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Randomized control trial of an internet-based parenting intervention for mothers of infants☆

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ABSTRACT

Early parenting home-visiting interventions have been found to be highly effective in promoting child development. Yet, there are many obstacles in the implementation of home-visiting programs, including travel and access to trained providers. Internet-based interventions can reach many parents of infants to overcome these barriers. The objective of this randomized control trial was to evaluate the impact of the Internet-adaptation of the Play and Learning Strategies (PALS) program, a preventive intervention program to strengthen effective parenting practices that promote early language, cognitive, and social development. Mothers in low-income environments ($N = 164$) of infants were randomized to either (a) an Internet-facilitated PALS parenting intervention or (b) an Internet-facilitated attention control condition. Measures included direct observations of maternal behavior with her infant, questionnaires about maternal functioning and parenting knowledge, and real-time program usage. Experimental participants demonstrated significantly greater increases in parenting knowledge and observed language-supportive parenting behaviors with a correlated positive change in infant language behaviors. Effects were pronounced when participants received a greater dosage of the intervention. Results suggest that the Internet-based translation of the PALS program is effective as a remotely delivered intervention for economically disadvantaged families to strengthen early parenting behaviors that promote infant social communication and child language development.

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1. Introduction

Children growing up in low-income environments face considerable barriers to healthy development (Blair & Raver, 2012), particularly language development (Perkins, Finegood, & Swain, 2013). Research indicates a potential causal flow between caregiver speech and child language development (Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010), with children living in poverty being less likely to experience a rich language environment in the home, including having access to books and having parents read to them (Evans, 2004). In the seminal work of Hart & Risley (1995, 2003), children in low-income environments exposed to 30 million less words in the home when compared to children in high-income homes, experienced deficits limiting knowledge and skill acquisition early in life as well as affecting their subsequent language and learning trajectories. Research further estimates approximately 50% of mothers in low-income environments do not read daily to their children, with path analyses suggesting reciprocal and snowballing relations between maternal book sharing and children's vocabulary development (Raikes et al., 2006). A focus on early language development in low-income homes is particularly important given longitudinal findings that early receptive language skills and development are significantly associated with literacy, psychosocial adjustment and mental health across the life span (Schoon, Parsons, Rush, & Law, 2010a, 2010b).

Given the importance of early language development to children's life success, and income-related links to this development, national calls have come forth to intervene early in life to build a supportive and nurturing language-rich environment within poverty homes (Suskind et al., 2013). A focus on the parenting context surrounding language development is highlighted given

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that parents living in poverty experience more distress and conflict that, in turn, leads to parenting strategies that are, on average, more punitive and less nurturing and responsive to children's needs (Duncan, Magnuson, & Votruba-Drzal, 2014).

1.1. Early intervention

Interventions that not only promote sensitive and responsive parenting behavior during infancy but also focus on connecting language and reading to these parenting practices show great promise in supporting infant social-emotional, cognitive and language development predictive of subsequent success (Dunst, Simkus, & Hamby, 2012; Suskind et al., 2013). One of the most promising infant parenting programs in this regard is the Play and Learning Strategies program (PALS; Landry & Smith, 2007; Landry, Smith, Swank, & Guttentag, 2008; Welsh, Bierman, & Mathis, 2014). Parenting strategies targeted within PALS include reading and contingently responding in a warm manner, maintaining attention, introducing new activities and materials, using words and actions to facilitate communication, using book reading techniques to strengthen language development, and integrating parenting into everyday activities (Landry, Smith, & Swank, 2006; Landry et al., 2012).

In the traditional in-home PALS program, trained facilitators implement sessions and build supportive one-on-one relationships with the infant's caregiver. Coaches use videos of mother-infant interactions to demonstrate key principles and behaviors. As well, coaches guide parent practice of PALS skills within each session. PALS in-home sessions last approximately 90 min and target: (a) reading infant signals, (b) responding with warm and sensitive behaviors, (c) maintaining infants' focus of attention, (d) watching for opportunities to introduce an object or social game, (e) using rich verbal content in combination with physical demonstrations and (d) incorporating this constellation of behaviors in everyday activities such as dressing, feeding, and playing. In addition to these skills, another session, Reading with Babies (Read to Me, Inc.; http://www.readtomeprogram.org/index.html), was included in 2003 to promote very early pre-literacy development. In addition to these seven skill-focused sessions, two review sessions are interspersed to focus on sharing what has been learned with an alternative caregiver for the infant and one final session is a cumulative summary and review of all material.

Mothers of infants who received PALS, when compared to mothers who received attention-control, were significantly more likely to engage in praise and encouragement as well as language facilitation techniques with their infants. Following up these infants into preschool, these children engaged in significantly more comments, questions, coordinated gestures and verbal behavior, and engagement during book reading (Landry et al., 2012). PALS is included in the Department of Health and Human Services Home Visiting Evidence of Effectiveness (HomVEE) list of empirically-supported interventions (https://homvee.acf.hhs.gov/). Clearly, the PALS program has the potential to address the language deficits and 30-million-word gap associated with children living in economic disadvantage.

