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Joint engagement and attachment patterns in infants with visual impairments

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Joint Engagement and Attachment Patterns in Infants with Visual Impairments

by

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Abstract

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This dissertation reports on two early childhood developments, joint engagement and attachment patterns, and explores a possible relationship between the two in a sample of 20 infants with various levels of visual impairments, without additional disabilities. Joint engagement and security and organization of attachment patterns have been associated with positive developmental outcomes, such as better language and socio-emotional skills, better performance in theory of mind tests, and reduced risk for psychopathology. There is a need for research on these topics in the population of children with visual impairments, and the relationship between joint engagement and attachment patterns has not been explored in this population.

Study 1 focuses on joint engagement, that is, infants' coordination of their attention between a social partner and an external focus of shared interest. Infants and their caregivers were videotaped during 30-minute free play sessions at their homes. Videos were coded to establish the duration of joint engagement episodes, and the overall time dyads participated in it. Results showed that all infants tested participated in joint engagement and that the percentage of time it represented of the 30-minute free play session significantly increased between ages 12 and 18 months. The average duration of single episodes of joint engagement increased but only approached significance. The level of each infants' visual impairment was described as reductions from norms in visual acuity and contrast sensitivity as measured using both visual evoked potential and preferential looking techniques. Of the visual measurements, infants' reduction in contrast sensitivity measured with preferential looking technique predicted infants' percentage of time in joint engagement across ages. This finding supports the importance of considering contrast sensitivity levels, rather than only those of visual acuity, in research with this population.

Study 2 focuses on attachment patterns. Infants and their caregivers underwent the Strange Situation Paradigm with added instructions to accommodate for the perceptual needs of infants with visual impairments. Results showed that all but 1 of the 27 SSPs collected were deemed classifiable. Most attachment patterns were secure, ranging between 56% in the younger group of infants tested, and 70% in the older group.

Attachments coded as disorganized ranged between 22% and 6% in the younger and older groups respectively.

Study 3 explores the relationship between infants' security of attachment and the percentage of time they participated in joint engagement with their caregivers during free play. Results did not find a significant effect. This is in line with the mixed results in the literature on the connections of attachment and joint engagement, which not only varies in the finding of significant effects within a given population, but also varies between the results in different populations.

Contents

List of Tables

List of Figures

Preface

Visual impairments encompass a wide range of visual abilities, including no light perception (total blindness), low vision (warranting accommodations like Braille) and visual impairment (reduced visual acuity requiring large print or >3x magnification). Only a minority of children with visual impairments is totally blind (Lueck, 2004).

The World Health Organization (WHO) estimates, as of 2010, the global population of children between ages 0-14 years with visual impairments is 19 million. Of these, 17.5 million children have low vision and 1.4 million are blind (World Health Organization, 2012). The etiology of visual impairment and blindness varies globally.

According to a 2012 survey of schools for the blind in the United States, the top three causes of childhood visual impairment are cortical visual impairment, optic nerve hypoplasia, and retinopathy of prematurity (Kong et al., 2012). In Western societies the majority of these children present with additional disabilities (Sonksen, & Dale, 2002).

Visual impairments are typically defined and expressed in terms of visual acuity (ability to see detail), and range between the minimal degree of visual impairment (visual acuity of 20/70) to the greater degree (visual acuity of 20/400 or worse). A way to interpret the visual acuity fraction is to think of the numerator as the distance the person needs to be in order to see a target that someone with normal vision can see at the distance expressed by the denominator. For example, a person with a visual acuity of 20/40 can see a letter when he is 20 feet away from it while a person with normal vision can see the letter from a distance of 40 feet (Flom, 2004).

Research on infants with visual impairments commonly reports only their visual acuity levels, however several other visual functions can be impacted. Visually impaired children with similar levels of visual acuity can differ in how those other visual functions are reduced. For instance, a reduced ability to notice differences in brightness—contrast sensitivity— will add difficulties to a child's clinical picture, beyond the challenges caused by his reduced visual acuity (Orel-Bixler, 2014).

The way visual impairments influence development varies greatly depending on how much residual vision the child has. For instance, developmental skills reported to be achieved by infants with visual impairments at a later age than sighted peers show the greatest lags in those with the most severe levels of visual impairments—e.g., no light perception or light perception at best (Dale & Salt, 2007).

Additionally, children with similar visual impairments can develop at different rates depending on their families' access to developmental counseling, and more broadly on how society in general mediates the social and physical world for these children. The presence of additional disabilities plays a significant role to the point that findings from studies with infants with additional disabilities should not be automatically extended to those without them.

This dissertation's aims are to study in a sample of 20 infants with visual impairments with no additional disabilities, and their caregivers, two early developments:

the ability to coordinate attention between a social partner and an external focus of shared interest—joint engagement—and the ability to identify one's main caregiver and to seek her when in a threatening situation—attachment behavior. It also explores the existence of a relationship between these infants' attachment patterns and participation in joint engagement with their caregivers.

Unlike previous research that had focused solely on infants having the most severe levels of visual impairments, these studies report on infants with varied degrees of visual impairments and thus provide information that is more representative of the visually impaired population. Also, unlike most research on this population, the visual measurements collected are not circumscribed to assessments of visual acuity, but also include contrast sensitivity.

Study 1 reports the percentage of time infants and caregivers participated in joint engagement during a 30-minute free play session, as well as the average duration of single joint engagement episodes. It also looks at the relationship between these percentages and the infants' reduction from norms for both visual acuity and contrast sensitivity.

Study 2 reports the application to these infants of a laboratory procedure for the classification of attachment patterns—the Strange Situation Paradigm—and the distribution of patterns found in the sample.

Study 3 compares the percentage of time infants who had a secure attachment versus insecure attachment pattern spent in joint engagement with their caregivers.

Study 1

Percentage of time infants with visual impairments and their caregivers spend in joint engagement and its relationship to infants' visual acuity and contrast sensitivity

1.1 Background

Joint engagement refers to children's ability to coordinate attention toward a social partner and an object of mutual interest. In the literature, this is also referred to as joint attention, secondary intersubjectivity and shared attention. Prior to the emergence of joint engagement, infants attend separately to people and objects. Sighted newborns preferentially look at human faces, both schematic and veridical ones (Macchi Cassia, Turati, & Simion, 2004), and their interest in face-to-face interaction with other humans is at its peak between the ages of 3 and 5 months (Bigelow, 2003). By 5-6 months of age infants attend more to objects, and dyadic interactions with social partners decrease (Adamson & Mc Arthur, 1995). With the emergence of joint engagement toward the end of the first year of life, infants start to attend to both people and objects within the same interactions (Adamson, Bakeman, Deckner & Nelson, 2014; Bakeman & Adamson, 1984).

According to Bakeman and Adamson (1984), if during an episode of joint engagement the child does not actively acknowledge the caregiver's participation, this is labeled "supported" joint engagement. For example, the caregiver might show her infant a pom pom, whereupon the child starts to attend to it. In this situation, the caregiver's actions influence the infant's interaction with the object; the child is aware of the caregiver's action, but his attention remains primarily on the object.

In contrast, if during joint engagement the child does actively acknowledge the caregiver's participation, for instance, by looking back and forth between the caregiver's face and the object that is the common focus of interest, then the episode is labeled "coordinated" joint engagement. Coordinated joint engagement can be initiated by the infant or by his social partner. Each can do so by either following into the other's already established focus of attention, e.g., the child looks in the same direction the mother is looking until he finds her visual target; or by directing the other's focus of attention, e.g., the mother points out the target to the infant (Adamson, Bakeman, Deckner & Nelson, 2012; Adamson et al., 2014).

The distinction between the two types is descriptive; it does not imply that coordinated is better than supported. Whether supported or coordinated, joint engagement requires that the caregiver's involvement with the object somehow influence the child's engagement with it.

The prototypic example of coordinated joint engagement—that is, the child and social partner attend to the same focus and the child alternates his attention between the two—is also an index in studies of the related concept of joint attention. However, even though researchers of both coordinated joint engagement and joint attention use the same behavioral index, they vary in their claims of what this implies for the infant's social cognitive understanding. In this dissertation's summary of research findings, terms used by the research authors will be followed, yet the reader should keep in mind that despite this difference in terminology, studies of coordinated joint engagement and joint attention reference the same observable behavior.

Some authors posit that children who participate in joint attention have the cognitive understanding that they and their social partner are attending or could attend to the same stimuli. For Tomasello (1995, 2007; Tomasello & Carpenter, 2007) for instance, the emergence of joint attention marks the child's initial understanding of others as intentional agents in the sense of having goals and mental representations that inform their actions. From this perspective, the child is not merely sequentially alternating attention between the object and social partner but is attending to the social partner's focus of attention (Carpenter, Nagell, & Tomasello, 1998; Tomasello, Carpenter, & Liszkowski, 2007).

For other authors however, joint attention does not need to entail such a level of social cognition; instead it can be explained as the result of associative learning. Through repetition, the child has learned that if he looks back and forth between a social partner and the object of shared interest, a rewarding consequence will ensue; the caregiver will smile and speak to the child, and/or give the object to him (Baldwin, 1995, Corkum & Moore, 1995; Dunham & Dunham, 1995).

With respect to coordinated joint engagement, its definition requires the child to voluntarily and repetitively notice the social partner's role in their attention to a common focus but it does not make claims about the infant's cognitive understanding of others as intentional agents (Adamson et al., 2014; Bakeman & Adamson, 1984).

This difference in interpretation leads to diverse takes on whether declarative and/or imperative acts involve joint attention (or coordinated joint engagement). In *declarative* acts, the action of showing the external focus to the social partner is the goal in and of itself, and is cited as evidence that the child considers the social partner as an agent whose intentionality can be influenced. In *imperative* acts, the action of showing the external focus is not the goal per se but rather is a means to obtain something else. If the child shows an object to the caregiver because he wants her to give it to him, it is not necessarily the case that the child understands her as an intentional agent. Rather, the child can understand the social partner as a means to an end, and the imperative act can be the result of associative learning. Through repeated experiences, the child has learned that when a toy he desires is out of his reach and the adult is nearby, he will gain access to the toy if he points it out to the adult. Some authors reach a compromise regarding imperative acts and consider them as involving joint attention if gaze switches between the social partner's face and the desired object are part of the infant's imperative act. A richer socio-cognitive interpretation considers only declarative acts but not imperative ones, whereas a leaner interpretation would include both (Carpenter et al., 1998; Gómez, 2007).

Joint engagement and joint attention refer to the actual triadic social interaction involving the infant, social partner and shared external focus as well as the child's ability to participate in them. Even though studies tend to focus on the child's behavior, for instance by measuring the times when infants switch gaze between the social partner and object, the caregiver's participation is still a requirement. When viewed as a goal-directed partnership, joint engagement requires social partners who, when necessary, are willing to relinquish or adjust their set of goals to suit their partners'. Evidence from studies with low birth-weight infants, or those with Down Syndrome or Autism, have shown that joint engagement is susceptible to interactive miscoordination and requires work on the part of both partners to establish and maintain it (Raver & Leadbeater, 1995).

