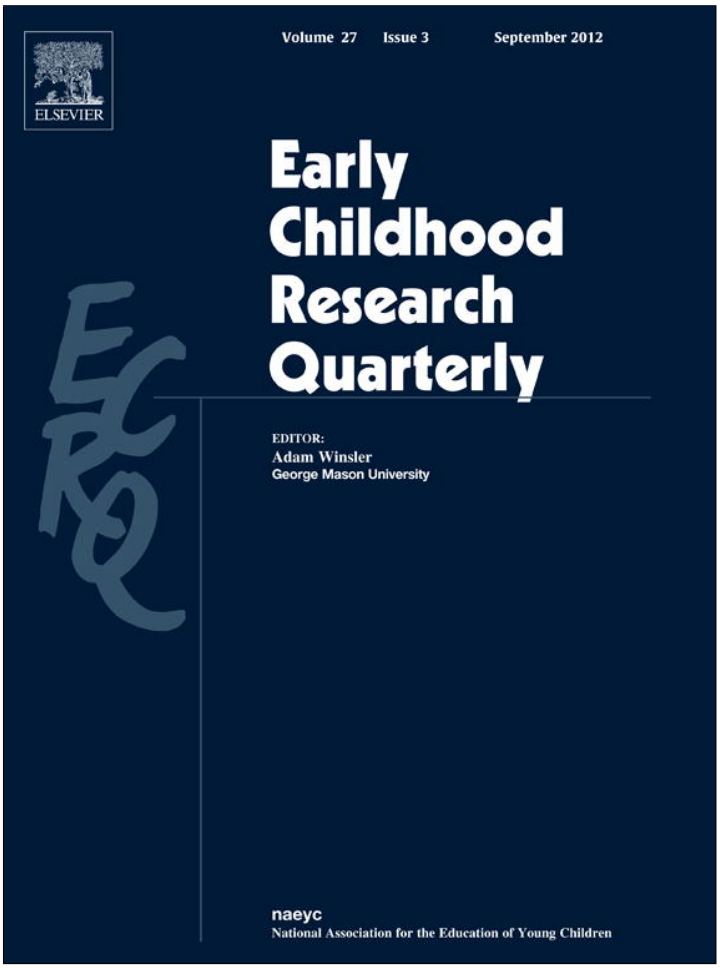

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Infant signs as intervention? Promoting symbolic gestures for preverbal children in low-income families supports responsive parent–child relationships

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ABSTRACT

Gestures are a natural form of communication between preverbal children and parents which support children's social and language development; however, low-income parents gesture less frequently, disadvantaging their children. In addition to pointing and waving, children are capable of learning many symbolic gestures, known as "infant signs," if modeled by adults. The practice of signing with infants is increasingly popular in middle-income populations around the world, but has not been examined as an intervention to promote positive qualities of the parent–child relationship. This study tested whether an infant sign intervention (ISI) encouraging low-income parents to use symbolic gestures could enhance the parent–child relationship. A final sample of twenty-nine toddlers and their families were followed for 7 months after assignment to the ISI or a control group. Children and mothers in ISI group families used more symbolic gestures than those in control families. Mothers' in the ISI group were more attuned to changes in children's affect and more responsive to children's distress cues. Mothers in the intervention group also viewed their children more positively, reducing parenting-related stress. This study provides evidence that a simple infant sign intervention is an effective tool to promote bidirectional communication and positive interactions for preverbal children and their parents.

1. Introduction

Preverbal children around the world use gestures to communicate before they have words to do so (Blake, Vitale, Osborne, & Olshansky, 2005), mainly using the flexible pointing gesture (Liszkowski, Brown, Callaghan, Takada, & De Vos, 2012). When the deictic gestures of pointing and showing are no longer sufficient to communicate their interests and intentions, children will typically invent a few symbolic gestures (Bates, 1979; Werner & Kaplan, 1984). For the most part, parents perceive children's gestures as communicative cues and respond accordingly. In fact, gestures can draw greater responsiveness from adults (Goldin-Meadow, Goodrich, Sauer, & Iverson, 2007; Vallotton, 2009). Thus, with gestures, children have an opportunity to elicit more responsive environments, influencing their own development. However, children's use of gestures is predicted by parents' use of gestures (Rowe & Goldin-Meadow, 2009a). Further, parents vary in the sensitivity and accuracy of their perceptions of children's behavior and their responsiveness to children's cues (Feldman & Greenbaum, 1997; Kelly, Morisett, Barnard, Hammond, & Booth, 1996; Weinfield, Sroufe, Egeland, & Carlson, 1999). In fact, in families facing the stresses associated with poverty, parents tend to gesture less often (Rowe & Goldin-Meadow, 2009a), and are less responsive to children's cues (Guo & Harris, 2000; McLeod & Shanahan, 1993). Nonetheless, even within these families, variation in gesture remains an important predictor of children's later language and social skills (Rowe, 2000; Vallotton & Ayoub, 2009). Thus, encouraging the use of gesture might be a natural way to promote greater responsiveness in the parent–child dyad in low-income families. Most existing interventions to promote parent–child communication take a unidirectional approach, teaching parents to more accurately read child cues (Censullo, 1994; Farrell, 2007; Hayes, Matthews, Copley, & Wesh, 2008; Tucker, Gross, Fogg, Delaney, & Lapporte, 1998), but do not promote clarification of child cues, nor help to make children active partners in communication. The current study examines the effects of promoting the use of symbolic gestures, as an "infant sign intervention," on mothers' attunement and responsiveness in interactions with their preverbal children, and their perceptions of children's behavior as stressful.

1.1. Preverbal communication through gesture

Long before they speak, infants draw adults' attention to their desires and interests using gestures such as pointing and showing (Tomasello, Carpenter, & Liszkowski, 2007; Wagner, 2006); they communicate disinterest and disgust by shaking their heads

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(Crais, Douglas, & Campbell, 2004; Pea, 1980), followed by agreement or acquiescence by nodding their heads (Crais et al., 2004). Infants can use the pointing gesture, which appears universal in its use by preverbal children (Liszkowski et al., 2012), to initiative joint attention (Tomasello et al., 2007), share information spontaneously or in response to questions (Liszkowski, Carpenter, Striano, & Tomasello, 2006), share their own interests (Liszkowski, Carpenter, Henning, Striano, & Tomasello, 2004), and even to refer to absent referents, as long as the child and adult share a common understanding of the absent referent (Liszkowski, Shafer, Carpenter, & Tomasello, 2009). Infants' use of pointing increases in frequency through preverbal development (Liszkowski et al., 2012; Vallotton, 2010) when it is used largely in place of words, then becomes a complement to words, integrated into spoken language as children begin to rely more on speech (Morford & Goldin-Meadow, 1992). For children who are slower to develop oral language, gesture continues to be a useful communication tool for a longer period of time, helping them compensate for delays or language impairment (Capone & McGregor, 2004).

Despite its universal use, the very flexible communication tool of pointing does have limitations. Pointing is a deictic gesture, primarily functional for referring to things within the immediately visible environment. With rare exception (see Liszkowski et al., 2009), pointing cannot represent or refer to an object or concept that is not within the present, perceivable context. As young children's cognitive representations and interests grow to encompass things beyond the here and now, so too do their desires to communicate about specific absent or non-visible referents. It is at this point in development that preverbal children invent symbolic gestures (Bates, 1979; Werner & Kaplan, 1984), typically inventing between one and five symbolic gestures between the ages of 11 and 20 months. Gestures for requests (i.e. holding both arms up to indicate desire to be picked up; fingers to lips as a request for food) come first at an average age of 14.2 months; gestures for attributes are next (i.e. blowing on something to indicate "hot"; stretching arms up over head for "big") at 15.3 months; and gestures for objects (i.e. panting for "dog"; throwing motion for "ball") start at 15.6 months on average (Acredolo & Goodwyn, 1988). Children create these symbolic gestures by borrowing motions performed by or on objects, or those performed in common routines (Namy, Acredolo, & Goodwyn, 2000; Werner & Kaplan, 1984). Adults appear to perceive these gestures as meaningful communication and respond to them accordingly (Acredolo & Goodwyn, 1985, 1988), even though adults do not produce many of these symbolic gestures themselves (Namy, Vallas, & Knight-Schwarz, 2008).