1.2. Using the Internet to increase service accessibility

Historically, the problem of service inaccessibility for youth and families, especially in minority and rural communities, has cut across all sectors of health care. Medical care providers were among the first, however, to envision using the internet as a means of providing services to displaced or marginalized patients (Maheu, Whitten, & Allen, 2001). Although the use of the internet for health care service delivery has been gaining momentum in the medical field, and in psychiatry in particular for several decades, the expansion of this service delivery model into the domains of psychosocial and behavioral intervention has been much slower, particularly for children. In fact, studies of internet-based interventions for any type of child or adolescent disorder remain remarkably limited (Abbott, Klein, & Ciechomski, 2008; Breitenstein, Fogg, Ocampo, Acosta, & Gross, 2016; Comer et al., 2015; March, Spence, & Donovan, 2008; Xie et al., 2013; Ybarra & Eaton, 2005). Web-based technologies offer an important opportunity for population-level impact based on a solid understanding of the relevant family developmental science, prevention principles related to behavior/relationship change, and the capacities of digital technologies.

1.3. Internet adaptation of PALS: ePALS

To address early language development within the context of access barriers to parenting intervention encountered by low-income families and those living in remote areas (Katz, La Placa, & Hunter, 2007), we chose to adapt the PALS intervention for Internet-based delivery (Feil et al., 2008) to improve accessibility. Development efforts focused on maintaining the original PALS content coverage of effective parenting strategies as well as learning and making electronic adaptations to promote efficiency and ease of use. We retained the core learning framework of a supportive and consistent parent-coach relationship, video modeling of skills within session instruction, video-recorded skills practice uploaded for co-viewing and reflective coaching via weekly parent-coach contact, and, finally, requirement of weekly skills practice homework. The main adaptation was a self-directed instructional component that presented key concepts and exemplar videos with text and audio narration with questions to ascertain understanding that mothers could complete at their own pace and was available 24-7.

We conducted a small, randomized-controlled pilot with 40 English-speaking, low-income mothers and infants (Baggett et al., 2010). Mothers, randomized to either experimental (ePALS) or a usual care control condition, received a laptop computer with word processing and Internet browser. The provision of a laptop was used to control for the effects of technology across both experimental and control conditions. We found the internet adaptation of the PALS program to have promise in reaching and engaging mothers economically and/or geographically distanced from services. More importantly, through direct observation of mother-infant interactions, we found significant increases in infant social engagement and engagement with the environment for the Infant-Net group when compared to the control group.

1.4. Current study

The current study builds on our prior pilot study and improves upon it in several ways. First, the current study allowed a replication study of effects within a larger and more diverse, at-risk sample. Second, in this study, we began to address potential language/culture barriers (Lee, Vu, & Lau, 2013; Parra Cardona et al., 2012) by offering English and Spanish-translated versions of the intervention. Third, we added attention-control condition as opposed to usual care in order to provide a more rigorous test of the internet adaption of the PALS program. Fourth, we applied an intent-to-treat approach.

Within this study, we hypothesized that mothers receiving ePALS, compared to controls, would show: (a) significant gains in knowledge about parenting strategies for promoting infant social-communication as well as (b) significant improvements in parenting strategies demonstrated to promote infant social-communication behavior. Further, we hypothesized that infants in the experimental condition would demonstrate significantly

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greater improvements in language development with this change being correlated with maternal change. As a potential moderating influence on intervention effects, we examined intervention dosage.

2. Methods

2.1. Participants

Following IRB approval for human subjects involvement, a variety of recruitment methods were used, including presentations at early childhood and family support services agencies serving mothers living below the federal poverty guideline, such as Early Head Start and WIC. Out of 477 English and Spanish speaking low-income mothers from (a) Kansas City, Kansas and Missouri metropolitan area and (b) rural and suburban Oregon who indicated interest at presentations, left a voice message on the research project phone, or were attempted to contact from Early Head Start waiting lists, 139 (29%) were not reachable resulting in 338 mothers (71%) being assessed for eligibility. For inclusion, eligibility included mothers and their infants between the ages between 3 1/2 and 7 1/2 months old at the start of intervention to be at or below 130% of the federal poverty guideline. Exclusion criteria included homelessness, living in an area without cellular service, or receiving inpatient mental health or substance abuse treatment at the time of screening. Based on study inclusion and exclusion criteria, we deemed seventy-six mothers (22%) ineligible to participate. Of the remaining 262 eligible mothers, 68 (26%) declined and 30 (11%) were never enrolled due to reaching full recruitment. We conducted an initial visit to obtain informed consent and administer pre-intervention assessments with 164 mothers and infants. Following the initial visit, we randomized mother-infant dyads to either the experimental ePALS (n = 87) or attention-control condition (n = 77). Due to the budgetary reasons, we stopped recruitment at 164 but the randomization process created an unbalanced design that did not change baseline equivalency. After randomization, we scheduled a visit with mothers to deliver a cellular-activated laptop with access to their randomized intervention. Of the 164 mother-infants randomized to condition, five mothers could either not be reached to complete the initial training session visit (n = 2) or they were found to have insufficient cellular connection for streaming video at the time of the initial training session (n = 3). Consequently, 159 mothers initiated intervention in either experimental (n = 83) or the attention control program (n = 76) and constituted our intent-to-treat sample. See Fig. 1 for a CONSORT Flow Diagram showing the participant progress through the phases of this randomized trial (Moher, Schulz, & Altman, 2001).

