
Content and skill review	Every Session	Every Session

Note. The Infant Net program includes the same session topics and content, including all video modeling content, as the PALS intervention program with the addition of one session 'Reading with Babies' (Read to Me, Inc.: http://www.readtomeprogram.org/index.html), which was included as supplemental session with the PALS program in 2003 to enhance very early pre-literacy development. Variations in intervention features are listed.

Figure 1.
Alignment of PALS Home-Based Intervention and Infant Net Intervention

Figure 2.
Program Page: Positive and Negative Signals

Figure 3.
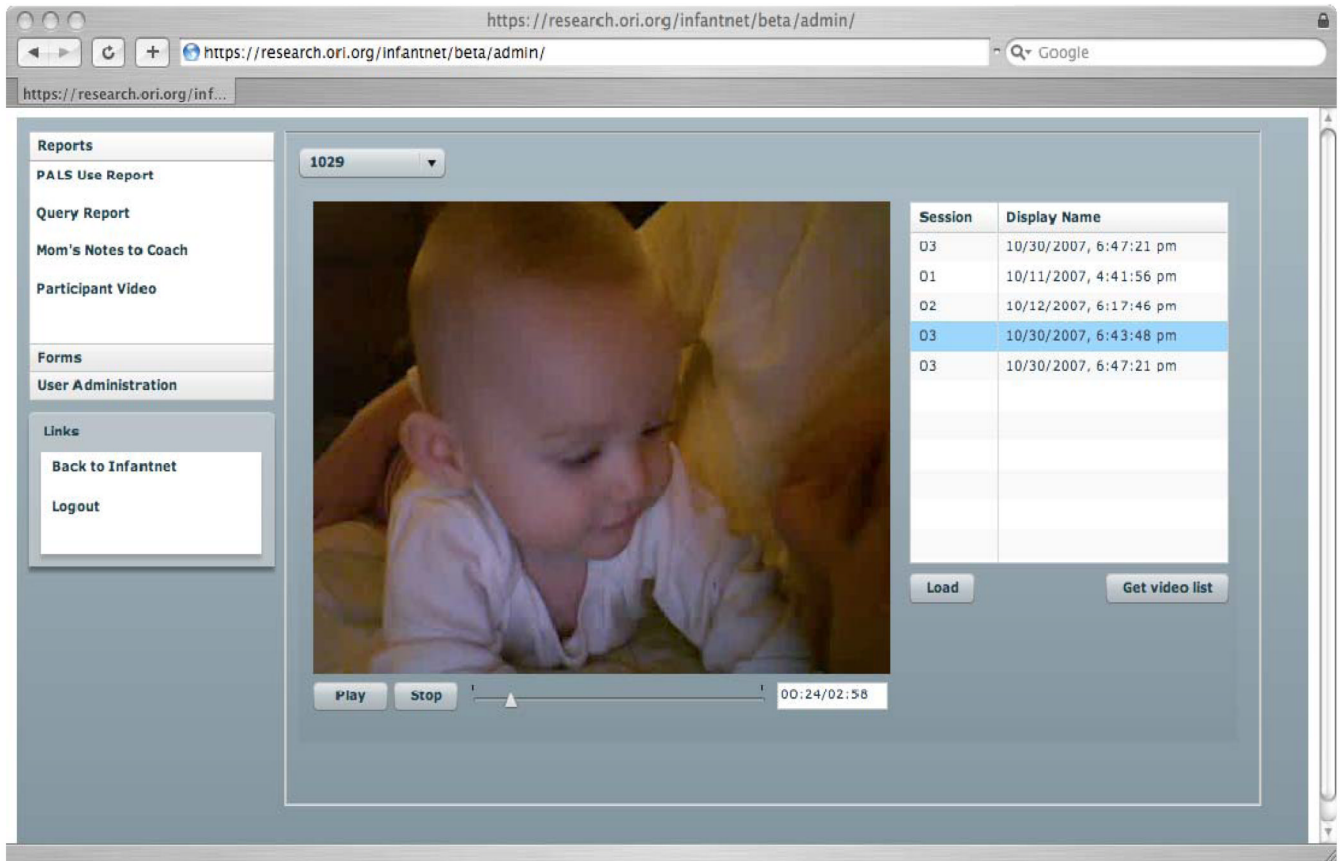Participant Check-In Questions

Figure 4.
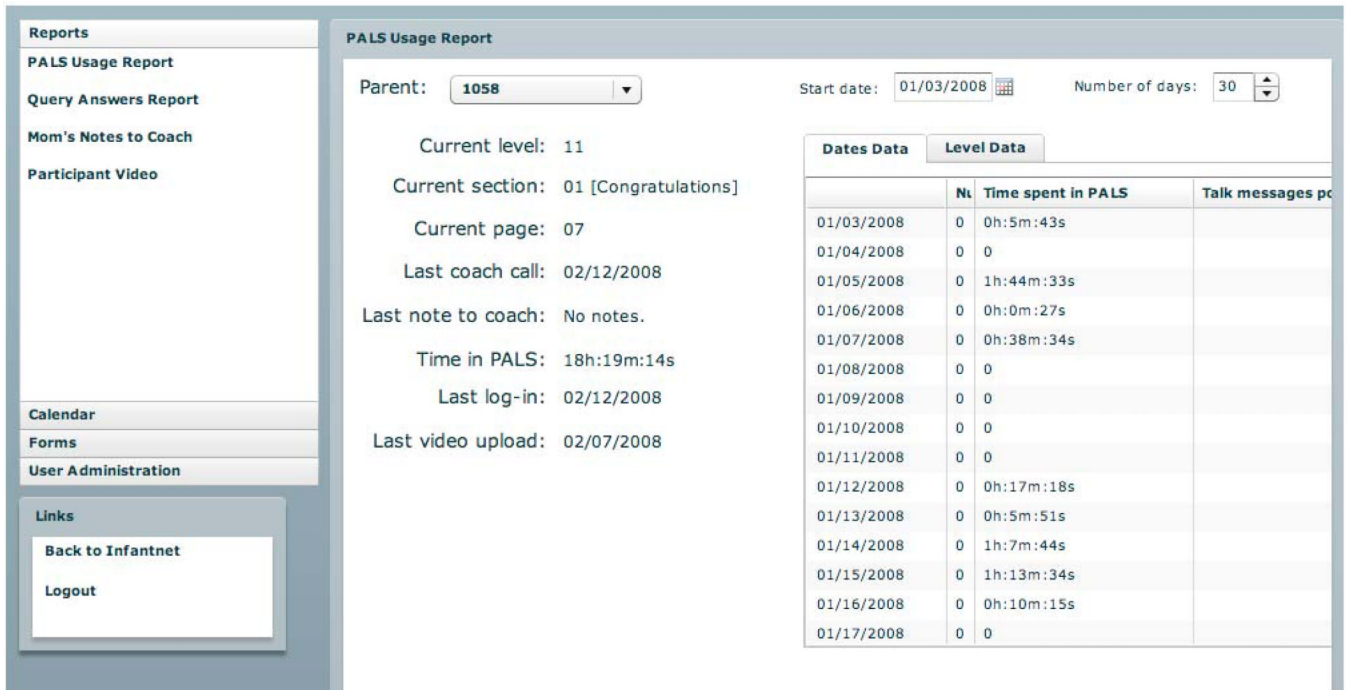Screen shot of computer-mediated participant-created video