1.2. Role of parental input in child gesture

While gesture is a universal part of human communication, the frequency and types of gestures produced are influenced by experience. Liszkowski and colleagues studied infants' and parents' pointing in eight cultures between infant ages 5 and 17 months. They found a general increase in children's pointing per minute in interactions with caregivers, and a strong correlation in each culture between the number of points produced by parents and the number produced by children (Liszkowski et al., 2012). Rodrigo, Gonzalez, and Ato (2006) examined mother and toddler pointing between age 1 and 3 years, and found a strong correlation between the frequency of mothers' and children's production of gestures for both pointing and instrumental gestures (Rodrigo et al., 2006). However, neither of these studies indicate that parents' pointing or other gestures actually lead their children to produce the gestures; instead, it may be that parents follow the age-related changes in their children's gesture production. In fact, there is evidence that mothers adapt their use of gestures to the child's level of language comprehension, using gestures to reinforce what they say, rather than to add information, when children are younger (Iverson, Capirci, Longobardi, & Caselli, 1999). On the other hand, there is also within-mother stability over time in the relative frequency with which they produce gestures compared to other mothers, and the variability between mothers predicts their children's later production of both gestures (Rowe, Özçalişkan, & Goldin-Meadow, 2008) and words (Iverson et al., 1999). Further, parents' use of deictic gestures, specifically to clarify what they are talking about during joint attention, increases children's understanding of the parents' message (Zukow-Goldring, 1996) and predicts greater vocabulary development for children (Tomasello & Farrar, 1986). That is, when parents are sensitive to their children's comprehension of communication, they use gestures to support their children's immediate comprehension and later vocabulary.

Symbolic gestures, typically involving an iconic relation to some arbitrarily chosen aspect of the referent (Bates, 1979), are produced relatively infrequently by parents compared to other gestures (Rodrigo et al., 2006), and compared to those produced by their children (Namy et al., 2008). Despite the fact that adults produce very few empty-handed symbolic gestures, these gestures and related symbolic actions (with objects in hand) still influence children's use and understanding of gesture. Namy and colleagues found that the frequency of adults' use of symbolic gestures (without an object in hand) and symbolic actions on objects–for example, rotating the propeller or a toy plane, or holding an object to their ear to represent a phone–predicted children's production of gestures and their comprehension of gestures as object labels (Namy et al., 2008). Thus, while parents do adapt their use of gestures to their children's developmentally based communicative needs, there are also individual differences in parents' use of deictic and symbolic gesture that predict children's use of gesture and words.

When adults intentionally model symbolic gestures, creating an enriched gesturing environment for children, children are capable of learning dozens of symbolic gestures prior to their transition to speech (Acredolo & Goodwyn, 1985; Goodwyn & Acredolo, 1993). In these enriched gesturing environments, children will use symbolic gestures frequently in everyday interactions, holding gestural "conversations" and even producing "sentences" of two or three different gestures which together represent a more complex idea (Vallotton, 2011b). There is some evidence that the frequency of symbolic gestures fades at the age when children transition to oral language, while use of more conventional gestures – pointing, waving, and head-nodding – is maintained as these gestures are integrated into language (Vallotton, 2010). However, there are some circumstances in which children will use symbolic gestures even after they begin using words: when the child is upset, when a word is too hard to pronounce, and when communicating with someone who does not speak the child's primary language (Grinbaum, 2001). Further, since children with language delays use deictic gestures in a compensatory way (Capone & McGregor, 2004), they may be able to use symbolic gestures similarly.

1.3. Gesture as child effect

From a child effects perspective, there are several ways that a child can influence his or her own development. One way is that a child's own behavior provides him with stimulation, which he then responds to with additional behavior, making development an iterative, integrative, self-propelling process (Fischer & Bidell, 2006; Piaget, 1968). As representational behavior, a child's gestures may exert a direct influence on his own development as they provide him with stimulus when he sees his own representations expressed visibly. Another way that a child influences her own development is that her characteristics or behavior may draw certain reactions from her environment (Bell & Harper, 1977; Scarr & McCartney, 1983). This is particularly noticeable when children with different

characteristics or behaviors draw systematically different reactions from their caregivers. As a communicative behavior, gestures elicit responses from adults, and thus may be one medium through which children exert an effect on their environment.

Children's gestures influence their own development across domains. Both gesture frequency and variety early in a child's second year of life predict his own vocabulary more than two years later (Rowe & Goldin-Meadow, 2009b; Rowe et al., 2008), while the toddler's use of gesture–speech combinations predicts his later sentence complexity, even controlling for child speech at 18 months (Rowe & Goldin-Meadow, 2009b). In addition to influencing language, variation in infants' gesture frequency predicts development of their own social skills – including joint attention skills and social-emotional concepts – through toddlerhood (Vallotton & Ayoub, 2009).

One explanation of the influence of children's own gestures on their later language and social skills is that children's gestures elicit greater responsiveness from adults. Infants and toddlers vary in the clarity of their nonverbal cues (Goldberg, 1977), as well as the frequency with which they initiate joint attention or respond to adults' bids for joint attention (Leerkes & Crockenberg, 2002; Mundy et al., 2007; Vaughan et al., 2003). Parents and other caregivers perceive and respond to children's gestures as meaningful communication (Acredolo & Goodwyn, 1988; Goldin-Meadow et al., 2007); thus gestures are part of the set of child communication cues which exert an effect on caregivers' behavior. Parents will adapt the frequency of their own gestures to children's use of gestures (Liszkowski et al., 2012; Rodrigo et al., 2006). Parents also respond to children's gestures with elaborated speech, particularly when the child pairs a word with a gesture to represent a more complex concept (Goldin-Meadow et al., 2007); this may be one mechanism by which children's own gestures influence their language development, as these gesture–speech combinations predict a child's move to two-word speech (Iverson & Goldin-Meadow, 2005). Further, because symbolic gestures contain conceptual content, they allow the child to indicate to an adult more specifically the focus of his or her attention. Thus, when adults respond, they can more easily join the child's focus of attention, providing language relevant to the child-lead focus of joint attention, which has been shown to directly benefit children's vocabulary (Tomasello & Farrar, 1986). In addition, non-parental caregivers become more responsive overall – for example paying closer attention, providing eye contact, vocalizing – to an infant when that infant is using more gestures to communicate, even controlling for overall child effects and variation across caregivers in general responsiveness (Vallotton, 2009). Thus, infants and toddlers can use gestures to create a richer social and linguistic environment by eliciting responses from adults, which then better supports their own development.

Importantly, there may be other child characteristics or behaviors which influence, or are associated with, both children's use of gestures and parents' perceptions of and behaviors toward their children. Children's responsiveness to their caregivers, including their soothability and their production of social cues, such as smiling and eye contact, affect the ways parents perceive their children and respond to them (Appleton, Clifton, & Goldberg, 1975; Crockenberg & Leerkes, 2003). These same behaviors are associated with children's communication skills such as using gestures (Carpenter, Nagell, & Tomasello, 1998); thus it may be necessary to account for some aspect of children's affective behavior in order to determine the effects of child gesture on parents.

1.4. Parent–child interaction and gesture in low-income families

By the time children are 14 months old, there is already substantial variation in both children's and mothers' use of gestures among low-income families, some of which is explained by maternal education (Rowe, 2000). In Rowe's (2000) study, mothers who used pointing gestures more frequently to add unique information to that provided via speech had children who pointed more frequently, whereas mothers' use of pointing to reinforce or disambiguate what they had said was not related to child pointing. Mothers with higher education within this sample were those who used gestures more often to direct children's attention; this type of gesture use was related to the child's receptive vocabulary on a mother-report measure. Thus, within a low-income sample, more-educated mothers will use gestures to engage their child's attention, and these mothers are those who perceive their child as understanding more of what they say. Moreover, the frequency with which children and mothers engaged in turn-taking sequences of pointing, a sort of gestural "conversation," predicts child production of words (Rowe, 2000).

Importantly, both adults and children in lower-income or less-educated families gesture less frequently than those in a higher socio-economic bracket, which helps explain differences in language development between children growing up in families with lower and higher SES (Rowe & Goldin-Meadow, 2009a). Though they produce fewer gestures, the variation in low-income mothers' gestures still predicts children's vocabulary development throughout toddlerhood (Pan, Rowe, Singer, & Snow, 2005) and at school entry (Rowe & Goldin-Meadow, 2009a).

Parents' use of gestures is part of a sensitive response to preverbal children's communication needs (e.g. Tomasello & Farrar, 1986; Zukow-Goldring, 1996). Thus, the less frequent use of gestures by lower-income or less-educated parents may be part of the poorer sensitivity and responsiveness which characterizes parent–child interactions in families living with the stresses and risks associated with poverty (Scaramella, Neppl, Ontai, & Conger, 2008; Shaw & Vondra, 1995). Fortunately, responsive parent–child interactions can serve as a buffer against developmental risks faced by children growing up in poverty (Ayoub, Vallotton, & Mastergeorge, 2011; Linver, Brooks-Gunn, & Kohen, 2002); and responsive communication in particular is one such buffering quality (Hustedt & Raver, 2002). Both parent- and child-gestures influence child development in multiple domains – partly because of gesture's role in responsive interactions – yet, children and parents in low-income families use fewer gestures. Thus, one may wonder whether an intervention to increase gesture use among low-income families may be beneficial for the quality of parent–child interaction and children's development.