At the time of pre-assessment mothers were, on average, 28 years of age and 66% were married. The sample was diverse with a large number of Hispanic mothers (39%). Overall, 42% of mothers self-identified as an ethnic or racial minority. Approximately half of the sample had a high-school diploma or less. Half had a computer at home and 84% reported comfort using a computer. Many mothers were experiencing symptoms of depression, with the average Post-Partum Depression Screening Scale (Beck & Gable, 2002) score at the clinical cut off for significant depressive symptoms. Given the study inclusion criterion of 130% of the federal poverty guideline, it is not surprising that 70% of mothers reported having "some difficulty paying bills each month". At the time of randomization, no significant between-condition differences were found on any demographic, computer comfort, or maternal distress indicants. At the training visit, a research assistant guided mothers through a training tutorial session in which mothers practiced using the laptop to navigate through the program using key features including video creation of mother-infant interaction. Mothers kept the laptop for four to six months to complete intervention (Table 1).

2.2. Experimental condition (ePALS)

The intervention in the experimental condition was a bilingual English–Spanish 11-session internet adaptation of the Play and Learning Strategies program (PALS; (Landry et al., 2008)). We created the internet adaptation to approximate the in-home PALS content presentation and learning structure as closely as possible. Learning components include: (a) self-directed learning of skills through video-based teaching, with check-in questions using immediate individualized feedback; (b) action plan outlining daily activity practice (homework) based on skills taught; (c) video-recorded practice, creating a 5-min, computer-collected, caregiver-infant interaction video uploaded to a project server, and (d) coach call to co-view weekly videos with mothers to provide individualized support for self reflection, conceptual learning and skill acquisition. See Fig. 2 for a screen shot of the home page and Fig. 3 for a screen shot of the mother-created video of parent-infant interactions. Mothers could easily select their preferred language, English or Spanish, either at the beginning of or at any time during intervention. We incorporated the original Spanish PALS videos and conducted a thorough forward, back, reconciliation language translation process (Maneesriwongul & Dixon, 2004).

Coaches for the experimental condition held at a minimum a bachelor's degree in a helping profession such as counseling, psychology, social work, or early childhood education. Prior to the study, coaches completed a two-day training conducted by a national PALS trainer. Following initial training, coaches: (a) met with a coach supervisor to preview the internet adaptation of the PALS program; (b) completed all session content as a "parent"; (c) listened to 3 model coach calls; (d) practiced completing coach and parent implementation fidelity forms; and (e) completed two audio recorded coach call practices certified as meeting 85% or higher implementation fidelity by the national PALS trainer and project supervisor.

2.3. Attention-control condition

We designed the attention-control program to control the effects of attention, treatment contact, social support, and non-specific therapist effects so that we have a clearer test of the ePALS intervention (Kazdin, 1980). The mothers in the attention-control condition received the same learning component structure as in experimental condition: (a) laptop computer with video camera and Internet connection for 4–6 months (b) same number of sessions with information provided about infant developmental milestones; and (c) same number of weekly contacts with a coach. During weekly phone calls, mothers and coaches co-viewed recorded infant-only videos to discuss infant developmental milestones displayed.

Coaches in the attention-control condition had at least a bachelor's degree in a helping profession such as counseling, psychology, social work, or early childhood education. Prior to the study, coaches completed training and received certification as having achieved at least 85% implementation fidelity on two audio-recorded attention-control coach calls. We trained coaches to adhere to an attention-control Coach Call guide and to avoid using PALS concepts and engaging in any parenting skill instruction or coaching during their call.

2.4. Assessment procedures and measures

Pre-and post-assessment measures included a multi-method approach incorporating direct observational assessment and ques-