If the child tries to get the social partner to attend to a shared focus and the partner does not do so, this is not joint engagement as social interaction. Instead, the child attempted to initiate one such interaction, which does speak to the child's joint engagement abilities, but joint engagement as a triadic social interaction has not occurred.

Indeed, social partners' behavior has consequences on the characteristics of the joint engagement. Exploratory play in pre- and full-term 6-month old infants increases when mothers use strategies to maintain their infants' already established focus of attention or to introduce toys when infants are unengaged, but not when used to redirect the infants' attention (Landry, 1995). Both naturalistic and experimental studies show that when social partners follow the infants' already established focus of attention rather than re-direct it, infants engage in more conversational turns, and show greater complexity of semantic, syntactic and conversational skills (Tomasello, 1988; Tomasello & Farrar, 1986). In contrast, dyads spend less time in joint attention when the mother persists more often in re-directing infants' attention despite the infants' refusal to shift focus. In another example, studies show that parents of non-verbal children with autism use more literal means rather than symbols to direct their infants' attention, which decreases these infants' exposure to symbols (Raver & Leadbeater, 1995).

Development

Studies of 6- to 18-month-old infants show that supported joint engagement emerges before coordinated. By 6-9 months, babies begin to switch gaze back and forth between caregiver and object, initiate and respond to object-oriented gaze and pointing, and attend to the caregiver in order to disambiguate unfamiliar stimuli (i.e., social referencing). Soon infants start to use gestures to share attention to a focus external to the social interaction; and by about 13 months, infants readily engage in nonverbal referential communication with a social partner about a present object (Adamson et al., 2015; Bakeman & Adamson, 1984, 1986).

Adamson et al. (2004) longitudinally studied normally sighted infants from 18 to 30 months of age. Babies were videotaped while interacting with their caregivers in a structured playing situation. Caregivers were given instructions to initiate scenes with their infants aimed at interacting, requesting, commenting, and narrating. Across all observed ages, the mean percentage of time infants participated in supported joint engagement ranged from 50% to 56%, and in coordinated joint engagement from 16% to 21%.

By the last half of the second year, symbols are being incorporated within joint engagement. For instance, the use of words allows the dyad to refer to absent objects or internal states, or to highlight an aspect of the situation. Besides language understanding, symbols are incorporated in the form of pretense acts—using an object as if it is something else—and symbolic gestures. This symbol-infused joint engagement increases dramatically between 18 and 30 months of age. In one study, it rose from 8% to 49% of 30-minute child-mother observations. By 3.5 years of age, the amount infants engaged in it reached a ceiling of about 80%, yet through age 5.5 years its focus became more complex and the infants increasingly took a more active role (Adamson et al., 2014; Adamson et al., 2004; Adamson & Bakeman, 2006).

Relationship with other developmental skills

Learning of objects' properties and functions

Studies have linked infants' participation in joint engagement and joint attention with several positive developmental outcomes in sighted children—for one, infants' learning of objects' properties and functions. Bigelow (2004) reported that 12-month old sighted children showed more use of objects in functional play—conventional use of objects, e.g., dialing the toy telephone; putting a lid on a cup—during joint attention. Children's functional play within joint attention, but not outside of it, correlated with functional play when the child was alone. In contrast, outside of joint attention, children showed more stereotypical play (e.g., mouthing, banging, fingering a single object).

Language development

Joint engagement has been tied to advances in language development. Observational studies found that infants first started to utter words with a communicational function within routine interactions with their caregivers. In these routines, child and caregiver paid attention to a predictable set of steps involving reference to objects, which made it easier for the non-verbal child to determine what adults were referring to with the words they utter (Bruner, 1975, 1995; Tomasello, 1988). Longitudinal studies of infants and their mothers showed that the time they spent in joint attention, whether within routines or in novel situations, positively related to infants' vocabulary (Tomasello & Todd, 1983). The cumulative time children spent in symbol-infused supported joint engagement between ages 18 and 30 months made a significant contribution to the prediction of their expressive and receptive language scores at 30 months of age (Adamson et al., 2004).

Support for this relationship also comes from studies that focused on infants' skills. Experimental data showed that 16-19 month-old sighted infants learned to match an adult's uttered word to the object the adult was gazing at even if the infants themselves were at the moment attending to a different object (Baldwin, 1991). Infants who showed a greater capacity to match mothers' direction of gaze at 6 months of age, had larger receptive vocabularies at 12 months, and larger expressive vocabularies at 18, 21, and 24 months (Morales, Mundy, & Rojas, 1998). Twelve-month old children's ability to follow a social partner's direction of gaze and pointing gesture, and 18-month old children's ability to use eye contact for initiating joint attention episodes, both predicted receptive language skills at 24 months, after controlling for general aspects of cognitive development (Mundy et al., 2007).

This relationship has also been reported in children on the autistic spectrum.

Mundy, Sigman, and Kasari (1990) studied children with autism who had fewer than five words of expressive language. It was not their IQ, mental and chronological age, nor language level at study entrance, but rather their ability to use gestures to engage in non-verbal joint attention—e.g., extending a toy toward the social partner's face—, that predicted their expressive and receptive language scores when they were tested 13 months later. Toth, Munson, Meltzoff, and Dawson (2006) found, in 3 to 4-year-old autistic children, that their ability to use their eye gaze, showing, and/or pointing to share attention had the strongest association to their concurrent language scores as compared to their imitation and toy play skills.

Theory of Mind

Joint engagement has implications for the acquisition of a theory of mind, that is, the understanding that people have mental representations like perceptions, beliefs and desires that guide their behavior. Successful completion of theory of mind tests requires the child to differentiate between his own state of mind with that of another person. This is evidence that the child understands that mental states are individually anchored and that his own perspective is not necessarily the same others have of a shared situation. For instance, in a version of the false belief paradigm, the child is presented with an object such as a candy box and asked what he thinks is inside. Typically children would say "candy." Then the child is allowed to see that instead the candy box contains sand, and is asked what would a peer say is inside the candy box when first presented with it. Children who understand false belief will say the peer will believe it contains candy. Children who do not will attribute to the peer the same knowledge they themselves have of the true content and say "sand."

Longitudinal studies found that children's performance in joint attention tasks at 20 months (e.g., turning to gaze at a social partner when she blocked the infant's access to a toy) predicted children's performance in theory of mind tasks at 44 months of age (Charman et al., 2000). Children's higher performance in the false belief task at pre-school age correlated with more time spent in coordinated joint engagement at ages 18-21 months, and symbol-infused joint engagement between 27 and 30 months (Nelson, Adamson, & Bakeman, 2008).

Socio-emotional development

Morales, Mundy, Crowson, Neal, & Delgado, 2005 found that the 6-month old infants' ability to follow a social partner's gaze direction was significantly positively correlated to these infants' use of strategies for emotional regulation at age 24 months. Also, the infants' participation in coordinated joint engagement—labeled "collaborative" by the authors—at 24 months was significantly positively correlated to their concurrent emotional regulation skills. In another study, 12-month old infants who showed a greater ability to look toward the object a social partner was looking and pointing at—i.e., responding to joint attention bids—were significantly more likely to use attention self-regulation strategies in a delay gratification task (Vaughan Van Hecke et al., 2012). In a sample of at-risk children—i.e., cocaine exposed—it was found that the more times they initiated joint attention between ages 12-18 months, the less disruptive behaviors—e.g., "teases other students"—were reported by their teachers when children were 36 months old. Results also showed that children's ability to respond to social partners' bids for joint attention negatively predicted withdrawn behaviors and positively predicted social competence (Sheinkopf, Mundy, Claussen, & Willoughby, 2004).

Non-visual joint engagement

By definition, coordinated joint engagement and joint attention can be established using non-visual cues; for instance, when a child feels his hand and an adult's hand tactually exploring the same object. Indeed, and although it might seem obvious, the amodal nature of joint engagement is evidenced by the fact that blind adults share attention. They can show an object by placing it in the other person's hands, or they can use language to follow or direct others' focus of attention. There is also evidence that sighted children can identify their caregiver's attitude toward a potentially threatening situation—i.e., social reference—using vocal cues alone (Leekman & Wyver, 2005); and that infants follow a hidden—i.e., not visually perceived by the child—social partner's direction of voice to its focus of attention (Rossano, Carpenter, & Tomasello, 2012).

Yet, research has relied heavily on infants' gaze switch as its index. Most research uses a testing paradigm that relies on visual behavior as it: a. presents a visual stimuli as the potential shared focus, such as a silent toy; b. provides the infant with visual cues of the social partner's focus of attention, e.g., the social partner gazes at the toy or points at the toy to the child; and c. indexes the child's joint attention by the child's gaze switching between toy and social partner (Butterworth, 1995; Scaife & Bruner, 1975).

However, some authors have acknowledged the limitations of using gaze switch as an index. Carpenter et al. (1998) recognizes how it fails to record episodes when infants are visually attending to the shared focus while attending only auditorily to the social partner. Adamson and Bakeman (1985) posit that joint engagement refers to a state of attention that is not solely based on patterns of visual gaze. Moreover, gaze alone may not fully index the intensity of the child's interest in either caregiver or object. For instance, a child sitting on her caregiver's lap during book reading might gaze at the caregiver when the shared activity starts but from then on gaze only at the book and yet continue to be aware of the caregiver's participation. In symbol-infused joint engagement, the child can signal his acknowledgement of the caregiver's participation by conforming to the caregiver's verbal commands regarding an object without gazing at her (Adamson et al., 2004).

An infant who has not developed joint engagement also does not show the caregiver emotional reactions in reference to objects. For instance, a pre-joint engagement infant might want an object which is out of his reach, yet he does not signal his desire to the social partner either by switching gaze or by emoting toward her (Adamson & Russell, 1999). Adamson and Bakeman (1985) studied the prevalence of affect during periods of joint engagement and found that in 6- to 18-month old infants, affect occurred often when they first became engaged with the same object their social partner was manipulating, and that in episodes with their mothers, infants continued to express affect throughout joint engagement. The integration of affect into joint engagement increased with age; at 6 months, more than a third of the infants' affective expressions occurred during joint engagement with their mothers; by 18 months this had increased to over 60%. The rate of infant affect did not vary significantly between supported and coordinated joint engagement. Mundy, Kasari, & Sigman (1992) found that infants with a mean age 20.2 months displayed more positive affect in association with joint attention rather than in requesting acts. It should be noted that although the authors did not consider requesting actions as joint attention due to its instrumental or imperative nature, they included infants' use of eye gaze, pointing and showing objects to the social partner. These results indicated that joint attention behaviors not only involve the coordination of attention to objects and events, but also the capacity to share affective experience vis-à-vis objects and events. Some researchers have included affective sharing as part of indexes for joint attention in the context of imitative learning (Carpenter et al., 1998).