1.5. Effects of promoting gesture in parent–child interaction

Responsive care of young children involves attending to, accurately perceiving, and appropriately responding to children's cues. Parents vary in their attentiveness and sensitivity to the cues of preverbal infants and toddlers (Feldman & Greenbaum, 1997; Kelly et al., 1996; Weinfield et al., 1999); and the qualities of parents' attention and response to their children is often a target for intervention. However, most existing interventions intended to promote parent–child communication for at-risk families take a unidirectional approach, teaching parents to more accurately read child cues (e.g. Censullo, 1994; Farrell, 2007; Hayes et al., 2008; Tucker et al., 1998), but do not promote clarification of child cues nor help to make young children active partners in communication. What kind of effects would we expect to see in the parent–child relationship if parents were asked to use symbolic gestures, popularly known as "infant signs," with their preverbal children?

Thus far, two experimental studies have examined the effects of promoting symbolic gesture use between parents and preverbal children. The first of these experiments showed that

the intentional use of symbolic gestures enhanced child language development (vocabulary, MLU) in a middle-income sample (Goodwyn, Acredolo, & Brown, 2000). These initial findings lead parents and early child educators around the globe to use symbolic gestures, popularly known as infant signs or Baby Signs®, in order to support child development. Parents who use these infant signs with their preverbal children claim that the practice reduces frustration and promotes child social skills, as well as giving them a "window" into their babies' minds (Acredolo & Goodwyn, 2002). Yet, to date, there has been only one experimental study of the effects of infant signs on the parent–child relationship. Conducted in Latin-America, the study involved 14 middle and upper-middle-class mothers and infants, half of whom were taught to use infant signs. The intervention promoted greater synchrony in mother–child visual and physical contact (Gongora & Farkas, 2009). Except for this single study, developmental science has yet to explore the influence of enhancing symbolic gesture use on the parent–child relationship; further, this practice has not been tested in populations other than typically developing, middle-class children. However, drawing from the descriptive research on this practice, as well as the effects of variation in typical gestures on the child–adult relationship, some hypotheses can be derived for the effects of an infant sign intervention on the parent–child relationship.

Parents and educators who intentionally use infant signs with preverbal children report that they have become more attentive to their children's behavior because they expect children to communicate intentionally, both through signs and through other behavior (Vallotton, 2011a). Yet, it may be the case that these adults chose to use infant signs because they already expected preverbal children to be able to communicate. Thus, an increase in parents' attentiveness to children should be tested as a potential effect of an infant sign intervention. Further, adults respond more readily to children's communication attempts when they use either conventional (Goldin-Meadow et al., 2007) or symbolic gestures (Vallotton, 2009). This may be because child cues are actually clearer (Goldberg, 1977), because parents attend more closely to those cues (e.g. Vallotton, 2011b), or perhaps because they see the child as a communication partner, producing and comprehending meaningful cues (e.g. Rowe, 2000). Further, if parents see their child as more communicative, they may worry less about the child's development, lowering parenting stress (Horowitz, 2000). Thus, both responsiveness to child cues and parenting stress should be tested as potential outcomes of an infant sign intervention.

1.6. Current study: infant signs as intervention

The current study examines the effects of promoting the use of symbolic gestures, as an infant sign intervention, on mothers' attunement and responsiveness to their children during interactions, and their perceptions of their children as stressful. This study addresses the following research questions:

1. Will a simple infant sign intervention increase the use of infant signs in low-income families?
2. Will infant signing increase attentiveness to children's expressions during interaction?
3. Will infant signing enhance responsiveness to children's social and distress cues?
4. Will infant signing change mothers' perceptions of their children to be more positive, decreasing their child-related stress?

2. Method

2.1. Participants

Family characteristics. The initial sample of participants for this exploratory intervention study were 40 children and mothers enrolled in an Early Head Start program, a federally funded early intervention program for children in low-income families or those with, or at risk for, a developmental delay. Because of attrition (described below), the final sample included 29 families whose characteristics were not significantly different from the total sample. The total sample included 22 families who were assigned to the experimental group, and 18 to the control group. Sixty two percent (62%) of families were monolingual Spanish speakers, 24% monolingual English speakers, and 12% were bilingual; 16% of families identified themselves as Caucasian, and 84% identified themselves as Hispanic, Latino, or Mexican. Twenty nine percent were single-parent families. Twenty four percent of mothers and 33% of fathers had less than a high school education (1st to 8th grade); 32% of mothers and 33% of fathers had at least some high school (9th to 12th grade); and 44% of mothers and 33% of fathers had more than a high school education. Families were not asked about their incomes, but they were asked about their occupations. Seventy nine percent of families had only one working adult. Sixty two percent of mothers reported that they did not work or were full time parents, 14% were in service occupations (cleaning, food service), 18% were in education or management (preschool teacher, food service shift manager), and 7% were students. For fathers, 17% had no job, 59% were employed in physical labor (landscaping, construction), 14% were in management (grocery store manager), and 10% were students.

Attrition. Eleven families dropped out of the study prior to completing Time 2 measures, mostly due to family re-location. The final study participants included 16 families in the infant sign group and 13 in the control group. There were no differences between the groups in mothers' ($t = -0.13$, $df = 23$, p = n.s.) or fathers' education levels ($t = 1.41$, $df = 23$, p = n.s.), the number of adults in the household who were employed ($t = -0.91$, $df = 21$, p = n.s.), nor the basic level of parents' work (mothers: $t = 0.43$, $df = 21$, p = n.s.; fathers: $t = -0.52$, $df = 21$, p = n.s.).

Child characteristics. The final sample of children included 17 boys and 12 girls. All children were at least 10 months at the beginning of their participation. For the purpose of this study, child age was restricted to the period during which children are most likely to learn and utilize infant signs, thus children were recruited into the study if they were not yet combining two or more words in the child's primary language. Using the MacArthur Communicative Development Inventory (CDI), children in low-income families have substantially slower development of vocabulary and word combinations on average compared to middle-income peers (Arriaga, Fenson, Cronan, & Pethick, 1998). Further, slower vocabulary acquisition is predicted by lower family income (see Tamis-LeMonda, Cristofaro, Rodriguez, & Bornstein, 2006 for review), low maternal education (Feldman et al., 2000), and the early learning of two language simultaneously (Oller, Pearson, & Cobo-Lewis, 2007); thus, the children in this sample were expected to be below national age norms in language development. To accommodate this variation, there was no specific criterion for the upper child age for inclusion in the study, as long as the child was not yet combining words into sentences. Thus, the average age at Time 1 was 23 months ($SD = 7.28$); there were no significant differences between the intervention and control groups in child age at the start of the study ($t = 0.823$, $df = 27$, p = n.s.; see Table 1 for further information on child ages). Not all children were old enough at Time 1 to have vocabulary or sentence length scores on the CDI; however, there is Time 1 data for 16 children,

Table 1
Descriptions of and descriptive statistics for all variables at each data collection point (Time 1 and Time 2), collapsing across intervention and control groups.

	Variable description	Mean (*SD*) or % Min–Max	
		Pre-intervention (T1)	Post-intervention (T2)
Infant signing			
Infant Sign Group	Family assignment to infant sign intervention	55%	0–1
Child Sign Vocabulary	Number of different infant signs child used	4.55 (4.36)	0–18
Mother Sign Vocabulary	Number of different infant signs mom used	4.10 (4.58)	0–21
Number of People Signing	Number of different people in the child's life using signs	1.86 (1.43)	0–5
Number of Signing Routines	Number of family's daily routines in which signs are used	2.00 (1.56)	0–5
Signing Frequency	Frequency of sign use: 0 = never; 1 = <once/day; 2 = once/day; 3 = several times/day; 4 = regularly throughout each day	2.07 (1.53)	0–4
Child characteristics			
Age	Child's age in months	23.40 (7.28) 9.51–36.22	30.82 (7.52) 15.46–42.99
Child Gender (Girl = 1)	Child's gender, coded as boy = 0, girl = 1	41% 0–1	–
Vocabulary	Child's age-normed percentile scored on vocabulary development from the MacArthur CDI	14.38 (11.53) 5.00–40.00	–
Sentences	Child's sentence length minus norm for child's age from the MacArthur CDI	−2.54 (1.87) −6.00 to 0.00	–
Child interaction behavior			
Social Cues	Frequency per minute of bids for mothers' attention with positive or neutral affective tone, e.g. smiles, seeking eye contact, reaching out to touch mom	2.44 (1.83) 0.33–7.43	3.22 (1.54) 0.50–6.50
Distress Cues	Frequency per minute of behaviors indicating that the child is upset, uncomfortable, or unhappy, e.g. turning away suddenly from mother, grunting or groaning in protest, or screaming with negative affect	0.32 (0.56) 0.00–2.24	0.28 (0.48) 0.00–1.84
Child Affect Lability	Total number of changes in child's affect over the course of 5-min interaction	8.10 (6.10) 0–23	15.21 (11.30) 0–38
Maternal interaction behavior			
Attunement	Percentage of changes in child's affect to which mother responded with a change in her own affect in the same direction within 3 s	0.13 (0.17) 0.00–0.67	0.11 (0.12) 0.00–0.40
Responsiveness to social cues	Percentage of child's social cues to which mothers' responded appropriately, e.g. reciprocating eye contact or touch, vocalizing to acknowledge child's bid	0.66 (0.25) 0.00–1.00	0.73 (0.18) 0.24–1.00
Responsiveness to distress cues	Percentage of child's distress cues to which mothers' responded appropriately, e.g. ceasing to shake object in child's face, returning a toy mother had taken, responding with physical comfort to obvious signs of upset	0.45 (0.42) 0.00–1.00	0.63 (0.42) 0.00–1.00
Total cue responsiveness	Percentage of child's total number of cues (social, request, or distress) to which mothers' responded appropriately	0.65 (0.24) 0.11–1.00	0.70 (0.20) 0.22–0.97
Parenting stress			
Child-Related Stress	Total child-related stress on the PSI (higher = more stress)	65.77 (29.42) 3–99	62.35 (34.37) 5–100
Reinforcing Stress	Mothers' stress related to perceiving her child as not reinforcing her in her role (higher = less reinforcing) (PSI)	70.18 (27.70) 15–99	62.83 (26.97) 15–99
Acceptability Stress	Mothers' stress related to perceiving her child's behavior as unacceptable (higher = less acceptable) (PSI)	60.95 (29.80) 10–99	63.65 (33.32) 10–100
Parent-Related Stress	Total parent-related stress (higher score = more stress) (PSI)	63.14 (28.86) 3–98	61.38 (31.46) 3–97