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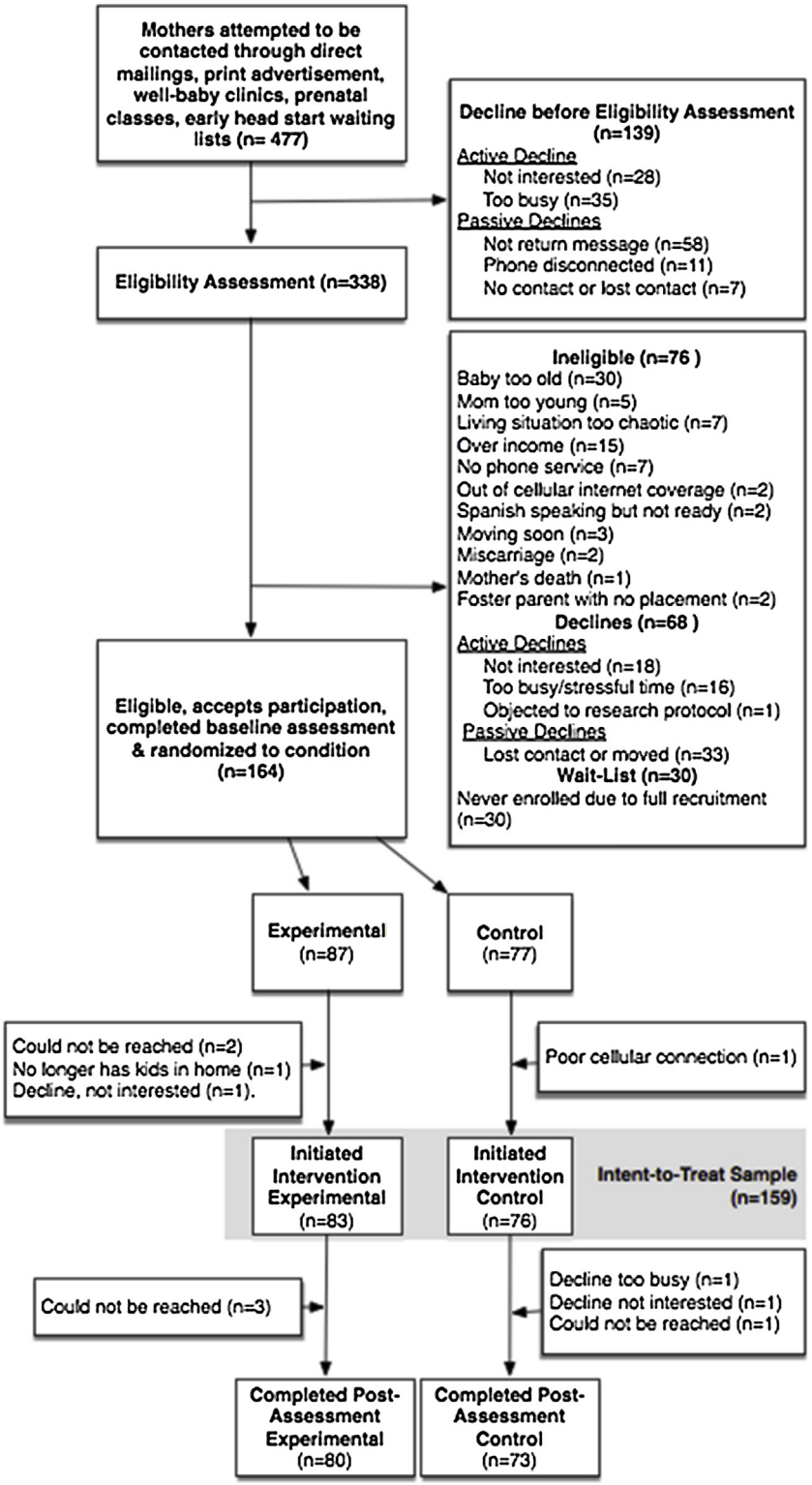

Fig. 1. Consort diagram.

tionnaires pertaining to maternal and infant functioning. Trained assessors (blind to condition) conducted a two-hour home visit to complete both pre- and post-assessments with mothers. Mothers completed post-assessment six months after pre-assessment. Given our intent-to-treat approach, we attempted to collect post-assessments on any mother who matriculated into intervention regardless of the number of sessions completed once started.

2.4.1. Program engagement

As indicants of program engagement, we measured time spent in the program as well as number of sessions completed. As participants progressed sequentially through the program at their own pace, an automatically-produced report displayed the amount of time spent in each session, time spent in each session component, and time signature for session completion.

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Table 1
Equivalence of demographic characteristics and screening measure.

Item	Total ($n = 164$)	Attention- control ($n = 77$)	Experimental ($n = 87$)	Test statistic	p Value
Demographic characteristic					
Mother's age *M(SD)*	27.23 (7.73)	27.54 (8.42)	26.95 (7.09)	0.48	n.s.
Infant's age in months *M(SD)*	4.41 (2.05)	4.16 (2.10)	4.63 (1.99)	−1.47	n.s.
% Female of infants	55.8	55.8	55.8	1.00	n.s.
% Non-Caucasian mothers	23.1	22.1	24.1	1.38	n.s.
% Non-Caucasian infants	31.7	35.1	28.7	1.54	n.s.
% Caucasian mothers	57.3	54.5	59.8		
% Caucasian infants	50.6	45.5	55.2		
% Hispanic mothers	38.7	43.4	34.5	.24	n.s.
% Hispanic infants	43.1	41.3	44.7	.19	n.s.
Mothers' marital status – % married/living together	67.1	72.7	62.1	2.10	n.s.
Mothers' education				1.62	n.s.
% High school or less	47.0	44.2	49.4		
% vocational/partial college	40.9	40.3	41.4		
% bachelor's degree or higher	12.2	15.6	9.2		
Financial stress score	15.88 (5.40)	16.50 (5.67)	15.34 (5.12)	1.38	n.s.
Infant temperament					
Surgency	4.08 (1.17)	4.10 (1.19)	4.07 (1.16)	0.17	n.s.
Negative affect	3.67 (1.10)	3.66 (1.13)	3.68 (1.08)	−.15	n.s.
Effortful control	5.04 (.81)	5.04 (0.86)	5.03 (.77)	.08	n.s.
Maternal depression (PDS total)	60.77 (24.30)	60.82 (21.83)	60.71 (26.43)	.03	n.s.
Computer comfort	3.36 (.76)	3.35 (.77)	3.37 (.75)	−.14	n.s.
Home computer ownership%	51.5	52.6	50.6	.07	n.s.