Joint engagement in children with visual impairments

Given researchers' focus on visual joint engagement, it is not surprising that the question of how infants with visual impairments develop joint engagement has many times been approached from a deficiency perspective. Researchers consider the role that vision plays in joint engagement in sighted children and foresee that infants' impaired or absent visual abilities will negatively impact its development. For instance, it has been argued that joint attention's development in blind children would be delayed since they are not able to use the direction of other people's gaze as a way to detect other people's intentionality (e.g. "Mom looks at a toy" as a signal that "Mom wants that toy"). However, by relying on tactual and auditory cues, blind children would ultimately achieve joint attention and understand the meaning of seeing as apprehending or perceiving (Baron-Cohen, 1995).

The presence and severity of risk factors for abnormalities in joint engagement depends on how visually impaired infants' caregivers and society in general accommodate these children's perceptual abilities and needs. For one, the presence of visual impairments can challenge the establishment in early development of contingent and mutually responsive mother-child exchanges. Infants with visual impairments can present idiosyncratic behaviors, which if interpreted by the caregiver as lack of interest in social interaction, will decrease the opportunities for positive exchanges between them. Infants with visual impairments are reported to respond to social interaction with decreased or absent eye contact, gaze or smiling. They may quiet and adopt "listening stand" (e.g., turn ear in direction of sound) when interested in a social partner's voice. They have been described as quiet and passive and might be more irritable and less responsive (Lueck, Chen, Kekelis, & Hartman, 2008). In comparison to sighted peers, these infants are reported to show decreased positive affect, and increased negative affect, fewer periods of positive vocalizations and more of negative ones. They are also said to ignore mothers' bids for social interaction and attempt to terminate interaction by averting gaze and turning head and body away from caregivers, and to initiate play interactions with their mothers nine times less often than typically developing infants (Cass, 1998; Kekelis & Anderson, 1984; Rogers, 1988; Rogers & Puchalski, 1984).

However, in her pioneering work, Fraiberg (1977) described blind infants as showing dampened or muted affect but stressed how the infants' hands movements and uses provided a better index of their emotionality. For instance, interest in objects or people was demonstrated by blind infants' active tactile exploration of them. This observation was corroborated in a different set of infants by Preisler (1990), who reported that in the age range of 3 to 6 months the blind and visually impaired infants she observed reacted to mother's approach by increasing their motor activity—legs and arms waving—

and making lip and tongue movements. This begs the question as to whether these infants' perceived passivity and lack of emotionality are a result of observers' biases regarding what indexes infants' interest and affect. Pérez-Pereira & Conti-Ramsden (2005) make a related observation when they question the evidence behind the claim that children with visual impairments have difficulty initiating communication with others. These authors notice that caregivers of children with profound visual impairments and blindness have been found to initiate communication at a higher rate than those of sighted peers. When data is presented as proportions between caregiver/child initiations, visually impaired children appear as less likely to initiate interactions, compared to sighted peers. But, when data is presented in terms of frequencies, no differences are found between blind and sighted infants.

Second, blind infants show impairments in abilities that in sighted children are deemed crucial for perceiving themselves in relation to others, such as seeing how others match infants' own facial expressions, detecting others' emotional body expressions in relation to people and objects, and following other people's gaze to their focus. To achieve a sense of interpersonal agency, these infants need social partners to use non-visual cues in order to attune and contingently respond to the infants' behaviors. Without them, these children have fewer opportunities to perceive that their actions have an effect, sometimes a predictable one, on others (Bigelow, 2003).

Third, visual impairments can interfere with infants' understanding that objects exist in the environment, even when they are not currently available to perception, and that objects can be retrieved in different locations in the environment. Children's experiences reaching and grasping objects, letting them go, searching for and retrieving them, contribute to such understanding (Piaget, 1957). Infants with visual impairments risk having less of these experiences. One issue is the age at which they start reaching for objects. Whereas reaching for objects in sighted infants is observed by 4-6 months of age, reaching upon hearing objects' sound cues emerges later—10-12 months—in both sighted and visually impaired children. However, blind infants can reach for objects they had previously felt tactually by 7 months. It is thus crucial for caregivers to modify the environment so that these children have early tactile access to objects (Lueck et al., 2008; Warren, 1984). Another contributing experience is infants' navigation of their environment through locomotion. By independently moving in space, infants experience how objects' existence is not tied to a specific location. They also notice how changes in an object's location modify how it is perceived, even though the object itself remains the same. Children with visual impairments are reported to achieve self-propelled gross motor abilities at a later age than sighted peers, for example walking at 18-24 months versus 12-15 (Adelson & Fraiberg, 1974; Brambring, 2006; Bueno & Toro, 1994). Particularly in the case of children who are blind or severally visually impaired, access to orientation and mobility strategies and technology—e.g., white cane—will mediate the amount of experience these children have navigating their environments and encountering and re-encountering objects in different locations.

Fourth, if children engage less with objects, there will be fewer opportunities for their caregivers to interpret the infants' behaviors as acts of communication regarding a focus external to the dyad. In development, infants' initial referential communication may or may not be intentional, but what is crucial is for caregivers to interpret the infants' actions as referring to an external focus that can be shared (Bigelow, 2003). Joint engagement and particularly coordinated joint engagement rely on each participant's ability to recognize when the other relates to a focus external to the dyad. This will be impaired if the social partners have difficulties identifying non-visual attentional cues and/or responding to them by actions that are within the perceptual capabilities of the other.

Preisler (1990) made a related observation when she noticed that between the ages of 10 and 12 months, the blind infants she observed did a great deal of vocalization when playing with objects, yet they were not sharing their experiences with objects with their mothers. The infants did show behaviors that evidenced they had noticed an object or event in the environment, for example by a slight movement of the head and/or body toward the source of sound and/or acquiring a stiff body posture. However, these behaviors were not immediately interpreted by their mothers as signaling infants' attention to an external focus.

If the caregiver cannot correctly identify the child's focus of attention, she won't be able to join in it and will have to rely more heavily on directing the child's behavior toward a focus determined by the caregiver. If children with visual impairments engage less or at a later age with objects and/or if caregivers fail to recognize the infants' interest on objects, the dyad will have fewer opportunities to engage in referential communication. There is evidence that social games between infants with visual impairments and their caregivers over-rely on repetitive vocal games, to the detriment of games involving objects (Dale & Salt, 2007; Preisler, 1990).

The idea that infants who are blind are likely to achieve joint attention at a later age than sighted peers was supported by Bigelow's (2003) longitudinal study of two congenitally blind children. The study defined joint attention as episodes in which the child was involved with object and social partner and aware of the partner's sharing in the attention to the object of shared interest. Bigelow developed her own coding protocol considering the existing literature on joint engagement and joint attention, and the behaviors she observed in the collected videos. The coding protocol identified infants' actions that incorporated non-visual abilities, which were suggestive of joint attention. These behaviors were classified into three categories, depending on how arguable it might be that—in the absence of infants' gaze switch—they did not involve joint attention.

The most ambiguous behaviors were labeled "preliminary." They included infants' use of adults as social tools; e.g., child tactually scans the adult's body to the hand that may hold an object. Also encompassed were acts by the infants that the social partner could interpret as communicative gestures about objects, which was evidenced by the mothers in the study often changing their scaffolding response to the child. For instance, the infant resists having a toy taken away and the caregiver responds by ceasing taking it away and verbally commenting on the child's desire to continue playing with it.

Less ambiguous than preliminary, "liberally construed joint attention behaviors" involved infants' comprehension or production of language, and could be interpreted as symbol-infused joint attention. For example, while mother and infant attend to the same object the child spontaneously labels it. In this case, the ambiguity arises since without the child looking back and forth between mother and object, it is unclear whether the child is communicating to the caregiver about the object or rather expressing only to himself. Included in this category are infants' imperative acts. For instance, when the child names an action that could be performed with the object of mutual interest, he could be intending to get the caregiver to perform the action and not to purely call her attention to it. Also included were times when the child used mothers' verbal directions to locate an object—e.g., when the child is searching for the ball, the mother says "The ball is by your foot," and the infant reaches in that direction. Lastly, liberally construed joint attention behavior encompassed instances when the child changed the way he is engaged with an object following the adult's request—e.g., the child is mouthing a toy, when the mother says to him "No, not in the mouth, bang it," and the child stops mouthing the toy and starts hitting the floor with it. The ambiguity in these behaviors is that they could be instances of supported joint engagement; children could be using the adults' behavior as a form of verbal scaffolding for their own actions on objects and not be attending to the adults when engaged with the objects.

The least ambiguous behaviors were labeled "conservatively construed joint attention behaviors." Here children engaged in social interaction with their social partner in a game-like context, and an object was an integral part of the interaction. They included games in which the child repeatedly gave an object to the adult and then took it again; repeatedly retrieved an object, each time after the adult had placed it in a new location; or labeled objects sequentially presented to him by the adult. They also included times when an object was incorporated into an established game with the adult, and the child demonstrated awareness of this addition. An example from Bigelow's sample consisted of a game in which the mother moved her hand repeatedly over the child's mouth while he produced vowel sounds. Then a bowl was added as the mother started moving a bowl back and forth over the child's mouth while he vocalized. The addition of the object changed the sounds produced by the game. The child then held onto the bowl while the mother moved it and began to giggle—evidence of the child's awareness of this addition. Lastly, conservatively construed joint attention included games in which the child cooperated with an adult in the manipulation of an object and there was evidence that the child was aware of the adult's actions on the object. An example from the study recounted an infant and mother playing with a toy that produced sound when a string was pulled; the child pulled the string while the mother pulled back on the toy. After some time, the mother stopped participating. In response, the child swung the toy at her several times and began to fuss until the mother went back to playing the game with the infant.

In Bigelow's study (2003), two infants were videotaped monthly for 30 minutes interacting with their caregivers. One child was observed between the ages of 13-21 months. This child demonstrated first preliminary behaviors (13 months), then liberally construed (16 months) and lastly conservatively construed (18 months) behaviors. The other child was observed from 17 to 30 months of age. This infant showed preliminary behaviors at study entrance; conservatively construed from age 23 months; and liberally construed starting at 25 months. Bigelow noticed that liberally construed and conservatively construed joint attention behaviors emerged in close parallel timing, which suggests the possibility that both categories indicate similar joint attention skills. She also pointed out that all conservatively construed joint attention behaviors were initiated by the mothers, after which the children were active in maintaining the interaction.

Other studies have included not only blind children but also those with various levels of residual vision. Their results shed light into the differences within the population of visually impaired infants. In a longitudinal study of 7 blind and 3 severely visually impaired infants Preisler (1990) video recorded their naturalistic interactions with caregivers from 3 to 12 months of age. She reported that blind infants had difficulties in sharing attention about objects and that even very low vision positively impacted this ability. By 7 to 9 months their caregivers interpreted infants' manual/vocal exploration of objects as a sign of attention and commented on their actions, thus attempting to initiate joint engagement, but their infants did not seem to follow in. By age 1 year, joint engagement was still difficult for blind infants and caregivers to establish. Preisler observed missed opportunities when infants evidenced their attention to external sounds by leaning their bodies toward them and freezing body positions and facial expressions, but such actions were not interpreted by the caregivers as attempts at sharing attention to the sounds.