Figure 5.
Participant Progress Report from Administrative (Staff Only) Page
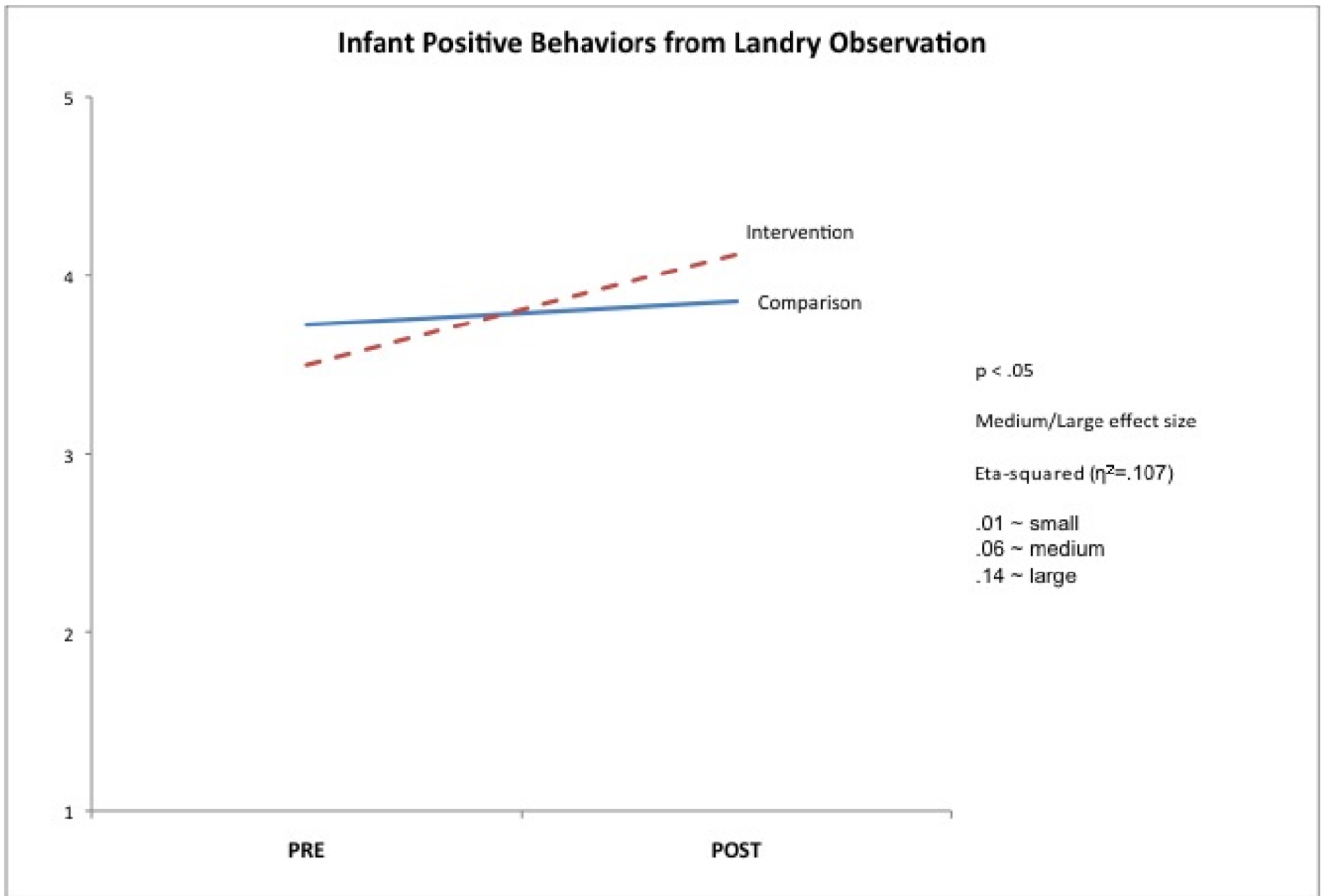