Note. Reported test statistics are t for continuous and χ^2 for categorical measures.

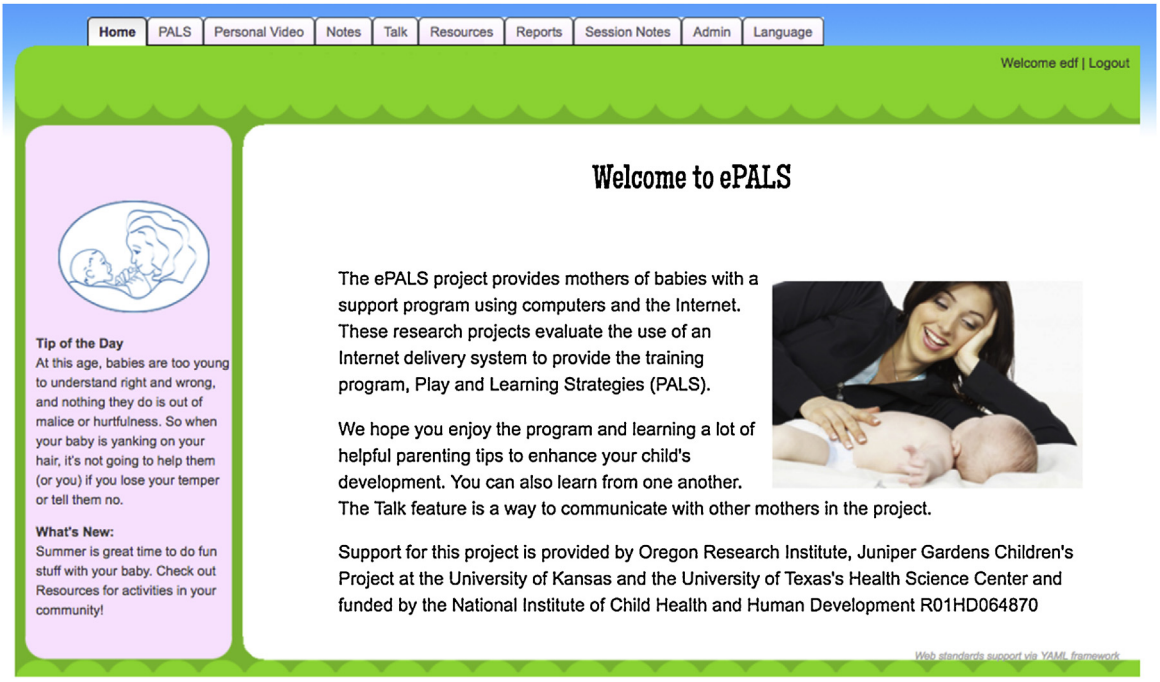

Fig. 2. Experimental home page.

2.4.2. Maternal knowledge

To assess maternal knowledge, we used the PALS Knowledge questionnaire, a 19-item scale consisting of multiple-choice, true-false, and open-ended item formats. This measure has been used in prior PALS studies to assess knowledge change in relevant PALS program parenting strategies. We used the summed item total of the measure (Baggett et al., 2010; Guttentag et al., 2014) to assess understanding of infant social-communication behaviors and sensitive, responsive parenting strategies to promote social-emotional communication. Internal consistency for the current sample at pre- and post-assessment was high (T1 Alpha = .74; T2 Alpha = .83).

2.4.3. Mother-infant observed behavior

The Landry Parent–Child Interaction Scales (Landry, Smith, Miller-Loncar, & Swank, 1998) were used to code the direct observation of maternal and infant behavior during a 5-min book activity in which mothers were provided with three bilingual board books and asked to interact with their infant with the books in a way that was comfortable for them and their baby. Maternal behavior scales of interest to infant language development include: (a) Positive behaviors of warmth and positive affect; (b) Book Sharing Techniques including praise and encouragement, flexible responding, verbal scaffolding, open prompts, and book related comments; and (c) Intrusive behavior. Infant behavior scales of interest included: Positive Behavior (engagement), Expressive Language, Receptive Language, and Negative Affect. Trained PALS observers at the Children's Learning Institute, UT Health, naïve to condition and time-point, rated mother-infant interaction videos. Trained observers, naïve to condition and time-point, rated mother-infant