The risk of mismatched exchanges between visually impaired infants and their caregivers has been supported by several studies. However, this is not an inevitable consequence and the literature also reports cases in which caregivers learned to interpret their infants' signals and adapted their communicational means in ways that made sense for their infants, particularly during their pre-verbal years (Als, Tronick, & Brazelton, 1980; Loots, Devisé, & Sermijn, 2003).

Tadić, Pring, and Sonksen (2009) compared sighted and visually impaired preschool children's ability to respond to adults' bids to establish shared attention, maintain it and shift between external foci, during the administration of a developmental assessment. Compared to sighted peers, children with all included levels of visual impairments scored significantly lower on establishing and maintaining shared attention. Those who had only light perception or worse showed a significantly lower ability to shift attention between foci, than both children who were less severely visually impaired and those who were sighted. In children with the most severe visual impairments, scores on exploration, manipulation, recognition, and meaningful use of objects had a significant positive correlation with their abilities to maintain and shift attention.

Dale, Tadić, and Sonksen (2013) concluded from parents' responses to a standard interview, that 1-3 year old children who had only light perception or worse obtained significantly lower social communication skills scores than sighted peers, with the greatest difference found for items related to joint attention. In contrast, children who were less visually impaired did not differ significantly from sighted peers. Two questions differentiated children depending on their visual impairment level. When asked if their infants "shared experience with toy" and "shared interest in event," parents of infants who had only light perception or worse were less likely to respond affirmatively, whereas most parents of infants who had form vision or better did so.

Several studies have posited that it is at ages when blind and severely visually impaired infants can use verbal communication that they can reliably participate in joint engagement with their caregivers (Bigelow, 2003; Loots et al., 2003; Preisler, 1990).

Atypicalities in visually impaired infants' joint engagement are reported among the characteristics of a phenomenon of developmental regression and stasis that has been reported in a subgroup of children who are blind or severely visually impaired. This developmental regression started roughly between 15 and 27 months—ranging from 11 to 22 percent of reported samples (Cass, Sonksen, & McConachie, 1994; Dale, 2005; Dale & Sonksen, 2002).

Atypicalities in visually impaired infants' joint engagement are also among behaviors some authors consider "autistic-like" behaviors observed in this population.

There is evidence that children on the autism spectrum either do not show joint attention or have difficulties participating in it (Mundy, Sigman, & Kasari, 1990; Colombi et al., 2009). Furthermore, they spend less time on coordinated joint engagement with their parents than typically developing peers and those who have Down Syndrome—whereas supported joint engagement seems relatively spared (Adamson, Bakeman, Deckner, & Romski, 2009; Adamson et al., 2012). Joint attention deficits are commonly used in the early detection of autism (Naber et al., 2007).

However, it is debated whether these behaviors should be considered as signs of autism. Hobson (2005) argues that in infants who congenitally have no vision or only light perception, there is no clear boundary between those diagnosed as having co-morbid autism and those who, despite showing autistic-like behaviors, do not meet the diagnostic criteria for autism. In his view, there is a likely kinship in the pathogenesis of autistic features and autism in blind and sighted children. In both populations, they originate from disturbances in early social experiences needed for the normal development of mind and personality. Blindness impairs infants' perception of people's emotional reactions and attitudes towards the external world. Autism impairs children's ability to establish empathy or identification with others' emotional reactions and attitudes towards the external world (Hobson, 1986, 1993; Sandler & Hobson, 2001).

In contrast, Pérez-Pereira and Conti-Ramsden (2005) argue that the autistic-like behaviors attributed to children with visual impairments are only superficially similar to those observed in children with autism. One reason for this is the behaviors' different origins in each population. Children with autism show a substantial deficit in their capacity for empathy, as they cannot identify with others' attitudes toward a shared world. In contrast, congenitally blind children are deprived of an essential socio-emotional experience for the development of a theory of mind, since they cannot see others' emotional attitudes directed to the shared world. It appears both contrasting opinions arise from similar observations on the origin of visually impaired infants' putative autistic behaviors, but whereas Hobson seems to base the diagnosis of autism on its behavioral symptoms, Pérez-Pereira and Conti-Ramsden apply the diagnoses only when the symptoms are due to a substantial empathy deficit despite visual access to others' referential emotional attitudes.

Study 1 aims

This study has two aims:

The *first aim* is to contribute to the understanding of the development of joint engagement in infants with visual impairments. Specifically, this study will report the percentage of time infants with visual impairments and their caregivers participate in joint engagement during a 30-minute free play interaction at the ages tested in this study. It will also report the average duration of joint attention episodes.

The limited research on joint engagement development in children with visual impairments brings into question our current ability to determine what is the normative in this population. This should be assessed with data from studies using samples from their population that are sensitive to the adaptive needs degraded or absent vision presents to the mother-infant dyad, and which can lead to indexes of joint engagement which may or may nor be shared by sighted peers.

By comparing visually impaired infants' joint engagement rates to that of sighted peers' normative data, we can only state differences between two populations but cannot evaluate the normalcy of one based on findings from the other. Rather, determining whether a child with visual impairments is delayed in joint engagement development should be done in comparison to normative times for their own population.

The present study will advance the knowledge required to determine when a visually impaired child's joint engagement skills should be considered as early indexes of autism, and thus reduce the chance of a misdiagnosis, which can increase the risk of disturbances in mother/visually impaired child bonding and mothers' misunderstanding of their infants' behaviors.

The *second aim* of this study is to investigate whether there is a relationship between visually impaired infants' percentage of time in joint engagement and their visual impairment levels expressed as reductions from age norms for visual acuity and contrast sensitivity. A relationship between these infants' visual levels and the average duration of their joint engagement episodes will also be explored.

The literature review shows that most if not all previous studies on joint engagement reported only infants' visual acuity levels (vision for detail) to determine the extent of the infants' visual impairment. However, contrast sensitivity, that is, the ability to detect differences in the brightness of or subtle shades of gray in large objects (Orel-Bixler, 2014) is also of interest when researching infants' ability to share attention with social partners. Whereas visual acuity refers to the smallest detail that a person can see, contrast sensitivity describes the smallest amount of contrast needed for someone to see large objects. Two infants with similar levels of visual acuity can behave differently in their ability to discriminate objects against their backgrounds. The child with the highest impairment in contrast sensitivity will have more difficulty seeing a large object that is against a low contrast background. Contrast sensitivity is also relevant for navigating the environment—e.g., detecting stairs and curbs, seeing a route in low contrasts situations such as fog—and face discrimination, i.e., detecting the faint shadows in faces that carry the visual information related to facial expressions ("Lea Contrast Sensitivity," n. d.). There is also evidence that contrast sensitivity is a better predictor of visual attention than visual acuity (Orel-Bixler, Haegerstrom-Portnoy, & Dornbush, 1983). Although typically there is a correlation between visual acuity and contrast sensitivity, when vision is abnormal this correlation is not as strong and thus contrast sensitivity cannot be predicted based on visual acuity (Haegerstrom-Portnoy, 2004).

1.2 Methods

Participants

The sample was comprised of 20 infants with visual impairments without additional disabilities. Of these, 10 were females and 10 were males. Due to the low incidence of this population of infants, they were recruited either as longitudinal (N=7) or cross-sectional subjects (N=13), per their caregiver's preference. The study's protocol was approved by University of California, Berkeley's Committee for Protection of Human Subjects. Prior to study procedures, informed consent and media release authorization was obtained from all infants' caregivers.

Infants were recruited through the collaboration of the Blind Babies Foundation, a non-profit that provides developmental services for infants with visual impairments, and the patient population in the Infant/Toddler Clinic and the Special Visual Assessment Clinic at the UC Berkeley School of Optometry. Before agreeing to enter the study, caregivers were provided with information about its aims and procedures and had an informational meeting with the lead investigator, either over the phone or in person. At that time, the lead investigator answered any questions caregivers had about the study. Afterwards, they decided whether or not they wanted to participate in the study.

Sixteen infants were born full term and 4 were born prematurely. The gestational age of the premature babies ranged from 24 to 34 weeks, with a mean of 30.75 weeks (SD = 4.57 weeks). Ages reported in this study were corrected for prematurity. At study entrance, all but two infants were receiving in-home intervention, ranging from one to two 90-minute monthly visits by specialists in the development of visually impaired infants. The other two infants were being counseled on a less regular basis by medical and school professionals.

Infants were videotaped at home interacting with their caregivers. Home video recordings were scheduled as closely as possible to infants' ages of 12 and 18 months. These ages were chosen since previous research had shown that coordinated joint engagement emerges toward the end of the first year of life and it becomes more prevalent at around 18 months (Adamson et al., 2014; 2015). The collected videos were divided into two age groups: a. Age 1—infant's age is at or below 1 year, 2 months, 28 days; b. Age 2—infant's age is at or above 1 year, 2 months, 29 days.

Nine infants (6 females, 3 males) were observed at age 1, mean fractional age of 1.08 or 1 year, 28 days (SD = 0.12). Eighteen infants (10 females, 8 males) were observed at age 2, mean fractional age of 1.62 or 1 year, 7 months, 15 days (SD = 0.23). Seven (6 females, 1 male) infants were observed at both ages. Table 1.1 lists the infants and the ages at which each one was observed. Figure 1.1 shows the age distribution.

Table 1.1: Study 1 subjects' ages.