Figure 6.
Infant Positive Behavior during Interaction at Pre- and Post-Assessment
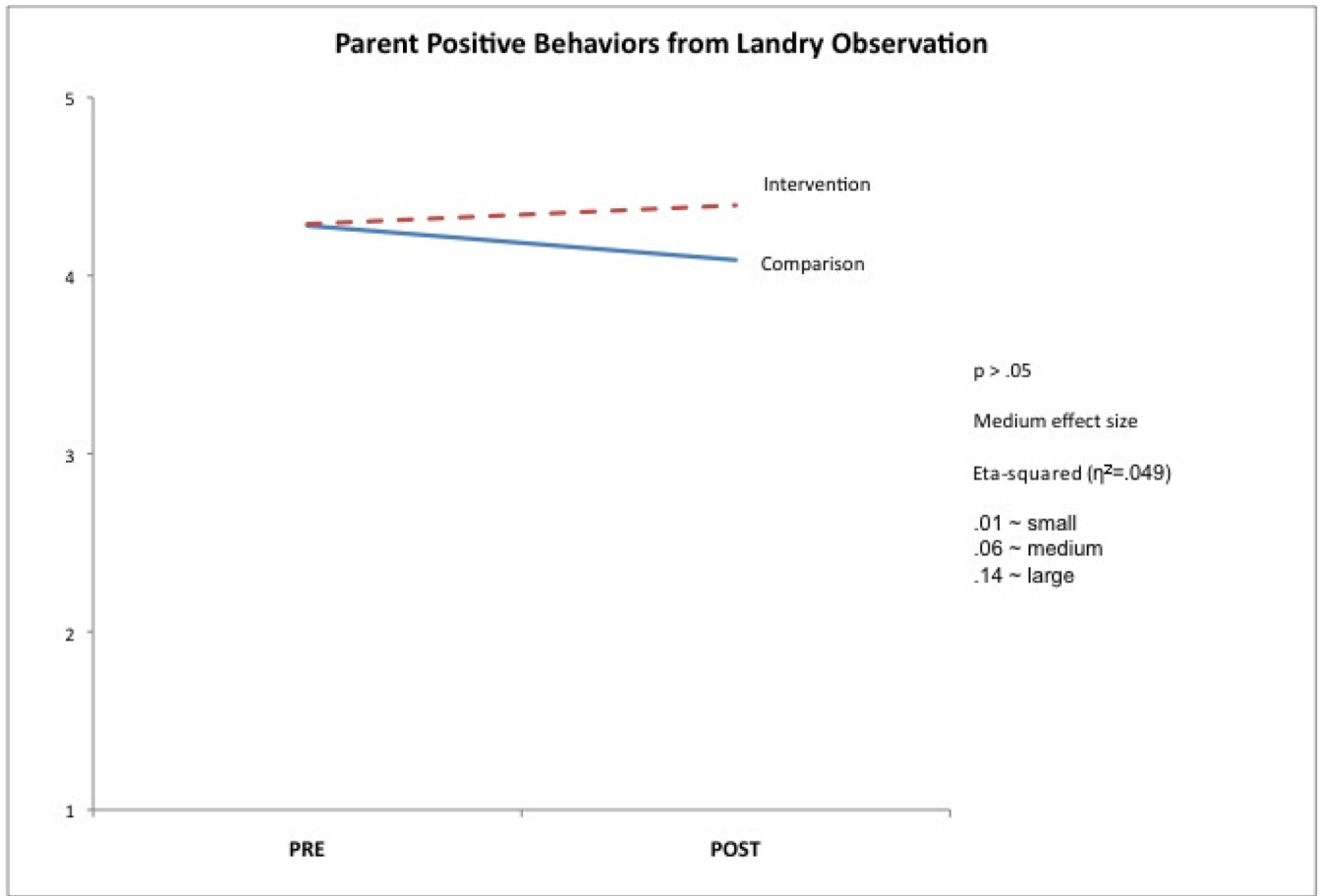