indicating that the experimental and control groups were equivalent in normed scores on vocabulary ($t = -0.085$, $df = 14$, p = n.s.) and sentence length ($t = -0.765$, $df = 12$, p = n.s.; see Table 1).

2.2. Procedures

Table 2 provides an overview of the study methodology and timing.

Recruitment and randomization. Families were recruited through Early Head Start (EHS) service providers, either home visitors or classroom teachers. To limit contact between the experimental and control groups, random assignment was done at the level of the EHS provider serving each family, producing a nested structure of data, with families nested within service providers. For data analysis, I refer to the providers as "sites." Of the seven groups of families by EHS sites, four were randomly selected into the experimental group.

Informed consent. Families participated in three home visits from the research team. Informed consent was collected at or before the first visit. If the families were enrolled in EHS Home Visiting services, then the first visit was during a regularly scheduled home visit. If the families were enrolled in center care, then the first visit by the research team was conducted after the families had been introduced to the researchers by their Head Teacher.

Data collection. Data were collected in two primary waves of in-home visits, with one mid-point assessment of the use of infant

Table 2
Methodology overview.

	Random assignment	Recruitment	Time 1	Mid-point	Time 2
Timing	EHS staff members were randomized to the experimental or control group at the start of the study; all families served by that staff at that time and afterward were assigned to the group to which the staff member was randomized	Rolling recruitment as eligible families entered services	As soon as eligible family was enrolled and child was old enough	3.5 months after Time 1/Beginning of Intervention	3.5 months after Mid-point; 7 months after Time 1
Intervention			Experimental families begin intervention immediately following collection Time 1 measures, during same home visit	Experimental families offered additional infant sign materials, including 12 sign magnets and a storybook containing 17 signs	
Measures			Parent–child interaction MacArthur CDI Child Behavior Checklist Parenting Stress Index	Gesture Acquisition Interview	Parent–child interaction MacArthur CDI Child Behavior Checklist Parenting Stress Index Gesture Acquisition Interview

signs. Time 1 data collection occurred just prior to the intervention; for those in the experimental group, the Infant Sign Intervention (ISI) was given during the same visit, immediately following data collection. The mid-point interview was 12–14 weeks after Time 1, and Time 2 data were collected 12–14 weeks after the mid-point. Thus, the total period after the initial intervention was 6–7 months.

Compensation. Both the experimental and control groups of participants received two sets of gifts for their participation: an age-appropriate children's book at each data collection visit, and a copy of the videos taken of their child for the purpose of the study.

2.3. Intervention

A low-intensity parent–child intervention, using materials from the Baby Signs® Program with additional materials designed for the intervention, was given to experimental group families to increase their use of infant signs. The intervention was offered to experimental group families just after the first wave of data collection. The intervention was not conducted by EHS staff, but was provided instead by the research team, individually with each family, in order to maintain consistency across families. The EHS staff members were naive to the hypotheses of the study, but they were aware of the nature of the intervention and of the assignment of the families they served; they were instructed not to talk about the nature of the study with their families. After initial recruitment of families into the study, and introduction of the research team to the families, involvement of EHS staff in the study was minimal. The intervention took place in families' homes when both mother and child were present, and consisted of two phases. In phase one, just after Time 1 data collection, all experimental group families received the following: (1) a one-time explanation and demonstration of the use of infant signs, which lasted 3–5 min; (2) a two-page laminated explanation of infant signing, with tips for success, which reinforced the explanation provided orally; (3) a collection of 10 fridge magnets that each featured a sketch and description of one sign; the sign-magnets represented the following concepts: *happy*, *sad*, *sleepy*, *diaper*, *cat*, *dog*, *where?*, *all gone*, *snack*, and *more*. Appendix A contains the text from the 2-page, laminated handout. Appendix B provides examples of the fridge magnets. Families in the intervention group were not explicitly instructed to use the infant signs with their children; instead, they were asked whether they were interested in trying it, and were provided materials to do so. In phase two, three months after Time 1, families participated in a mid-point assessment of their use of infant signs; at this point, experimental group families were offered: (4) a set of 12 additional sign magnets which included: *drink*, *fish*, *bird*, *scared*, *out/outside*, *gentle*, *frog*, *hat*, *flower*, *angry*, *book*, *hot*, *noise*, *stop*, *thank you*, *love*, and *please*, (5) a story-book, created for the intervention, with 17 embedded signs including the original 10 plus 7 more: *outside*, *scared*, *car*, *look/see*, *ball*, *noise/hear*, and *monkey*. All materials were offered in Spanish or English; 25 families requested materials in Spanish, 13 families requested materials in English, and two families requested materials in both languages.

Though the intervention was not designed specifically for Hispanic or Latino families, the use of gestures to communicate with preverbal children is common across cultures, including Mexico (Zukow-Goldring, 1989, 2006), where most of study families originated. Further, the only other experimental study on the effects of infant signs on parent–child interaction was conducted with Hispanic families in Chile (Gongora & Farkas, 2009).

2.4. Measures and variables

All measures and variables are described below. Descriptions and descriptive statistics for each variable are in Table 1. Data collection visits were conducted in the language the family preferred. Parents were offered both Spanish and English versions of each parent-report measure and could select the language they preferred. To make sure literacy level was not a barrier to participation, families were also asked if they would prefer a researcher to read the questions to them and record their answers; no participants in the final sample used that option.

Infant sign use. Families' use of infant signs was measured at the mid-point and Time 2 using a structured Gesture Acquisition Interview with both the experimental and control groups. Although the control group was not exposed to the intervention, it was possible that some were exposed to infant signing through other sources, and some families use signs spontaneously, without any special curriculum (Acredolo & Goodwyn, 1988). To assess infant signing in both groups, the same questions were asked of experimental and control families. The phrase "Baby Signs®" was never used with the control families; instead, they were given an explanation of "symbolic gestures" and asked if their child did anything like that. In the interview, a researcher asked the mother a series of questions

about her own and her child's use of infant signs, and recorded her answers. In order to get credit for using a particular sign, the mother had to name the sign in answer to the question "What baby signs/symbolic gestures do you use with your child?" and she had to demonstrate the sign manually. It was not assumed that mothers and children would do the same signs, thus, mothers also had to spontaneously name and demonstrate signs that the child did in order for the child's signs to be recorded. Mothers often asked children to perform the signs; however, children do not always perform signs when asked; thus, mothers' performance of children's signs is likely more representative of children's sign repertoires. The variables derived from these data include (a) child sign vocabulary, which is the number of different signs the children used, (b) mother sign vocabulary, the number of different signs the mother used, (c) signing frequency, (d) the number of different daily routines in which signs were used, and (e) the number of people who used signs with the child.

Responses from the mid-point and Time 2 were combined to create variables representing the family's cumulative use of signs across the intervention period. For example, if mothers reported that the child used signs for *more*, *dog*, and *outside* at the mid-point, and reported that the child used signs for *more*, *dog*, *fish*, and *sad* at Time 2, then the child's sign vocabulary across both interviews would be 5: *more*, *dog*, *outside*, *fish*, and *sad*. The variables for mother signing vocabulary, number of routines, and number of people using signs were combined in this cumulative way. The variable for frequency, which was recorded on an ordinal scale, was averaged between the two interviews. Descriptive statistics for these variables are in Table 1.