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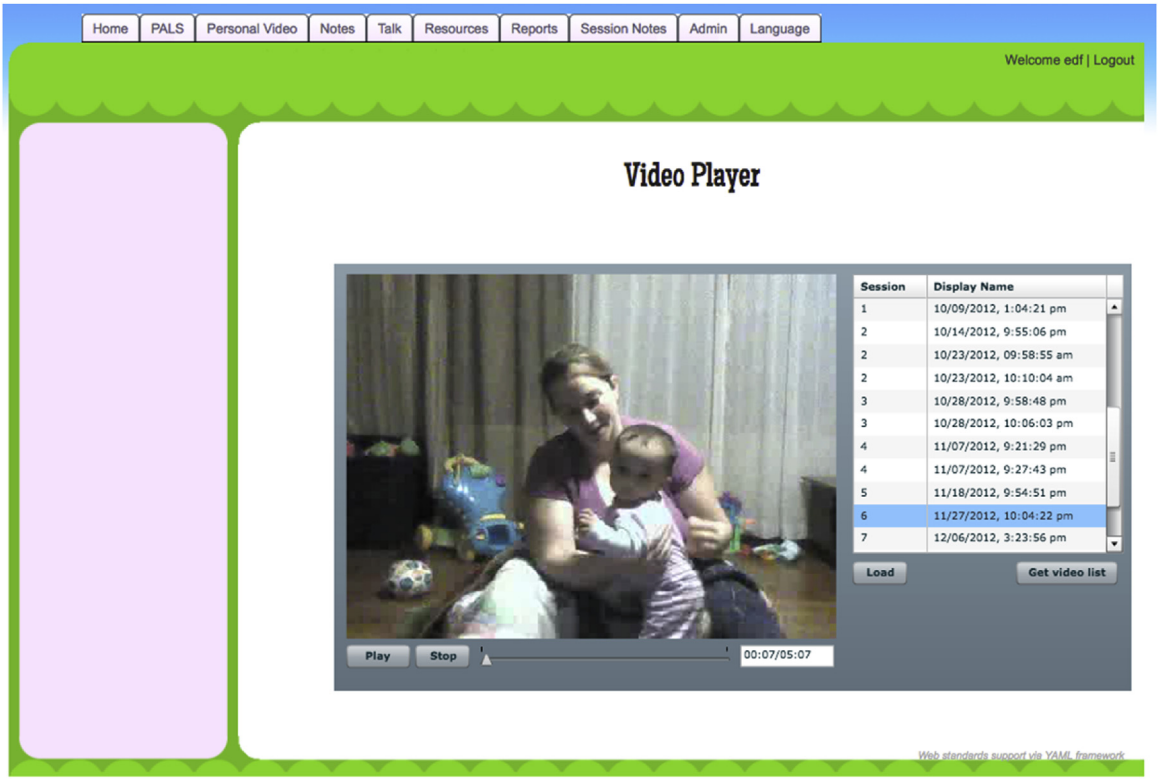

Fig. 3. Screen shot of mother-created video of parent–infant interactions.

interaction videos with approximately 20% double-coded for inter-observer agreement, with mean ICC = .86.

2.4.4. Satisfaction

We administered a satisfaction questionnaire at post-assessment to all mothers randomized to the experimental condition. Twenty-eight items, rated on a 5-point Likert-type scale, pertained to five dimensions of satisfaction: Acceptability of intervention procedures (3 questions), Acceptability of information taught (4 questions) and Perceived program impact on you as a parent (8 questions). We recoded questions such that a high score on each item represented a positive view of the intervention.

2.5. Analytic approach

We tested intervention effects on our primary mother/infant outcomes utilizing a multiple regression approach, regressing T2 on T1 outcomes, entering condition, dosage, as defined by number of sessions completed, and a condition × dosage interaction. The parameters of interest were the condition main effect, to view overall effect of experimental vs. attention-control on residualized mother and infant outcomes, and the condition × dosage interaction step. To view each regression step, we viewed Cohen's f^2. ANOVAs were subsequently performed comparing residualized outcomes between condition × dosage categories (Cohen, 1988).

3. Results

3.1. Attrition and missing data

Of the 159 mother-infant dyads randomized to condition and started the intervention, post data were collected from 150:72 (93%) assigned to the attention control condition and 78 (90%) assigned to the treatment condition. Multiple imputation was used to replace missing values following best-practice recommendations (Donders, van der Heijden, Stijnen, & Moons, 2006; Graham, 2009). Missing data were imputed using the fully conditional specification, which uses all available data to impute missing data via a sequential regression approach. Missing data points were replaced with imputed data in 20 data sets, which were analyzed separately. Model parameters and standard errors, which incorporate within and between model variability were combined following Rubin (Rubin, 1987), as implemented in SPSS, Version 24 (IBM Corporation, 2016).

3.2. Data reduction

To reduce the number of variables, we conducted a principal component factor analysis on maternal and infant behaviors of interest, with communality estimates above .30 as our criterion to retain variables. Maternal behaviors of enthusiasm, flexible responsiveness, intrusiveness, and book reading techniques were analyzed at T1 and one factor was extracted. Intrusiveness, however, was not strong with a communality estimate of .14 and was eliminated. The final maternal T1 factor indicants of book read enthusiasm, flexible responsiveness, and book reading techniques met our criterion and was replicated at T2, with the factor explaining 71% and 72% of the variance in the T1 and T2 indicants.