Subject Number	Age 1 N = 9 M = 1.08 SD = 0.12 Minimum Age = 0.91 Maximum Age = 1.24			Age 2 N = 18 M = 1.62 SD = 0.23 Minimum Age = 1.36 Maximum Age = 2.3		
	Years	Months	Days	Years	Months	Days
1	1	1	25	1	6	25
2	0	10	29	1	5	1
3	---	---	---	2	3	8
4	1	0	12	1	5	26
5	1	2	28	1	6	9
6	1	1	4	1	6	4
7	---	---	---	1	6	7
8	1	0	1	1	6	0
9	---	---	---	1	5	9
10	1	2	26	---	---	---
11	0	11	23	1	6	3
12	---	---	---	1	9	18
13	---	---	---	2	0	5
14	---	---	---	1	7	26
15	---	---	---	1	9	28
16	---	---	---	1	6	17
17	1	0	10	---	---	---
18	---	---	---	1	6	22
19	---	---	---	1	8	16
20	---	---	---	1	4	11

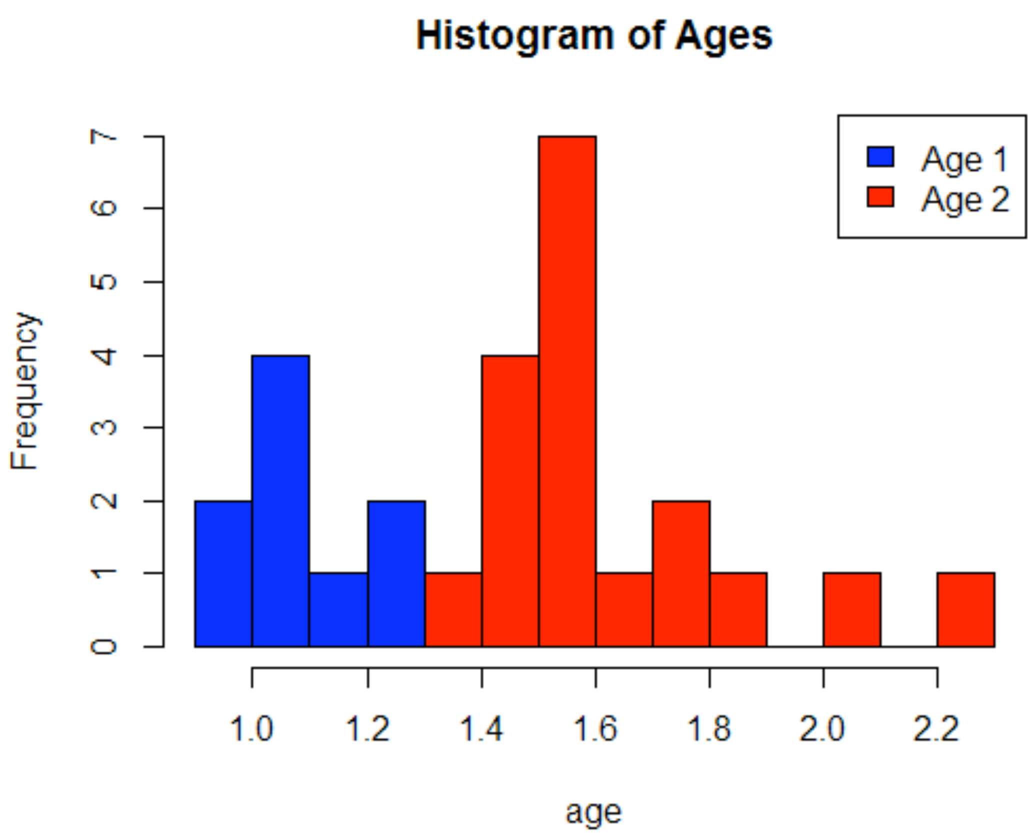

Figure 1.1: Study 1 subjects' age distribution.

Infants' race/ethnicity were as follows: White = 6, Hispanic = 5, Asian = 2, African American = 1, and 6 had more than one race: White and Asian = 2, White and Hispanic = 2, White and African American = 1, White, Asian, Hispanic and Native American = 1.

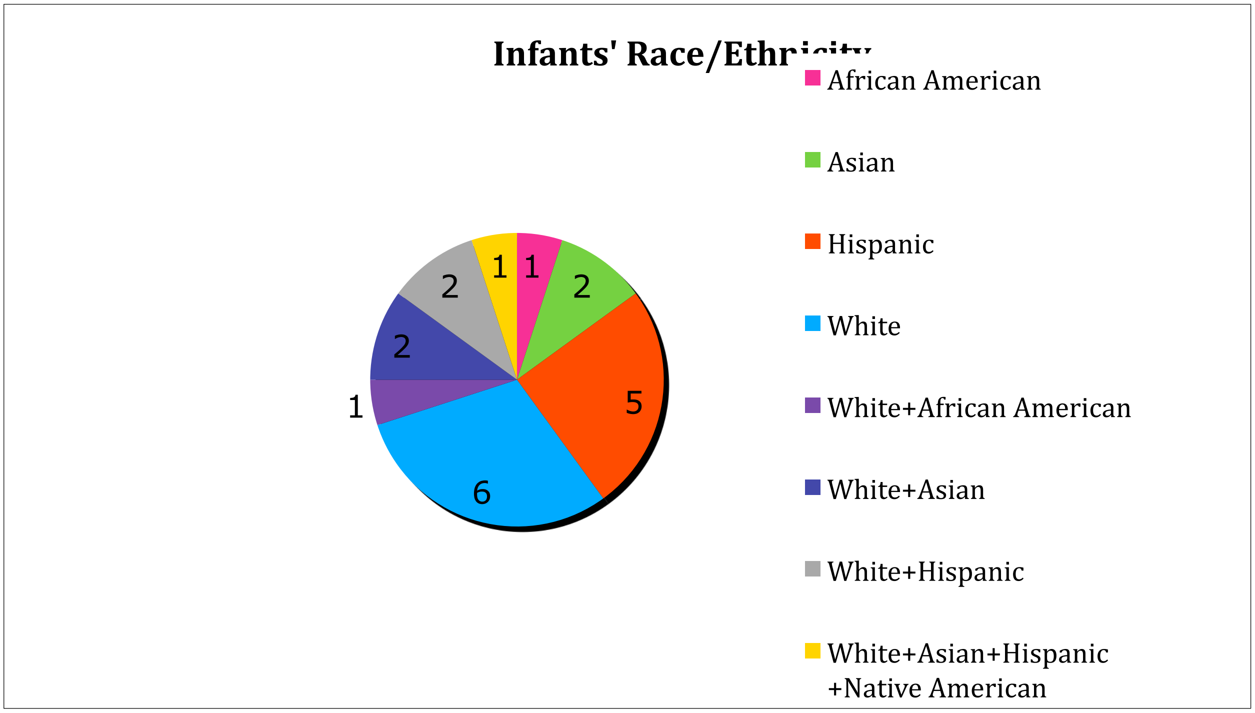

Figure 1.2: Infants' race/ethnicity.
Color areas represent percentage.
Values represent number of subjects.

Of the caregivers, one was the infant's biological father, one was the adoptive mother, and the remaining 18 were the biological mothers. Caregivers' average age ranged from 19 to 44 years, with a mean of 31 (SD = 7). Caregivers' race/ethnicity were as follows: White = 11, Hispanic = 5, Asian = 2, African American = 1, and 1 reported more than one race: White, Asian, Hispanic, Native American. In terms of their educational level, 3 reported having a master's degree, 5 a bachelor's degree, 8 more of a high school diploma (e.g., technical school, associate degree), 2 a high school diploma, and 2 completed middle school.

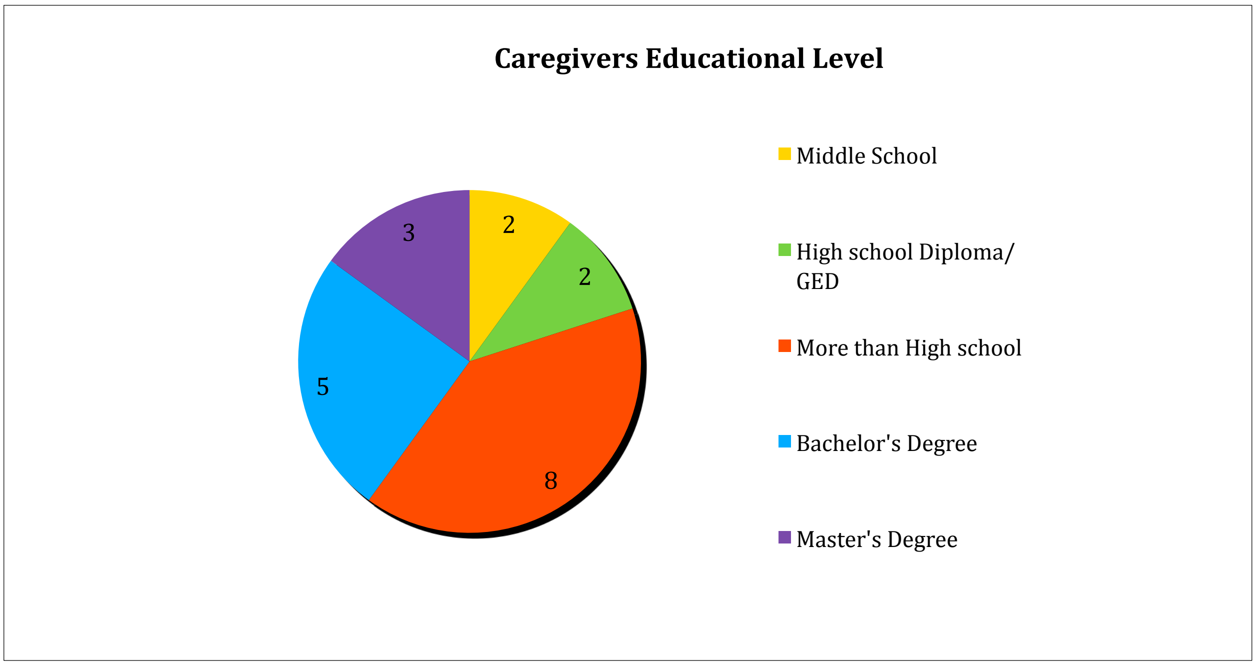

Figure 1.3: Caregivers' educational level.
Color areas represent percentage.
Values represent number of subjects.

Seventeen of the 20 caregivers reported their families' annual income. The annual income distribution was heavier in the highest bin, more than $95,001 (N=5); followed by the lower bin, $5,000-$10,000, (N=3).

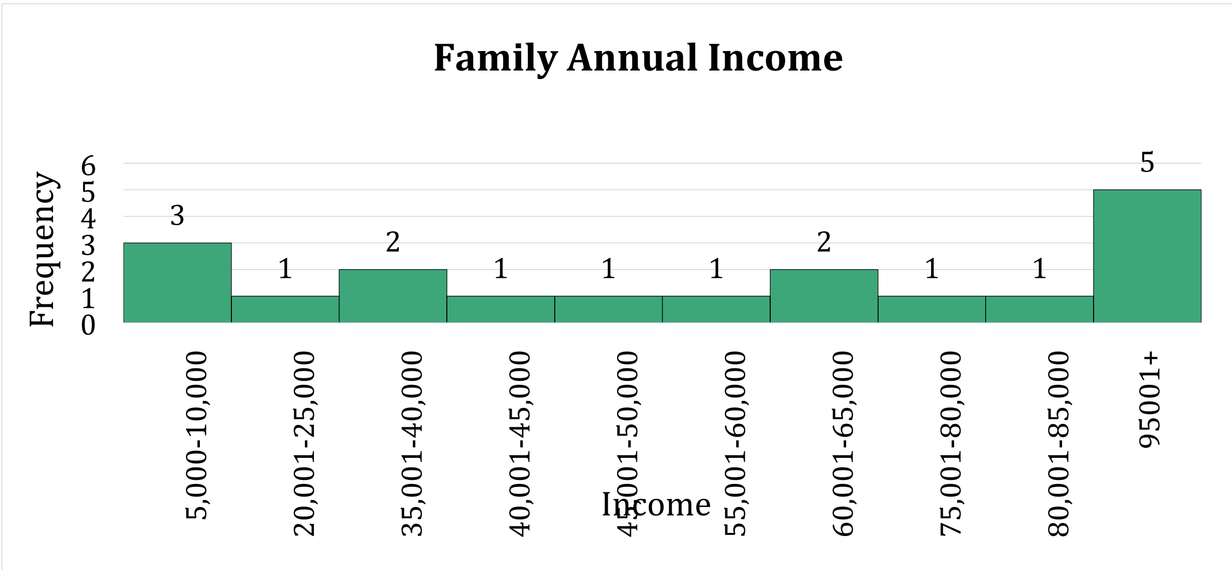

Figure 1.4: Families' annual income.