Parent–child interaction. At Times 1 and 2, mothers and children were videotaped during a series of semi-structured play episodes, including a 6 min free-play, a 2-min clean-up, and a puzzle episode of 5–7 min. Age-appropriate toys were provided by the researcher, who laid out a 3 foot × 3 foot cloth on which the mother was asked to sit with her child, keeping the child on the cloth to stay within view of the camera. Toys for free-play included a ball, two cars, a maraca, a string of beads, a doll and bottle, a book, and a set of blocks which varied in size and complexity by child age. Parents were instructed to "Play with your child as you normally would." This episode ended when the researcher brought in a large box and instructed the parent to ask the child to clean up by putting all the toys into the box. For the current study, 5 min of free-play were coded. The play episodes were filmed longer than the desired 5 min in case the dyad spent time off camera; the average length of these episodes was 6.24 min at Time 1 and 6.21 min at Time 2. All of the free-play time in each episode was coded, but only the first 5 min of on-camera time was included in analyses. Four of the 58 episodes coded for the current study had less than 5 min of on-camera time (times were 4.17, 4.85, 4.87, and 4.92); to compensate for this discrepancy, all frequency variables were divided by the number of seconds of recorded on-camera time in the episode, then multiplied by 300 in order to make these variables equivalent to those of episodes recorded for 5 min.

Coder training and inter-coder reliability. Two microanalytic coding schemes were used to code mother and child behavior during each second of the interaction: (1) mother and child affect and (2) children's cues and mother's responses. Coders were trained in pairs but worked separately to obtain and maintain standards for inter-coder reliability. Coders were kept naive to the participants' group assignments, as well as to their scores on other coding schemes and other measures. Each coding scheme and the variables derived from them are described below.

Inter-coder reliability was assessed using Cohen's Kappa since coding schemes were comprised of mutually exclusive categorical codes. Coders were trained on practice tapes; when the Kappas were above .65, coders began to code independently, with 10% of tapes double-coded to reassess inter-coder reliability. Because Kappa is sensitive to the number of unique codes in a scheme, the small number of codes in each of the current coding schemes set a low upper-limit for the Kappa. The average reliability across these tapes was $K = .70$.

Attunement. Each change in affect by mother and child was coded second by second. A basic five point scale was used, from 1 very negative to 5 very positive, with 3 representing a neutral affect. Though the scale was simple and did not differentiate between distinct emotions that share a valence (e.g. anger and sadness), the microanalytic time-based nature of the coding enabled detection of each change in the valence of affect, the direction of the change toward a positive or negative valance, and correspondence between changes in children's and mothers' affect. The variables derived from this coding for use in the current study include child affect lability (frequency of change in child's affect) and mother affect attunement (percent of changes in child affect to which mother responded with a change in the same direction within 3 s).

Responsiveness. Another set of codes captured each child cue and the response of the parent to each cue, second-by-second throughout the interaction. Child cues were coded as belonging to three mutually exclusive categories (a) bid for social interaction, (b) request for something other than attention, or (c) distress. Child cues were often subtle, such as seeking eye contact as a social bid, or turning the head away from the mother to avoid stimulus as a distress cue; but the cues could also be more obvious, such as reaching out and touching the mother as a bid for affection, or vocalizing loudly when mother took a toy away as a sign of distress.

For each child cue coded, maternal response to that cue was also recorded. Mothers' behavior was examined for 5 s following each child cue to determine whether she responded appropriately, inappropriately, or not at all. For a response to be coded as appropriate it had to be contingent upon the child's behavior, noticeable by the child, and not harsh in any way. A response that was so minimal as to seem un-noticeable by the child, or was harsh or critical in any way, was coded as inappropriate. If the mother did not respond in a way noticeable by the researcher within 5 s, then she was given a code of non-response. Because each response code was paired with a specific child cue that had been coded for content, separate variables were derived for responses to each type of cue. The variables derived from this coding scheme at each wave – responsiveness to social cues and responsiveness to distress cues – are calculated as the percent of child cues to which mothers responded appropriately.

Mothers' perceptions of children. The Parenting Stress Index (PSI; Abidin, 1995) assesses parents' perceptions of stress related to their child and their role as a parent. The index includes two major scales: child-related stress, and parent-related stress. The child stress scale has 6 sub-scales: distractibility/hyperactivity, adaptability, reinforces parent, demandingness, mood, and acceptability. The Chronbach's alpha for the child scale ranges from .70 to .83, and test–retest reliabilities for this scale ranges from .55 to .82 (Abidin, 1995). In the current sample, the alphas for child and parent subscales were between .76 and .90. One criticism of the PSI is that it is subjective and vulnerable to parental bias; however, the purpose of this measure in the current study is to assess parents' perceptions of their children. Thus, the subjective nature of this questionnaire does not pose a methodological problem here. For the current study, the subscales thought to measure aspects of the child's temperament, which are unlikely to change due to the intervention, were not used. The subscales chosen for analysis were (a) reinforcing, measuring the degree to which the mother felt reinforced in her parenting role by the child's behavior, (b) acceptability, measuring mothers' perception of child behavior and development as acceptable, (c) as well as total child-related stress. Also, (d) the parent-stress scale total score is used as a control

Table 3
Group differences in mothers' and children's gesturing acquisition and use, as reported by mothers during two interviews.

	Group statistics			Mann–Whitney		
	Group	Median	*SEM*	Mean rank	*U*	Sig. (2-tailed)
Child Sign Vocabulary	Control	1.00	0.564	9.27	29.5	0.001
	Infant Sign	6.00	1.138	19.66		
Mother Sign Vocabulary	Control	0.00	0.690	9.85	37.0	0.003
	Infant Sign	5.50	1.265	19.19		
Number of People Signing	Control	0.00	0.317	9.12	27.5	0.000
	Infant Sign	3.00	0.270	19.78		
Number of Signing Routines	Control	1.00	0.398	11.35	56.5	0.036
	Infant Sign	2.50	0.365	17.97		
Signing Frequency	Control	1.00	0.474	12.23	68.0	0.121
	Infant Sign	2.50	0.329	17.25		

because it measures other stressful aspects of the parent's life that may influence perceptions of the child.

3. Results

3.1. Effects of intervention on use of symbolic gestures

First, to assess whether the intervention had an effect on use of symbolic gestures, I compared the use of symbolic gestures in the control and experimental groups. Because the data were not normally distributed, I used non parametric statistics (Mann–Whitney *U*); results are presented in Table 3. The infant sign intervention increased the number of different symbolic gestures children and mothers used, the number of people using signs with the child, and the number of daily routines in which families used signs. However, it did not significantly increase the overall frequency with which families reported using symbolic gestures; families in the control group reported using symbolic gestures less than once/day, while families in the infant sign group reported using signs on average several times/day. This similarity is probably due to the fact that many control families used a few symbolic gestures naturally without intervention. Further, three experimental families did not use the intervention, and one control group family who had been exposed to infant signing incidentally used signs regularly with their child.

3.2. Effect of infant signing on affect attunement

In order to test the hypothesis that an infant sign intervention would increase parents' attunement, I fit a series of regression models, using SAS PROC REG, to test the effects of group assignment on mothers' attunement to child affect; models controlled for child age and gender, mother's attunement at Time 1, and child's affect lability, since children who have more labile affects give mothers more to respond to. Because the use of symbolic gestures is a natural, if relatively rare, behavior which occurs in most preverbal child-parent dyads, I also tested the effects of mothers' and children's symbolic gesture vocabularies, across the whole sample, on mothers' attunement. Finally, I tested a combined model with all three predictors to determine whether the effects of the intervention would be accounted for by mothers' and children's symbolic gesture vocabularies. The results of these fitted models are in Table 4.

Assignment to the intervention did not have an effect on mothers' attunement to child affect (Table 4, Model A); neither did mothers' infant sign vocabulary (Model B). However, child's infant sign vocabulary was positively associated with mother's attunement to child affect (Model C). Further, this effect remained when controlling for both experimental group status and mother's sign vocabulary (Model D). On average across the whole sample, mothers responded to only 8% of the changes in child affect with a contingent change in their own affects. Each sign a child had in his or her vocabulary increased mothers' attunement by almost 2%, an effect size of 0.72. Thus, children who used nine signs (one standard deviation greater than total sample average) had mothers who responded contingently to 18% of the changes in their affect, while children who did not use any signs had mothers who responded to none of the changes in their affect.

It is also interesting to note that mothers were significantly more attuned with changes in boys' affect than they were to changes in girls' affect (Table 4, Models B and D).