Infant behaviors of book-read engagement, social engagement, negative behavior, receptive language, and expressive language were analyzed at T1 and one factor was extracted. Social engagement did not have a strong loading, with a communality less than .3, and was eliminated. The remaining four behaviors were factor analyzed at T2 for replicability. At T2, negative behavior did not merge with the other language-related behaviors. Thus, at both T1 and T2, negative behavior was removed, leaving infant book-read engagement, receptive language and expressive language as indicants. This factor strongly replicated at T1 and T2, with all indicants

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Table 2
Descriptive statistics for outcome measures.

	Experimental		Attention-control	
	Pretest	Posttest	Pretest	Posttest
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Maternal knowledge	6.28 (2.71)	9.57 (3.08)	5.97 (2.94)	6.42 (2.82)
Maternal behavior[a]	−.43 (2.41)	.40 (2.48)	.47 (2.48)	−.44 (2.53)
Infant behavior[a]	−.40 (2.11)	.15 (2.09)	.44 (2.30)	−.16 (2.68)

[a] Unit-weighted standardized sum of observed behavior indicants.

meeting our criterion and explaining 56% and 64% of the variance in the indicants, respectively.

3.3. Baseline equivalence

No significant between-group differences emerged between the treatment and attention-control groups at baseline on demographic, maternal distress, or PALS knowledge indicants. However, when viewing the two direct observation maternal- and infant-behavior constructs, significant differences by condition were found ($t_{157} = 2.35$, $p = .02$; $t_{157} = 2.46$, $p = .02$, respectively). We selected a regression-based approach to control for pre-level outcome differences in language-related behaviors (Oakes & Feldman, 2001).

3.4. Intervention condition and dosage effects

We examined the outcomes of maternal knowledge of infant social-emotional behavior, and parenting strategies that promote it, as well as observed maternal language promoting strategies and infant language behavior constructs via regression. Table 2 presents between-condition descriptive statistics for the outcome variables of interest. All continuous variables were standardized before entry into regression models. f^2 is reported for the cumulative model estimate at each step. For maternal PALS knowledge, T1 PALS knowledge explained 25% of the variance in maternal T2 knowledge ($f^2 = .33$; large effect), condition differences explained an additional 20% ($f^2 = .82$; large effect), and dosage and its interaction with condition explaining another 15% ($f^2 = 1.47$; large effect). For mothers' language-related supportive parenting behaviors, T1 behavior explained 4% of the variance in T2 behavior ($f^2 = .05$; small effect), condition differences explained an additional 4% ($f^2 = .10$; small to medium effect), and dosage and its interaction with condition explaining another 10% ($f^2 = .21$; medium effect). For infant language behavior, T1 behavior explained 2% of the variance in T2 behavior ($f^2 = .02$; small effect), condition differences explained an additional 1% ($f^2 = .03$; small effect), and dosage and its interaction with condition explaining another 4% ($f^2 = .07$; small effect). A significant correlation was found for experimental mothers and infants between their residualized language-related behaviors ($r_{83} = .48$, $p = .000$).

Table 3 presents the final regression models for all outcomes. Parameters of interest were the condition and condition × dosage interaction. For maternal knowledge, $t(154) = 8.89$, $p < .001$ and maternal behavior $t(154) = 2.87$, $p < .01$ we found significant effects for the condition effect. However, in both cases, these were qualified by significant condition × dosage interactions (maternal knowledge, t[154[=3.34, $p < .01$, maternal behavior, t[154] = 2.99, $p < .01$). Finally, for infant behavior we also found a significant condition by dosage effect $t(154) = 2.13$, $p < .05$.

To examine our condition × dosage interactions more closely, we utilized a dichotomous "complete" variable based on the criterion of moms completing 9 or more sessions (Baggett et al., 2017) which comprises all the unique PALS skills. We created 4 categories: low dosage attention-control (n = 17), low dosage experimental (n = 26), high dosage attention-control (n = 59) and high dosage experimental (n = 57). Table 4 presents the distribution of highest session completion by condition and dosage category. Initial ANOVA analyses were further decomposed with pairwise comparison utilizing a conservative Bonferroni adjustment for post-hoc evaluation. Comparisons reflecting a p-value less than .05 are reported. For maternal PALS knowledge, significant between-group differences were found ($F_{(3,155)} = 37.35$; $n^2 = .42$, large effect), with high dosage experimental mothers increasing in PALS knowledge significantly more than all other mothers who decreased in knowledge over time (.74 vs. −.41, $d = 1.72$, strong large effect). For maternal language-supportive behavior, significant group differences were found ($F_{(3,155)} = 7.03$; $n^2 = .12$, strong medium effect), with high dosage experimental mothers' behavior increasing significantly more than low dosage experimental mothers (.44 vs. −.34, $d = .84$; large effect) and high dosage attention-control mothers (.44 vs. −.26, $d = .74$, large effect). For infant language behavior, we observed a small positive experimental trend ($F_{(3,155)} = 2.32$; $n^2 = .04$, small effect), with the difference between high-dosage experimental and attention-control groups contributing most strongly to this trend (.16 vs. −.22, $d = .38$, small effect).