Per capita income was calculated by dividing the mid value of the income range reported by caregivers—e.g., 37,500.5 in the case of $35,001-40,000—by the number of people living at the family's home. A value of 95,001 was used when caregivers reported an income of more than $95,001. Four families had a per capita income below $5,000; 4 between $8,750 and $15,833; 5 between $18,750 and $20,833; 2 had $23,750; and 2 had $31,667.

The per capita income values were standardized. The distribution of standardized per capita income shows that 10 families were above the sample's mean; 8 within 1 standard deviation, and 2 between 1 and 2 standard deviations above the mean. The remaining 8 families were below the mean, 4 within 1 standard deviation and 4 between 1 and 2 standard deviations below the mean.

A composite measurement of SES was computed adding the standardized income per capita and standardized caregiver's educational level. The distribution of the composite SES shows that 8 families were below the mean; 5 within 1 standard deviation, 2 within 1.5 standard deviations, and 1 was 2 standard deviations below the mean. The remaining 10 families were above the mean; 7 within 1 standard deviation, and 3 between 1 and 2 standard deviations above the mean. Eleven caregivers reported receiving some type of government financial aid.

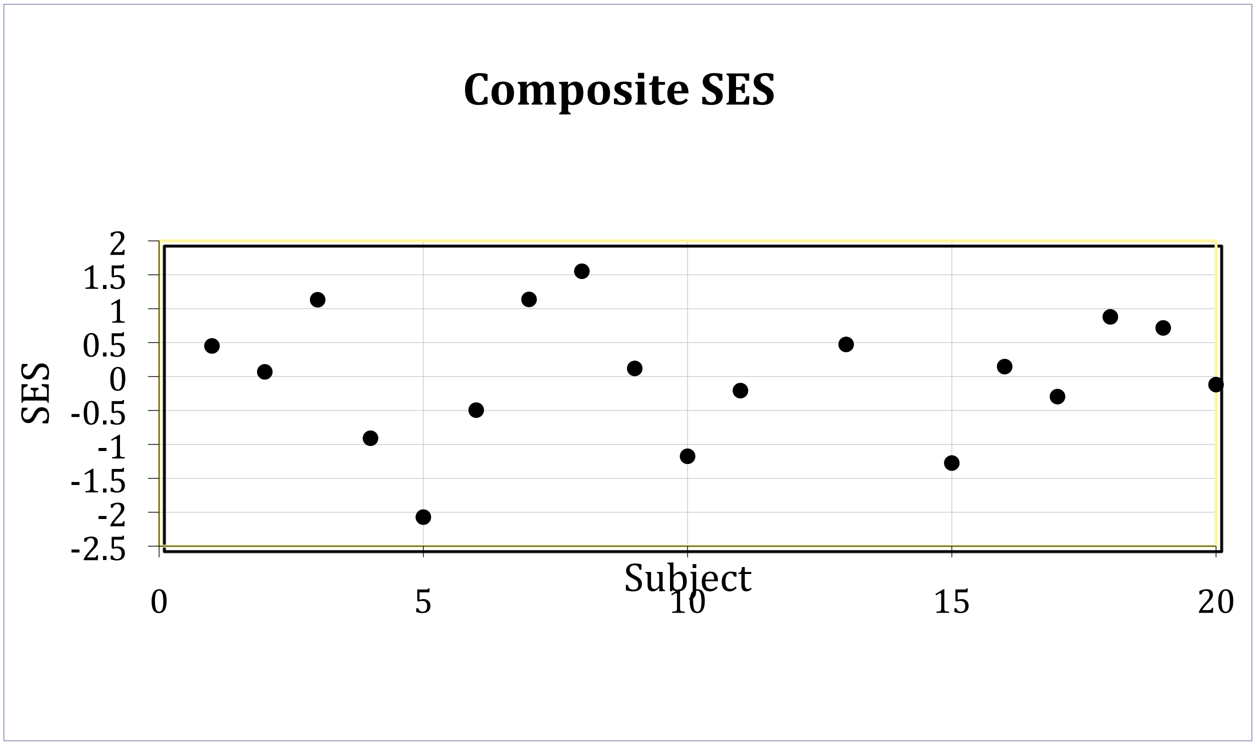

Figure 1.5: Families' composite SES.

Procedures

Observational procedure

Thirty-minute video recordings were performed at each infant's home. A total of 27 videos are reported in this study. Their mean duration is 29.9 minutes, standard deviation of 0.1 (6.03 seconds).

Caregivers were asked to choose a room within their home where they would feel comfortable playing with their infants. In order to obtain a video recording as close to a 360-degree view of caregiver and infant as possible, 2 cameras with wide-angle lenses were placed directly in front of and behind the caregiver and child. This arrangement maximized the capture of the study participants' activity even if they moved in space.

Observational conditions

In order to allow for the most naturalistic observation, caregivers were instructed to play with their infants as they would normally do. Given that children with visual impairments benefit from repeated exploration of toys and perform at their best in familiar environments and with familiar objects (Lueck et al., 2008), during the first 15 minutes of the video recording caregivers were asked to use their infant's toys. During the video recording of the first 15 minutes the lead investigator waited in a different room.

To address infant's expected differences in socioeconomic status, for the next 15 minutes caregivers were provided with a standard set of toys brought by the lead investigator. This standard set of toys was compiled taking into consideration infants' absent or degraded visual abilities, and thus it included toys that afforded a diversity of sensory experiences. Specifically: a toy with 5 fine-motor operated pop-up figures; 3 mittens with a different texture on each side; a red mylar pom pom; 4 different rattles; 2 books with simple drawings/pictures and several textures; 3 bells of different color and sound; a radio toy; a metallic container; a puffy ball made of elastic; a rolling red car; 6 single colored wooden cubes (3 yellow, 1 red, 1 green, 1 blue); 2 rectangles each with single color; 4 cylinders each with single color; a cube with different texture on each side; 8 big Lego pieces; a shaker; and a light-up toy (Figure 1.6).

Figure 1.6: Standard set of toys used in the joint engagement sessions.

When the first 15 minutes of recording were completed, the lead investigator came into the room, gave the caregiver a bag with the standard set of toys, and helped her put away the infant's toys. The lead investigator left the room until the second 15 minutes of recording were completed.

Codes: Joint engagement and non-joint-engagement

This study focused on two behavioral codes: joint engagement and non-joint engagement. These codes' definitions are based on the coding protocol developed by Bakeman and Adamson (1984; Adamson & Bakeman, 1985; Adamson, Bakeman & Deckner, 2004; Adamson et al., 2012; Adamson et al., 2014; Nelson, Adamson & Bakeman, 2008). Some modifications were done to their coding protocol based on preliminary observations of this study's video recordings. In what follows and whenever appropriate such modifications will be explained.

The coding protocol aims to segment the infant's activities into two mutually exclusive behavioral states:

- Joint engagement: when the child is concurrently engaged with both an object and a person.
- Non-joint engagement: when the child is engaged solely with an object or solely with a person.

In this study an infant was considered to be in state of engagement given either of two indicators:

- He was attending to the object and/or person using any one or combination of sensory channels. For example: the infant listened to the mother's speech or to the music emanating from a toy.
- He was performing an action that involved the object and/or person. For example: the infant grabbed and moved the caregiver's hand or a toy. By definition, in this type of situation the infant was also attending to the object.

Joint engagement

The infant was considered to be in a state of joint engagement if he was engaged with the same object or event that the caregiver was engaged with, and if the caregiver was involved in the activity. For example, the child rolled a ball toward the caregiver, the caregiver rolled it back to the infant, and so on. Unlike in Adamson and Bakeman's protocol (Adamson & Bakeman, 1984; Adamson et al., 2014), in this study if the caregiver called the child's attention to an object and as a consequence the child attended to it, the child was considered to be in joint engagement, even if he did not eventually act on the object. In the original coding protocol this situation would be coded instead as non-joint engagement since it would consider that the child was not "actively" engaged with the object. In this study's protocol, such qualification of the child's engagement was not required. As long as the caregiver intentionally called the child's attention and as a consequence the infant switched his attention from a previous focus to such object, the child was considered to be in joint engagement. But if the child on his own switched his attention to the caregiver's engagement with the object, without the caregiver having called the child's attention to it, this was coded as non-joint engagement.

The joint engagement code does not require the child to actively acknowledge the caregiver's participation in the joint engagement with the same object. Continuing with the example above, if the child felt the vibrations produced by his mother's tapping on the ball without showing any overt signs of noticing the mother's role in this experience, the child would be coded as being in joint engagement. The child would also be coded as being in joint engagement if besides feeling the vibration, he also turned his face and upper body toward mom and vocalized toward her.

However, if the child rolled the ball toward the caregiver, the ball touched the caregiver and as a result bounced back to the child while the caregiver was searching for something else and thus not attending to the child's action, the child was not coded as being in joint engagement. Likewise, the child was not coded as being in joint engagement if the child was attending to the caregiver acting on an object and the caregiver's attention was only on the object. For instance, the father started to shake a pom pom, the infant turned to the caregiver and listened to the pom pom's sound, and the father continued solely focused on shaking the pom pom.

A child was also not coded as being in joint engagement if the child was engaged with an object while the caregiver was merely narrating the infant's action without participating in it. For example, the child was bouncing a ball while the mother said, "You want to play with the ball now." However, if after the mother's speech, the child turned toward her and laughed while continuing to bounce the ball, and the mother laughed in response, this would be coded as joint engagement. Similarly, if the mother then started tapping with her hands on the ball and as a result the child stopped bouncing it and felt with her hands the vibrations arising from the mom's tapping, the child would be considered as being in joint engagement. In these last two cases, the mother's engagement with the object influenced the child's engagement with it. In the former, the child went from focusing solely on the object to coordinating his attention to both object and mother; in the latter, the child modified his action on the object as a consequence of the mother's action on it.