3.3. Effect of infant signing on maternal responsiveness to child cues

Preliminary analyses showed that, unlike the other outcome variables in this study, there were significant between-site differences in the levels of mothers' responsiveness to child cues at Time 1, before the intervention. Thus, I fit a series of multi-level models, using SAS PROC MIXED, to account for site-level variance, nesting children within sites (EHS staff members). In order to determine whether the infant sign intervention increased mothers' responsiveness to children's cues, I fit two series of multi-level models, with responsiveness to social cues and responsiveness to distress cues as separate outcomes. In each series, child age and gender were controlled, as well as mothers' responsiveness to all of children's cues at Time 1. As with the attunement outcome, the effect of intervention group status was tested first to determine whether the intervention had a significant effect on responsiveness. Next, mothers' and children's infant sign vocabularies were added separately, then together, to determine whether the effect of the intervention was attributable to child's or mother's use of signs. The results are in Table 5.

The intervention did not impact mothers' responsiveness to child social cues, nor were mothers' or children's use of signs associated with responsiveness to social cues (Table 5, Models A and B). On average, mothers' responsiveness to social cues was relatively high at Time 1, with mothers responding contingently to 66% of child bids for attention. This increased slightly in both groups to 73% at Time 2. These results are seen in Fig. 1, Panel A.

The infant signing intervention increased maternal responsiveness to child distress cues. As seen in Table 5, Model C, being assigned to the experimental infant sign group predicted the percentage of child distress cues to which mothers responded appropriately at Time 2. The effect of being in the infant sign group increased by 47% the child cues to which mothers' responded appropriately at Time 2, an effect size of 1.12. The sizeable difference between the two groups can be seen in Panel B of Fig. 1. Though initially similar in their responses to child distress at Time 1, by Time 2 mothers in the experimental group responded contingently and warmly to almost to 80% of their child's distress cues, while mothers in the control group responded appropriately to only 50%.

Table 4
Results of fitted regression models testing the effects of the Infant Sign Intervention and children's and mothers' use of infant signs on mothers' attunement to children's affect. *Note*: Effects of each parameter are presented in unstandardized beta coefficients with standard errors provided in parentheses below.

Parameter	A: Infant Sign Group	B: Mother's Sign Vocab	C: Child's Sign Vocab	D: Group + Mother and Child Sign Vocab
Fixed effects				
Intercept	0.1492*	0.1027~	0.0530	0.0961~
	(0.0630)	(0.0497)	(0.0526)	(0.0534)
Age at Time 2	−0.0004	−0.0005	0.0018	0.0004
	(0.0041)	(0.0037)	(0.0034)	(0.0033)
Child Gender (Girl = 1)	−0.0912~	−0.1214*	−0.0955~	−0.1101*
	(0.0577)	(0.0557)	(0.0491)	(0.0498)
Time 1 Attunement to Affect	−0.0282	−0.0424	−0.0515~	−0.0588~
	(0.0334)	(0.0317)	(0.0295)	(0.0280)
Time 1 Child Affect Lability	0.0508	0.0860*	0.0884*	0.1094**
	(0.0345)	(0.0369)	(0.0322)	(0.0333)
Infant Sign Group	−0.0028			−0.1167*
	(0.0549)			(0.0546)
Mother Sign Vocabulary		0.0112~		0.0053
		(0.0060)		(0.0075)
Child Sign Vocabulary			0.0156*	0.0197*
			(0.0057)	(0.0077)
Model fit				
R^2	0.147	0.272	0.383	0.509
F	0.69	1.50	2.49~	2.66*

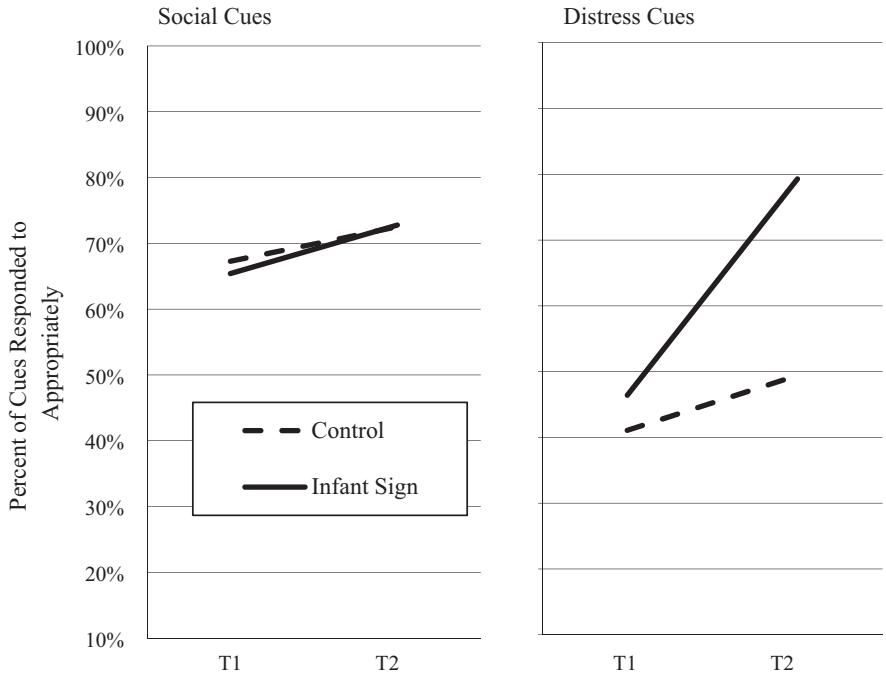
~ $p < .10$.
* $p < .05$.
** $p < .01$.

When mothers' use of infant signs was included in the model (Model D), the effect of being assigned to the intervention was diminished and no longer statistically significant. Thus, it appears that mothers' signing may mediate the effect of the infant sign intervention on mothers' responsiveness to child distress. However, this is not the case for children's use of infant signs. Children's use of infant signs is a significant predictor of responsiveness, even when controlling for assignment to the intervention (Model E). When children's use of infant signs is in the model, assignment to the infant sign group is still a significant predictor of mothers' responsiveness, and each sign the child uses is also associated with greater responsiveness; for every sign children used, mothers respond appropriately to an additional 2.5% of their distress cues. When all three predictors are in the model (Model F), both

Table 5
Results of fitted multi-level models to test the effects of the Infant Sign Intervention on mothers' responsiveness to children's social and distress cues. *Note*: Effects of each parameter are presented in unstandardized beta coefficients with standard errors provided in parentheses below.

Parameter	Response to social cues		Response to distress cues			
	A: Infant Sign Group	B: Group + Mother and Child Sign Vocab	C: Infant Sign Group	D: Group + Mother's Sign Vocab	E: Group + Child's Sign Vocab	F: Group + Mother's and Child's Sign Vocab
Fixed effects						
Intercept	0.7483***	0.7135***	0.7221*	0.6909*	0.6433*	0.6452*
	(0.0734)	(0.0789)	(0.2285)	(0.2044)	(0.2222)	(0.2187)
Age at Time 2	−0.0046	−0.0041	0.0020	−0.0032	0.0087*	0.0074~
	(0.0043)	(0.0039)	(0.0078)	(0.0053)	(0.0009)	(0.0009)
Child Gender (Girl = 1)	−0.0021	0.0307	−0.3410~	−0.2237	−0.2749**	−0.2632*
	(0.0639)	(0.0606)	(0.1202)	(0.0908)	(0.0153)	(0.0120)
Time 1 Total cue responsiveness	0.0570	0.0568~	0.2860*	0.2702*	0.2721***	0.2710*
	(0.0342)	(0.0322)	(0.0539)	(0.0370)	(0.0068)	(0.0049)
Infant Sign Group	0.0360	0.0369	0.4723*	0.2518	0.3472**	0.3256*
	(0.0649)	(0.0705)	(0.0948)	(0.0899)	(0.0121)	(0.0121)
Mother Sign Vocabulary		−0.0150		0.0478~		0.0069
		(0.0089)		(0.0148)		(0.0027)
Child Sign Vocabulary		0.0189~			0.0249**	0.0229*
		(0.010)			(0.0011)	(0.0011)
Random effects						
L1 Between Children	0.0245**	0.0193***	0.0153*	0.0063*	0.0002*	0.0001*
L2 Between Site	0.0070	0.0147	0.2418~	0.2117~	0.2950*	0.2863*
Model fit						
−2LL	−20.4	−23.7	3.3	− 3.6	−26.2	−30.9
X^2	0.71	2.31	6.61*	10.03**	36.00***	36.44***

~ $p < .10$.
* $p < .05$.
** $p < .01$.
*** $p < .001$.



Panel A. Average responsiveness to child social cues in the Control and Infant Sign groups at Pre- (T1) and Post- Intervention (T2)

Panel B. Average responsiveness to child distress cues in the Control and Infant Sign groups at Pre- (T1) and Post- Intervention (T2).