Table 3
Intervention and dosage effects on parenting and infant outcomes.

	b	t	p	F(4,154)	p
Maternal knowledge					
Knowledge T1	.47	8.38	.000		
Condition	.49	8.89	.000		
Dosage	.28	4.75	.000		
Condition × dosage	.20	3.34	.001	50.19	.00
Maternal behavior					
Parenting behavior T1	.23	3.02	.003		
Condition	.22	2.87	.004		
Dosage	.11	1.35	.176		
Condition × dosage	.24	2.99	.003	8.54	.00
Infant behavior					
Infant behavior T1	.14	1.72	.085		
Condition	.07	.82	.413		
Dosage	−.13	−1.44	.150		
Condition × dosage	.18	2.13	.034	2.45	.05

3.5. Experimental participant program satisfaction

We were very encouraged by the positive ratings and comments we received from participants in the study. Mothers reported high (a) acceptability of intervention procedures (mean = 4.31, SD = .75), (b) acceptability of information taught (mean = 4.60, SD = .56) and (c) perceived program impact (mean = 4.52, SD = .58).

4. Discussion

In the current study, we focused our attention on behaviors displayed within a book sharing activity to examine the internet-adaption of PALS (ePALS) effects on parenting strategies known to promote language development. Overall, our results suggest ePALS can assist low-income mothers to develop parenting strategies that address the 30-million-word gap (Suskind et al., 2013). We found that ePALS strengthened mothers' language-supportive parenting behavior toward her infant during the book share activity, with higher ePALS dosage moms demonstrating significantly higher residualized post-test language scores when compared to low dosage ePALS and high dosage attention-control mothers. For infants, the findings were less strong, associated with small effects, with high dosage ePALS infants demonstrating relatively higher residualized post-test language scores when compared to

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Table 4
Highest session completed by condition and dosage category.

Session #	ePALS (experimental)		Attention-control	
	High dosage (n = 57)	Low dosage (n = 26)	High dosage (n = 59)	Low dosage (n = 17)
1	0	9	0	3
2	0	8	0	2
3	0	3	0	0
4	0	2	0	5
5	0	0	0	1
6	0	1	0	1
7	0	2	0	3
8	0	1	0	2
9	2	0	0	0
10	5	0	1	0
11	50	0	58	0

high dosage attention-control infants. We also found a significant correlation between residualized posttests scores for maternal language-supportive behaviors and infant language behaviors for mothers and infants in the experimental ePALS condition. The stronger findings for maternal parenting is not surprising given that mothers were the proximal target of the ePALS intervention. It is quite possible that infants would show stronger gains after being exposed to these parenting practices for a longer period of time than the 6-month intervention window. Participants reported high satisfaction with the program. Overall, however, our results are in line with well-substantiated findings, which include not only the importance of supporting not only nurturing, flexible, and responsive caregiving to set a strong foundation for infant brain development and early learning (Black et al., 2017), but also specific book sharing strategies for supporting language and emergent literacy, important to future learning and life success (Landry et al., 2012; Suskind et al., 2013).

Two limitations in the current study, related to potential generalizability of results and scaled-up dissemination, were that we provided laptops to mothers in both conditions as well as professional, research-based coaching. We selected these two study facets, mindful of their limitations, to achieve an initial efficacy examination rather than an examination of effectiveness. Because this is our first adequately powered randomized controlled trial of the internet-adaptation of the PALS program, we maintained research coaches in this study for comparability to the original PALS home visiting studies. We are developing an Internet-based, remote training system for ePALS program implementation. Our hope is to test this system within community agencies within the next two years to assess fidelity of implementation within diverse settings such that a large-scale effectiveness study can be undertaken.

Given our current focus on infant language development during book sharing in this study, further examinations will explore potential moderating influences on intervention effects including maternal language, Spanish vs. English administration, as well as maternal depression. Additionally, the observational component of our study also included a play activity. Our goal is to view potential differences between book and play activity contexts in which maternal parenting behaviors take place and how these differing contexts potentially affect the strengthening of multiple areas infant development, including social, emotional, cognitive, and language development. Moreover, we know that consistency in warm, nurturing and responsive parenting across developmental periods in a child's life can lead to stronger future outcomes (Landry et al., 2008). Continuity in caregiving across developmental periods is an important goal towards addressing the longer-term developmental disparities for children living in societal disadvantage (Reidt-Parker & Chainski, 2015). Consequently, future studies should seek to replicate the infant-language effects and examine intervention effects across developmental periods as well as across caregiving contexts such as at home with parents and in childcare with other outside-the-home caregivers. We have successfully developed and evaluated an adaptation of the ePALS system for use in early learning and childcare environments (Baggett, Davis, & Feil, 2015) which resulted in significant positive provider change in PALS strategies with infants as well as correlated positive change in infant behavior (Davis, Baggett, Feil, Landry, & Leve, 2017). Future work will attempt to implement PALS skills in both the home and childcare environments to determine the additive benefit to infant development of cross-environment consistency in consistency in parent and caregiver strategies that promote infant social, communication, and cognitive development. It is our hope the work we do will lend support to calls for investment in early childhood to reduce disparities that serve to negatively impact the life trajectory of children (Bivens, Garcia, Gould, Weiss, & Wilson, 2016) and for which we have yet to fully embrace as a national priority (Black et al., 2017).

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