Non-joint engagement

The infant was considered to be in a state of non-joint engagement if he:

a. Engaged only with a person—e.g., the child listens to the caregiver's speech.
b. Engaged only with an object—e.g., the child mouths a toy.
c. Searched for something to engage with without engaging with any object and/or person for 3 or more seconds. E.g., the child fleetingly touches several toys.
d. Cried without this being part of an interaction with a person. E.g., the child cries without attending to any external focus whether object or person.
e. Observed the caregiver's acting on an object, if the caregiver had not caused the child to begin attending to her action on the object. E.g., the mother starts turning pages of a book, and then the child stops his previous action and listens to the sound of the pages being turned. (But unlike in Adamson and Bakeman's protocol, if the caregiver intentionally called the infant's attention to her action on the book, and consequently the child switched her attention from its previous focus to the caregiver's action on it, this was coded as joint engagement even if the child did not eventually manipulate the book.)
f. Was engaged with his own body movement, whether her whole body or only part of it. E.g., the child shakes her head side to side. This is an additional type of situation from Bakeman and Adamson's protocol (Bakeman & Adamson, 1984; Adamson et al., 2014).

As defined above, this study's behavioral code definitions are socially based. They require the coder to decide whether the observed behavior fulfills the codes' conceptual criteria. The examples listed under each code are exemplars and not exhaustive—that is, the coder can classify an observed behavior under a particular code even if it does not match any particular example in the coding protocol (Yoder & Symons, 2010). This characteristic of socially based code definitions is particularly useful since this study applies a coding protocol to a population different than the one it was originally designed for. Specifically, Bakeman and Adamson's (1984) protocol was originally designed for the study of fully sighted children. However, researchers have applied the protocol to children with autism spectrum disorder (Adamson et al., 2012; Bottema-Beutel, Yoder, Hochman & Watson, 2014).

This study's codes are mutually exclusive; a particular behavior cannot be coded as both joint engagement and non-joint engagement. They are also exhaustive meaning that they ought to account for all of the observed behaviors (Bakeman & Quera, 2011).

In Bakeman and Adamson's protocol (Bakeman & Adamson, 1984; Adamson et al., 2014) an engagement state, whether joint engagement or non-joint engagement, must last at least 3 seconds. Variations in the infant's engagement that last less than 3 seconds are not coded as a separate state. However, in this study this rule was only applied for non-joint engagement episodes. Preliminary review of video recordings showed that some of the infants in the sample did not engage with their caregivers in episodes of joint engagement that lasted at least 3 seconds. However, they did engage in episodes of joint engagement that lasted less than 3 seconds. It was decided that a more accurate portrait of the joint engagement in this study's sample would be obtained if such episodes were accounted for. Thus, in this study the code joint engagement did not have to last at least 3 seconds. It should be noted that the videos that were preliminarily reviewed, and which lead to this modification, are not part of the data presented here; instead they were videos of the infants recorded at ages not reported in this study. To see the full coding protocol, please refer to appendix 1. In order to aid coders, a decision flow chart was developed (Figure 1.7).

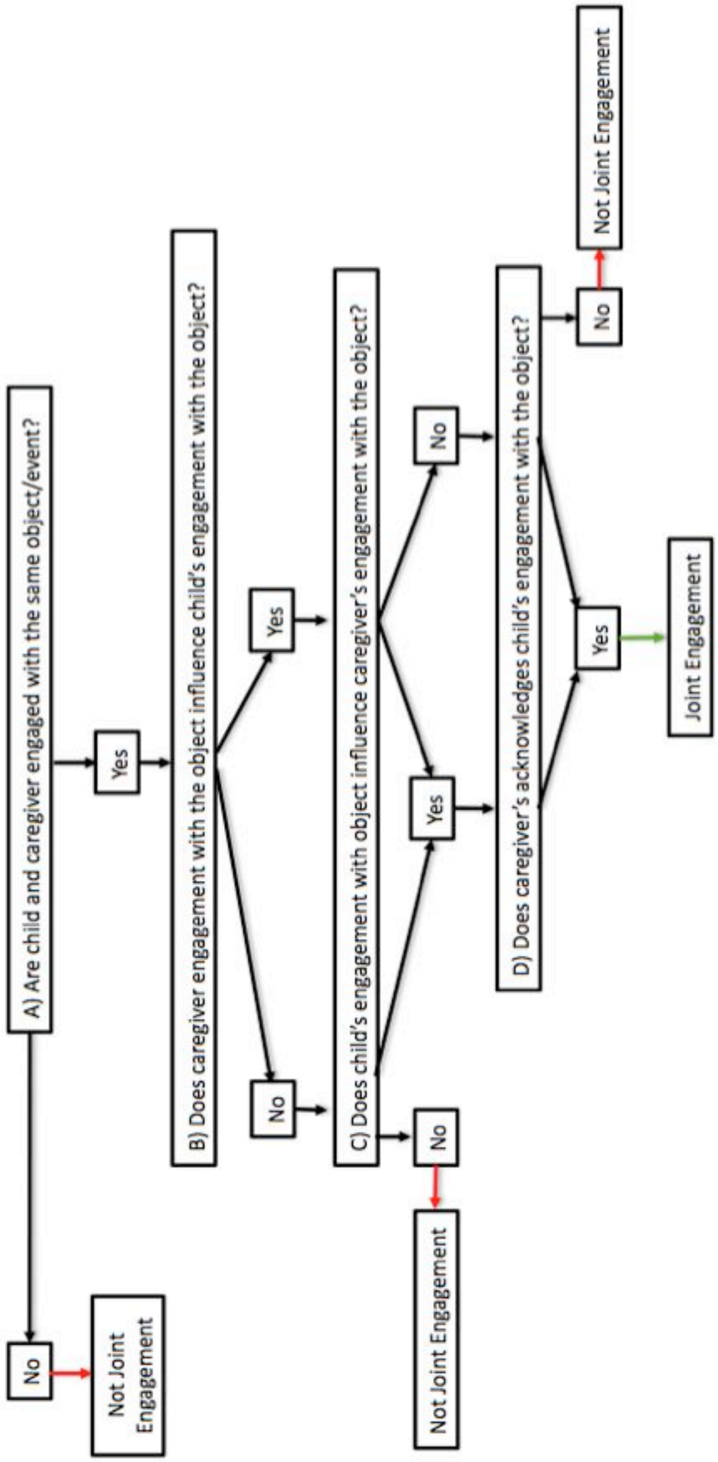

Figure 1.7**:** Coding decision flow chart

Coding procedures

This study used a continuous behavior sampling; the 30-minute videos were coded in their entirety. Although this method is the most time demanding, it was chosen because it provides the most complete coding. Behaviors were coded as timed events—that is, the beginning and ending times of their corresponding codes were registered. Timed events were chosen since states of engagement extend over time and thus their extension was deemed more relevant than their counts (Yoder & Symons, 2010).

Videos were coded in an exhaustive and exclusive manner; each second of the 30-minute videos were coded as only one of the two study's codes. The resulting data files consisted of a sequence of behavioral codes with their beginning and ending times, without time gaps or overlapping codes. This type of systematic observational measurement allows for the calculation of metrics such as the percentage of time a given code was observed in a session.

Coders viewed a video until they considered that a change in the child's engagement state had occurred. Then coders reviewed the relevant portion of the video as many times as needed in order to determine the seam between engagement states. Codes and their durations were entered automatically into computer files using Mangold International's INTERACT (http://www.mangold-international.com). A 30-minute video took on average 12 to 16 hours to code.

A first coder—the lead investigator—coded all 30-minute video recordings (N = 27). For reliability purposes, a second coder—a research assistant—coded 48.15% of the total sample (N = 13). Of the 13 videos included in the reliability sample and to approximate the study's full sample distribution in terms of ages, more videos corresponded to infants observed at age 2 (N = 9), and fewer videos at age 1 (N= 4).

The first coder trained the second in the use of the coding protocol. The training included: readings and discussions regarding the concept of joint engagement; review of the coding protocol; and review of written and videotaped examples of behavioral codes. Both coders were masked to the infants' visual status.

Agreement

Prior to coding for reliability, coders worked on achieving an agreement criterion. The videos used for this process were not included in the data reported in this study.

Each coder independently coded the same video. For each video, coders conducted exact point-by-point agreement checks, that is, they compared both the codes assigned and their onset and offset times. Coding disagreements were identified and discussed until coders reached a consensus. When necessary, the coding protocol was updated to better formulate its behavioral codes. These updates included: identification of new examples, non-examples and near non-examples of codes; written clarifications of the codes' criteria; and the creation of additional coding rules to disambiguate areas of disagreement.

To assess the changes in coders' agreement level two reliability statistics, Cohen's kappa and percentage agreement, were calculated for each video. There is no agreement among researchers regarding gold standards for kappa values although some have been proposed, e.g., < .40 = poor; .40 - .75 = fair to good; >.75 = excellent. However, kappa values are influenced by several factors such as the prevalence of codes in the study's sample.

According to this perspective no gold standard is valid but rather a kappa value ought to be interpreted considering the factors that influence it. Given that factors such as behavior prevalence are not available until the whole study sample is coded, and following the literature in the social sciences, the agreement criterion for this study was defined as a percentage agreement of 80-85% (Bruckner & Yoder, 2006; Bakeman & Quera, 2011; Sim & Wright, 2005; Viera & Garrett, 2005; Yoder and Symons, 2010).

Reliability

Once the agreement goal was obtained, coders started the process of establishing reliability using videos from the sample reported in this study. After both coders independently coded a video, Cohen's kappa and percentage agreements were calculated. If the percentage agreement decreased noticeably between two coded videos, coders reviewed their disagreements before coding the next case. No videos included in the reliability sample were "recycled." That is, none were re-coded after the coders' first attempt did not reach the reliability criterion.

Comprehensive vision examination

Infants underwent a comprehensive vision examination in the Clinical Research Center at the UC Berkeley School of Optometry. The comprehensive eye examination included a standard battery of assessments. Prior to examination, a complete history was taken including a review of any drug sensitivities and previous medical records. The vision examination included measurements of ocular alignment, fixation and motility (an assessment of the posture of the eyes, which eye is preferred for fixation, and the ability to move the eyes), refractive error (focusing error of the eyes to determine the need for glasses) and the health of the eyes (integrity of the anterior and posterior structures of the eyes). The following measures of visual abilities or vision function were obtained: visual acuity (ability to see fine details), contrast sensitivity (ability to see brightness differences), color vision, and confrontation visual fields (ability to find objects in the periphery).

During the vision examination every infant received eye drops; a topical anesthetic (0.5% Ophthaine) followed by a cycloplegic agent (1% Cyclopentolate). These eye drops were necessary to relax accommodation for accurate assessment of refractive error, and to dilate the pupil to facilitate the ocular health evaluation. The infants received sunglasses to wear home after the examination since dilated pupils may increase sensitivity to sunlight.

Measures of vision function were obtained with tests used routinely during infant and toddler eye examinations. Preferential looking (PL) testing procedures were applied to measure visual acuity, contrast sensitivity, and color vision based on the behavioral "looking" responses of the infant (Teller, 1997). Behavioral based measures of vision function may be affected both by the child's visual impairment and their performance ability. For this reason, an objective measure of acuity, such as visual evoked potential (VEP) testing, may be a more accurate method of assessing visual acuity of infants and young children. The VEP provides general information about geniculo-calcarine function and occipital responses to visual stimuli. Because the VEP represents a neural response, neither a verbal or motor response is required. To objectively measure visual acuity and contrast sensitivity, the sweep Visual Evoked Potential (VEP) test was performed. This procedure has well-established norms for infants (Norcia, 1994).