Fig. 1. Change in mothers' responsiveness to children's social and distress cues from Time 1 (pre-intervention) and Time 2 (post-intervention) in the control and infant sign intervention groups.

the infant sign intervention and child's use of infant signs are statistically significant predictors, though mothers' use of signs is not. Fig. 2 shows the combined effects of assignment to the intervention group and children's use of infant signs on mothers' responsiveness to distress cues, controlling for mothers' use of infant signs, as well as child age and gender. At Time 2, children who used no signs had mothers who responded to less than half of their distress cues, while children who used 9 signs (one standard deviation higher than the sample average) had mothers who responded to almost all of their distress cues.

3.4. Effect of infant signing on mothers' perceptions of children

To test whether the intervention affected mother's perceptions of her child, I fit a series of regression models (in SAS PROC REG) with mothers' perceptions of children as reinforcing and acceptable, as well as mothers' total child-related stress (PSI Child scale), as separate outcomes. For these variables, a higher score indicates a worse outcome (e.g. more child-related stress). The Time 1 level of the outcome was controlled, along with child age and gender, and mother's total parent-related stress (PSI Parent scale) at Time 2. Intervention status alone was tested first, then effects of mother and child infant sign vocabularies, followed by a model combining all three predictors. Results of the fitted models for mothers' perceptions of children as reinforcing (Models A–C) and acceptable (Models D–F) are presented in Table 6.

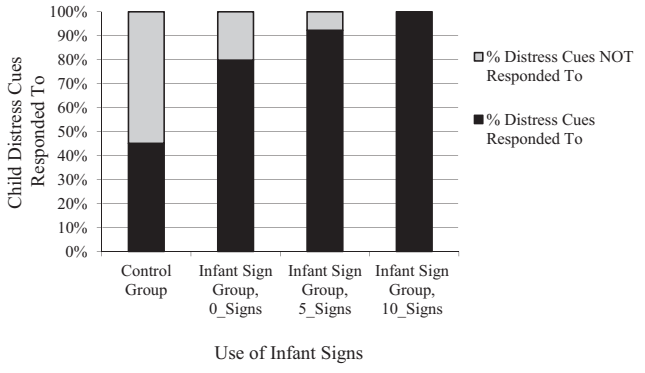


Fig. 2. Effects of children's use of infant signs, in addition to infant sign intervention assignment, on mothers' responsiveness to children's distress cues.

Reinforcing. As seen in Model A, the intervention had a significant effect on mothers' perceptions of their children as reinforcing, reducing mothers' stress in this scale by 25 points (effect size = 0.59). Children's use of signs was also associated with this aspect of mothers' perceptions of their children, controlling for mothers' use of signs (Model B). However, when all three predictors were in the model, the effects of both the intervention and children's signing were reduced somewhat and neither was statistically significant, though together these predictors produced a better fitting model (Model C). Thus, the effects of the intervention on mothers' finding their children reinforcing may be mediated by children's use of infant signs.

Acceptability. The intervention did not directly impact mothers' perceptions of children as acceptable (Table 6, Model D); also, children's use of signs was not associated with mothers' perceptions of them as acceptable. However, mothers' own sign vocabularies were associated with their perceptions of their children as acceptable (Models E and F); for every sign in mother's vocabulary, stress related to child acceptability was 5.44 points lower (effect size 0.75).

Table 6
Results of fitted regression models testing the effects of the infant sign intervention and mothers' stress related to perceptions of children as reinforcing and acceptable (lower score = perceive child as more reinforcing; lower score = perceive child as more acceptable). *Note*: Effects of each parameter are presented in unstandardized beta coefficients with standard errors provided in parentheses below.

Parameter	Reinforcing			Acceptable		
	A: Infant Sign Group	B: Mother's and Child's Sign Vocab	C: Group + Mother's and Child's Sign Vocab	D: Infant Sign Group	E: Mother's and Child's Sign Vocab	F: Group + Mother's and Child's Sign Vocab
Fixed effects						
Intercept	70.4344***	71.8096***	74.7155***	79.3197***	78.8808***	81.5026***
	(8.3031)	(8.7099)	(8.6410)	(11.8711)	(17.7667)	(10.9380)
Age at Time 2	−0.4731	−0.3338	−0.4098	0.2516	0.3738	0.3053
	(0.5885)	(0.6002)	(0.5816)	(0.8414)	(0.7349)	(0.7362)
Child Gender (Girl = 1)	19.5575**	16.2039**	18.0617~	−3.2397	−0.5739	1.1022
	(8.9018)	(9.1550)	(8.9276)	(12.7270)	(11.2099)	(11.3008)
Time 2 Parent-Related Stress	14.5581**	15.3498**	14.9338**	18.4632*	20.3891**	20.0137**
	(4.5295)	(4.6468)	(4.4937)	(6.4759)	(5.6897)	(5.6882)
Infant Sign Group	−25.1576*		−15.8612	−25.3829~		−14.3102
	(8.8119)		(10.9313)	(12.5986)		(13.8372)
Mother Sign Vocabulary		1.0159	1.0063		−4.0178*	−4.0264*
		(1.4419)	(1.3915)		(1.7655)	(1.7615)
Child Sign Vocabulary		−4.2661*	−2.9964		0.4405	1.5861
		(1.8525)	(1.9905)		(2.2682)	(2.5196)
Model fit						
R^2	0.5977	0.6065	0.6580	0.4553	0.6093	0.6370
F	5.94**	4.62**	4.49**	3.34*	4.68**	4.10*

~ $p < .10$.
* $p < .05$.
** $p < .01$.

Total child-related stress. Neither intervention status, nor mother's or child's use of signs, were significant predictors of parents' total child-related stress. Mothers' use of signs showed a trend toward significance ($b = -1.6947$, $p = .07$), controlling for intervention status.

4. Discussion

This study was designed to test, first, whether a simple infant sign intervention could increase the use of symbolic gestures, a naturally occurring behavior between preverbal children and their parents, in low-income families already enrolled in intervention services. Second, this study tested whether such an intervention could change the qualities of parent–child interactions, increasing maternal attunement and responsiveness to child cues. This study also aimed to see if an infant sign intervention could affect parents' perceptions of their child as stressful, as often reported by those who choose to use infant signs. Finally, this study explored the possibility that some effects of the intervention might be specifically related to either child's or mother's use of infant signs.

4.1. Effects of the intervention on use of infant signs

The intervention was designed to be simple, inexpensive, and focus solely on promoting parent and child use of infant signs, rather than transmitting additional information about child development or capacities for communication. This intervention was effective in getting mothers and children, as well as other family members, in low-income families to use infant signs as part of their everyday routines. However, a more intensive intervention with multiple sessions and additional materials may be far more effective in increasing the use of infant signs in these families. Many such materials exist in the commercial sector, though they are typically designed for parents to either purchase materials for use by themselves at home, or designed as a series of parent–child classes or workshops. With the increased focus on home-visiting as a service-delivery model for low-income families in the U.S., there is a need for infant signing curricula that are designed to promote and support infant signing through a home-visiting service model.

4.2. Effect of infant signing on maternal attunement

It is surprising that assignment to the intervention did not have a direct effect on maternal attunement to child affect, given that mothers in the intervention group were told to expect their child to use signs, which might have increased attention to their child's behavior more generally. However, it is interesting that, controlling for group status and mothers' use of signs, child sign vocabulary was associated with greater maternal attunement to child affect. This is consistent with the idea that children can use gestures to affect their caregivers' behavior toward them, including the consistency with which caregivers provide eye contact, maintain visual regard, and mirror child affect and vocalizations (Vallotton, 2009). However, given that children's sign vocabularies were measured by mother report, it may be that mothers who are more attentive to their children are those who see more gestures from their children. This possibility is interesting in itself, and should be investigated by employing a combination of maternal-report and direct observation measures designed to elicit the range of gestures in a child's vocabulary.

4.3. Effect of infant signing on maternal responsiveness

The intervention had a strong effect on mothers' responsiveness to child distress cues, but no effect on responsiveness to social cues. Children rarely showed strong indicators of distress during the free-play episodes in this study; rather, distress was usually mild, and distress cues were often subtle. It may be that most mothers find it relatively easy to respond appropriately to children's bid for attention during face to face interaction, but that responding contingently and warmly to a range of subtle distress cues is harder. If this is the case, there would be more inter-individual variability in response to distress cues, and more potential change with intervention.

It is notable that mothers' own signing is associated with responsiveness to child distress cues, and appears to mediate the relationship between the intervention and responsiveness to child distress cues, and that children's signing is independently associated with mothers' responsiveness to their distress. These results are consistent with studies showing that children's uses of both typical gestures (Goldin-Meadow et al., 2007) and infant signs (Vallotton, 2009) elicit greater general responsiveness from caregivers. The result in this study, that responsiveness specifically to distress cues changed, may indicate that children's use of infant signs is associated with a difference in parents' perceptions of their children's distress cues. Children who use clear communication cues may help parents attune more closely to their cues, helping parents interpret these cues in a way that makes them more likely to respond with warmth. These potential mechanisms should be tested in future studies with a larger sample in which tests of multiple paths of mediation are possible.