Figure 7.
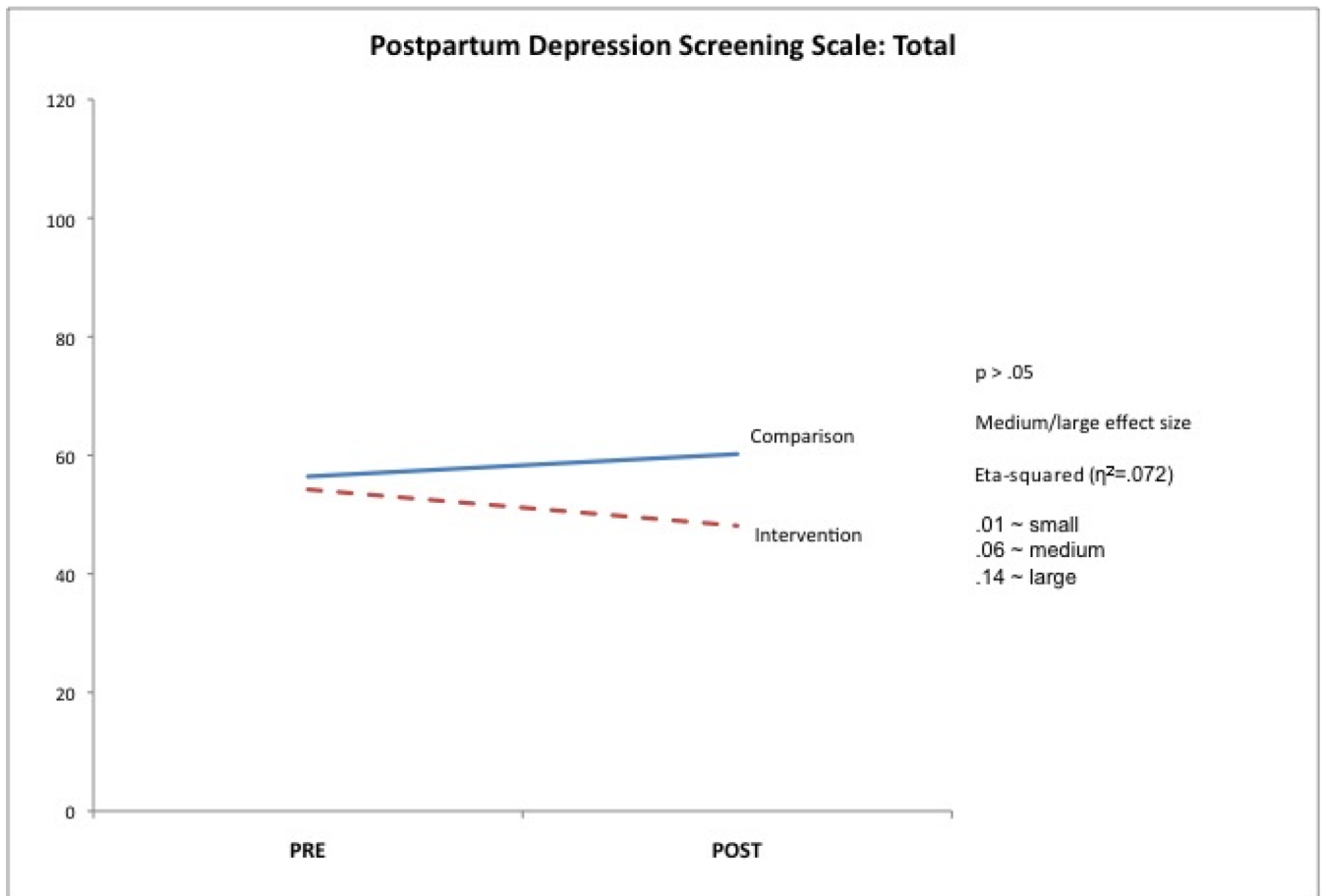Parent Responsiveness during Interaction at Pre- and Post-Assessment