4.4. Effect of infant signing on maternal perceptions

The intervention had a substantial effect on mothers' perception of their children as reinforcing them in their roles as parents. Even controlling for the intervention and mothers' use of signs, children's use of infant signs was associated with mothers finding children reinforcing. This is consistent with the idea that children who have clearer communication cues, to initiate interactions and respond to their caregivers, have caregivers who feel more satisfied in their relationship with the child (Goldberg, 1977), while children whose expressive cues lag behind developmental norms have parents who are more stressed in their relationship with their child (Irwin, Carter, & Briggs-Gowan, 2002). The intervention did not directly affect mothers' perception of their children as acceptable, though mothers' use of signing was associated with lower stress related to finding their children acceptable. This may be indicative of a dynamic relationship between mothers' use of signs and children's behaviors. For example, mothers' use of signs might increase the frequency and clarity of child cues, as in studies of mothers' typical and symbolic gestures (Goodwyn & Acredolo, 1993; Goodwyn et al., 2000; Iverson et al., 1999; Rowe & Goldin-Meadow, 2009a), which could mediate the relation between mothers' use of signs and their perceptions of the child's behavior as acceptable. Future studies should test this idea by examining the effects of an infant sign intervention on both parents' and children's interaction behaviors.

4.5. Limitations

The inability to conduct random assignment at the individual level leaves open the possibility that unmeasured common experience among participants assigned to the same Early Head Start service provider may be in part responsible for the apparent intervention effects. Assignment at the provider level is often necessary when working with programs in which families served by the same provider are in contact with one another, such as in EHS. It would be beneficial to test this intervention with families who are served solely through a home-visiting model, where families served by the same provider are not in contact with one another.

Another limitation of this study, shared by previous studies of infant sign interventions (Gongora & Farkas, 2009; Goodwyn & Acredolo, 1993; Goodwyn et al., 2000), is reliance on parent reports of gestures used by parents and infants. In the current study, the observational measure of parent–child interaction was not designed to elicit signing, but to capture the qualities of typical parent–child interactions; this had the benefit of maintaining the naivety of the coders to the assignment of the families. Yet, because infant signs were not elicited, the low number of signs observed during these interactions limits the option to examine, in a more micro-analytic and dynamic way, the role of infant signs in affecting the qualities of parent–child interactions. If future studies are to address the mechanisms of the effects of promoting symbolic gestures in adult–child interactions, a suite of observational and parent-report measures should be devised to capture both parents' and children's comprehension and production of symbolic gestures.

4.6. Future research

In addition to the outcomes measured in this study, there are many candidate qualities of interactions or of parents' perceptions of children that could be affected by such an intervention. For example, the finding that mothers see children as more reinforcing and acceptable may be related to mothers' mentalizing the child's behavior; that is, mothers whose children use signs may view their child's behavior as more intentional and consider the thoughts and feelings that are behind the child's behavior. Thus, it would be valuable to test the effects of an infant sign intervention on parent perception outcomes such as parents' mind-mindedness (Meins et al., 2002) or insightfulness regarding their children's characteristics and behaviors (Oppenheim & Koren-Karie, 2002). Further, parents' feeling of being reinforced by their children may be related to changes in parents' satisfaction in the relationship or in parents' sense of competence as parents (Appleton et al., 1975; Leerkes & Crockenberg, 2002); these changes are likely mediated by changes in child behavior, including the clarity of their cues (Goldberg, 1977).

It is also possible that these shifts in parental attitudes and perceptions of their children are natural, child age-related changes that occur once children begin to communicate more clearly, and that an infant sign intervention simply brings these natural shifts sooner. To test this, one could employ a longitudinal experimental study with frequent measurement points to capture growth in child communication cues, and use that growth to predict change in parent perceptions.

In a larger sample, it may be possible to tease apart the mechanisms of change due to the intervention in greater detail. There may be a sequence of changes that happen as a result of the intervention involving changes in both parent behaviors and perceptions and child interaction behaviors and communication skills. For example, it may be that the intervention simultaneously changes mothers' use of signs and her expectations of child behavior; these changes could cause an increase in child gestures, thus providing parents with clearer child cues. These clearer cues could cause parents to feel more reinforced and reduce their stress related to parenting, which could increase their warmth and responsiveness toward the child during interactions. Another possibility is that the intervention directly changes mothers' attentiveness to child cues as they watch for gestures, but this watchfulness also increases attunement to child affective and vocal cues, causing them to be more responsive to vocalizations and changes in affect. In addition to engaging a larger sample for such a study, it may be necessary to use micro-analytic observational methods and analyze multiple competing contingencies to examine the dynamic interplay between child and parent interaction behaviors across affect, vocal, and gesture behaviors.

4.7. Conclusion

Despite a number of serious limitations, the current study provides preliminary evidence that encouraging the use of symbolic gestures in low-income families is associated with more positive perceptions of children and more attunement and responsiveness in parent–child interactions. Promoting this practice increased parents' responsiveness, not just in moments when children were using signs, as found in other studies (Vallotton, 2009), but rather,

it increased parents' responsiveness across a variety of child cues including facial expressions, vocalizations, and other behaviors. Thus, in addition to promoting child language development (Goodwyn et al., 2000), the use of infant signs as an intervention may be an effective way to promote responsive parent–child relationships in low-income families.

Appendix A. Text of laminated handout, used with permission from Baby Signs, Inc.

Baby Signs: How to Talk with Your Baby Before Your Baby Can Talk

*From the book by Linda Acredolo & Susan Goodwyn

Did you ever notice how easy babies learn how to wave "bye bye" and shake their heads for "no" or nod for "yes"? Eventually babies learn to speak, but in the meantime these simple gestures help them to communicate quite effectively, even months before they can use spoken words. Most parents usually stop right there, never realizing their baby's potential for learning other gestures to communicate. What kinds of signs can babies learn? Here are just a few examples: **Drink, eat, more, all done, hot, diaper, book, dog, fish, flower, bird, hat, kitty, car, airplane**,. . . and many more that families and children use together. Just about anything that a child is interested in can be made into a sign.

These gestures that you can teach your child - what we call "Baby Signs" - give your child more tools than just pointing, crying, or an urgent "Uh uh uh" to get a message across. With Baby Signs, your child can enjoy interactions with you that otherwise would have to wait until s/he could talk.

How do I start using Baby Signs with my baby? Teaching babies how to use Baby Signs can be a simple task. As you show the motion to your child, you also say the word so that they understand that both the gesture and the word mean the same thing. Here are a few tips on getting started:

- Start with just a few signs. At the beginning, it's easier to remember to model the signs you've chosen if there aren't too many.
- Choose signs that will be important to your baby. We all remember better the things that we care about. For example, a pet in the family makes that type of animal a great choice.
- Repetition is the key to success. Just as any type of learning, the more exposure, the better. Keep your eyes open for opportunities to use the signs you're working on—with books, with TV, on family outings, and during normal daily routines such as meal-time.
- Model the word along with the sign. It's both natural and useful to pair word and sign. Doing this gives your baby the choice of what to use and speeds the transition to speech.
- Choose simple physical motions. If you try a sign other than those we've suggested, make sure you choose an action your baby can easily do.
- Watch your baby. Watch for signs that your baby might make up herself. Once you figure out what she means, use them with her on a regular basis. This will let her know that you are paying attention to her.
- Relax and have fun! Remember, Baby Signs are just an extension of what babies and parents do naturally.

When should I start? Children can use signs as young as 10 months, but not all babies learn at the same time. A good sign that your baby is ready to start learning Baby Signs is when he begins to wave "bye bye."

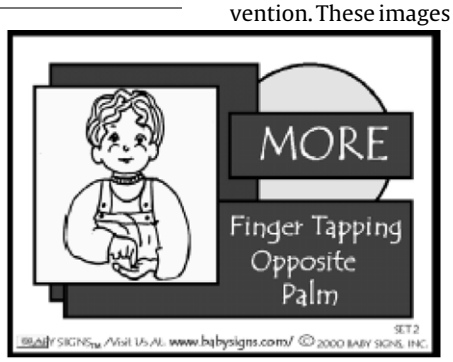
A common concern about Baby Signs. Many parents ask, "Won't the use of Baby Signs keep babies from learning the vocal words?" The answer to this question, based on 10 years of research with hundreds of babies, is a definite NO. In fact, it has just the opposite effect. Baby Signs provides babies with the kind of interactions that helps to encourage language development, not slow it down.

Have fun talking with your baby!

Remember, Baby Signs are a natural form of communication, relax and have fun with your child.

Appendix B. Sample images from refrigerator magnets and story book provided as part of intervention

The images below are examples of four of the refrigerator magnets initially provided to families as part of the infant sign intervention. These images were used with permission of Baby Signs, Inc.



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