Figure 8.
Parent Post-Partum Depression Symptoms Reported at Pre- and Post- Assessment

Table 1

Comparison of Intervention and Treatment Groups at Pre-Assessment

Variable Pre-Assessment	Intervention Group Mean (sd) (n=20)	Control Group Mean (sd) (n=20)	t value (p)
DEMOGRAPHIC			
1.Mom Age	24.5 (3.7)	26.8 (5.4)	t=1.56 (p=.13)
2.Child Age in Months	4.4 (.17)	5.3 (.22)	t=1.25 (p=.22)
3.% Whose Income is less than or equal to 185% Poverty	.85 (.37)	.79 (.42)	t= −.48 (p=.63)
4.Extenuating Financial Strain	.15 (.37)	.21 (.42)	t=.48 (p=.63)
5.# family members in home	3.8 (1.0)	3.9 (1.2)	t=.29 (p=.77)
6.# children in home	1.6 (.88)	1.9 (1.0)	t=.99 (p=.33)
7.% Families Receiving Other Child Services	.25 (.44)	.50 (.51)	t=1.65 (p=.11)
INTERNET			
1.% Current Internet Service in Home	.65 (.49)	.75 (.44)	t=.68 (p=.50)
2.Comfort with Computer Use	3.8 (.41)	3.6 (.66)	t=−1.0 (p=.32)
MOTHER-CHILD FUNCTIONING			
1.Observed Mom Positive Play	4.2 (.90)	4.3 (.65)	t=.47 (p=.64)
2.Observed Infant Positive Play	3.4 (.77)	3.7 (.70)	t=1.23 (p=.23)
3.Reported Maternal Depressive symptoms	55.4 (18.1)	56.0 (19.0)	t=.11 (p=.92)

Note. For those who didn't report income less than or equal to 185% poverty, there were extenuating circumstances reported that placed financial strain on them (e.g., medical bills, large child support payments, etc). Hence, income and extenuating circumstances variables are indirectly related to one another, yielding equivalent t and p values for but, in opposite directions; The Early Intervention variable reflects the percent of families receiving at least one early intervention service (e.g., Early Head Start, Birth to Three); The internet access variable represents the mean score based on a 4 point scale (1=not at all comfortable; 2 = somewhat comfortable; 3 = moderately comfortable; 4 = very comfortable); Maternal and Child Functioning variables at pre-assessment are the outcome variables analyzed at post-assessment.