The VEP measurement involves recording the small electrical signals that are generated within the occipital lobe of the brain while the infant views pattern-reversing stripes on a video monitor located at 50 cm. To record the signals, 5 sensors were placed on the infant's scalp over the occipital lobe of the brain. Conductive paste was applied between the sensors and the scalp, which were rinsed away with water after the measurements were taken. The sensors and paste caused no discomfort. The infants merely needed to attend to the video monitor for each ten-second trial during which nineteen different black and white stripe widths were presented. The amplitude of the VEP response decreases proportionately as the width of the stripes decreases across the trial. A computer analyzed the VEP response and scored the trial to indicate the finest stripe width that elicited a VEP response and this stripe width was reported as the visual acuity of the infant. Similarly, contrast sensitivity was measured by altering the contrast (subtle brightness differences or shades of grey) of the stripes. The VEP procedures used in this protocol are standard, not experimental, clinical procedures. Each complete eye examination took up to 60 minutes, including time waiting for dilation of the pupils, and the PL and VEP measurements.

Demographic survey

At study's exit, caregivers were asked to complete a demographic survey. The survey consisted of 9 questions regarding demographic information of the infant, caregiver and their families—e.g., household annual income, infant race/ethnicity (appendix 2). Caregivers were informed that the purpose of this data collection was to better characterize the study's sample. They were also assured that their answers were private and confidential. The survey was provided via regular mail and/or e-mail per parents' preference, and they chose either of these two mailing systems to return the answered surveys. Spanish monolingual caregivers were provided the survey in Spanish.

Data analysis

Reliability of coders

Two coders are said to be reliable when they both assign the same code to the same observed behavior. In order to measure reliability, Cohen's kappa was calculated using the GSEQ program (Bakeman & Quera, 2011). Unlike other statistics such as percentage agreement, kappa takes into consideration the agreement that could be a result of chance—i.e., as if coders were to assign codes randomly (Bruckner & Yoder, 2006; Bakeman & Quera, 2011; Sim & Wright, 2005; Viera & Garrett, 2005; Yoder & Symons, 2010).

Cohen's kappa was originally formulated for situations in which the number of coding decisions was pre-determined, and thus equal for both observers, e.g., the number of questions in a survey. Unlike that situation, this study did not present the coders with a pre-determined and equal number of behaviors to code. Instead, part of the coding process for each observer consisted in determining the seams between events. An event refers to an observed behavior that ought to be assigned to a particular code. In a situation like this, the number of events will most likely be different for each coder. Therefore, the classical kappa formula was not appropriate and a modified version was used (Bakeman & Quera, 2011; Bakeman, Quera & Gnisci, 2009; Sim & Wright, 2005).

Given a different number of events per observer, before kappa calculation the two sequences of events—one from each coder—need to be aligned. This was achieved using a time-based alignment in which events were aligned in terms of a time window composed of the same number of seconds for each coder. In previous research on joint engagement, a tolerance of 2 seconds was allowed, which lead to 5-second windows being compared—the current second plus 2 before and after it (Adamson et al., 2014). The comparison considered each second for coder 1 and looked for a match in any time unit of the 5-second window from coder 2. If coder 2 assigned the same code as coder 1 in any of those 5 seconds this was counted as an agreement (Bakeman & Quera, 2011; Bakeman et al., 2009).

Since there is no universally accepted gold standard to evaluate kappa values, bias and prevalence indexes and maximum kappa were calculated to aid the interpretation of the obtained kappa. The bias index expresses the extent to which coders disagree on the proportion they determine a code as present or absent. If there is a large bias, the value of kappa is higher than when bias is low or absent. The prevalence index measures the existence of an effect due to the prevalence of the code. A high prevalence index indicates that the prevalence of the code's presence is either very high or very low. In such case, chance agreement is high and the kappa value is thus reduced. Maximum kappa reports the value when coders agree to the maximum extent possible given observer bias. When there are fewer than five codes, especially two as in this study, lower values of kappa are acceptable. Finally, coders' accuracy was calculated based on the obtained kappa value and codes' base rates. (Bruckner & Yoder, 2006; Bakeman & Quera, 2011; Sim & Wright, 2005; Yoder & Symons, 2010).

Age changes in the amount of time infants were in joint engagement

Studies with sighted infants show that the amount of time they spend in joint engagement increases with age (Adamson et al., 2014; Adamson et al., 2004; Adamson & Bakeman, 2006). To determine how the amount of time infants in this study were in joint engagement changed with age, the percentage of time joint engagement was coded was calculated for each video using Interact (http://www.mangold-international.com).

Percentages were calculated separately for:

a. Toys 1: the first 15 minutes of video recording, when infants used their own toys

b. Toys 2: the second 15 minutes, when infants used the standard set of toys provided by the investigator.

To differentiate results depending on the length of the joint engagement episodes, percentages were calculated separately for:

a. Joint engagement episodes of any duration.

b. Joint engagement episodes that lasted at least 3 seconds.

Then, the average and standard deviation of the percentage of time in joint engagement were calculated separately for infants in age 1 and infants age 2. All calculations were done using R (The R Foundation for Statistical Computing, Vienna, Austria).

To determine if the difference in the mean percentages at age 1 versus age 2 were significant, two-tailed t-tests with Welch's correction to degrees of freedom were calculated. The Welch's correction to allow for unequal variance was used given the unequal number of infants in each age group.

To determine if there was a significant difference in the average length of joint engagement events between ages 1 and 2, two-tailed t-tests with Welch's correction to degrees of freedom were calculated.

All t-test statistics were done using R (The R Foundation for Statistical Computing, Vienna, Austria).

Relationship between infants' time in joint engagement and visual levels

To determine if there was a significant relationship between infants' visual function and the amount of time they participated in joint engagement, regression analysis was calculated with infants' age, visual acuity and contrast sensitivity as independent variables, and percentage of time in joint engagement as the dependent variable.

Visual acuity improves during the first few years of life. Adult levels of acuity are reached by the end of the first year when measured with the VEP but not until 3 years of age when measured with preferential looking techniques. Visual acuity is expressed in terms of the log of the minimum angle of resolution or logMAR. Each 0.1 in logMAR corresponds to one line on an eye chart. For example, normal visual acuity of 20/20 corresponds to logMAR = 0; an acuity of 20/200 acuity corresponds to logMAR = 1, that is, a difference of 10 lines on the eye chart between the person's acuity and the norm. Since visual acuity norms vary depending on infants' ages, each infants' reduction in visual acuity from the age norm was calculated (in logMAR) for each of the two procedures used, VEP and PL.

Contrast sensitivity has a more rapid rate of development than visual acuity, reaching near adult levels by one year of age with both VEP and PL techniques. Contrast sensitivity values for both the VEP and PL— were expressed as the lowest detectable contrast in percentages. The contrast levels available on the Mr. Happy test targets ranged from a maximum of 80% (nearly black and white) to the lower available contrast of 1.6%. The contrast levels on the VEP test targets ranged from 80% to 0.1% Michelson contrast.

To determine if there was a significant difference in the visual impairment levels represented at age 1 and age 2, two-tailed t-tests with Welch's correction to degrees of freedom were calculated for each of the four visual measurements —visual acuity and contrast sensitivity results based on both visual evoked potential and preferential looking.

To determine if the results from the visual evoked potential and preferential looking were correlated, correlations within contrast and acuity measures were computed using Spearman's rho, as these measures did not appear Normal based on QQ-plots (except the preferential looking measure of acuity, which appeared approximately Normal).

1.3 Results

Reliability statistics

The kappa value was .85 regardless of which of the two coders was considered as the first in the kappa calculation (Table 1.2). The maximum kappa was .99-1. The values of kappa range from -1 to 1. A value of 0 signifies that coders agreed at no more or less than chance would allow for. Values below zero indicate agreement below chance—i.e., potential systematic disagreements between observers; positive values represent agreement above chance with a value of 1 being perfect agreement.

The bias index was 0.001 and the prevalence index was 0.35. The base rate of the code joint engagement was .32, and that of non-joint engagement was .68. Considering the base rates and the obtained kappa of .85 it was estimated that observers' accuracy ranged between 0.95 and 0.99 (Bruckner & Yoder, 2006; Sim & Wright, 2005).

Table 1.2: Kappa result, joint engagement.

.85 Time-unit kappa, window = 2 seconds.
93% Percentage agreement.
1.00-.99 Maximum value of kappa.
Numbers in cells represent seconds.

		Coder 2		
		Joint Engagement	Non-Joint Engagement	Totals
Coder 1	Joint Engagement	6,762	798	7,560
	Non-Joint Engagement	753	15,043	15,796
	Totals	7,515	15,841	23,356

Age changes in the amount of time infants were in joint engagement

Toys 1

When joint engagement events of any duration were considered, the average percentage of time in joint engagement at age 1 (M = 27.67, SD = 15.87, N = 9) was significantly different than the average at age 2 (M = 43.85, SD = 22.90, N = 18), two-tailed t-test with Welch's correction to degrees of freedom t(22.07) = -2.14, p = 0.436 (Table 1.3, Figure 1.8).

When only joint engagement events that lasted 3 seconds or more were considered, a significant difference was also found between age 1 (M = 26.93, SD= 15.77, N = 9) and age 2 (M = 43.04, SD = 23.32, N = 18), two-tailed t-test with Welch's correction to degrees of freedom t(22.44) = -2.12, p = 0.045 (Table 1.3, Figure 1.8).

Two out of the seven longitudinal subjects showed a decrease in percentage in joint engagement between ages 1 and 2. In one case the percentage decreased by 20.26 points; in the other, by 15.18 points.

Toys 2

When joint engagement events of any duration were considered, no significant difference was found between age 1 (M = 27.09, SD = 16.78, N = 9) and age 2 (M = 37.11, SD = 22.49, N = 18), two-tailed t-test with Welch's correction to degrees of freedom t(20.89) = -1.30 p = .208 (Table 1.3).

Likewise, when only joint engagement events that lasted 3 or more seconds were considered, no significant difference was found between age 1 (M = 26.41, SD = 16.48, N = 9) and age 2 (M = 35.95, SD= 22.70, N = 18), two-tailed t-test with Welch's correction to degrees of freedom result t(21.34) = -1.24, p = 0.227 (Table 1.3).

Table 1.3: Two-tailed unequal variance t-tests (Welch's Correction to degrees of freedom) results for comparison of the percentage of time in joint engagement at ages 1 and 2.

Metric	Percentage of Time in Joint Engagement, Mean (SD)		test-statistic	p-value
	Age 1 (N = 9, age M = 1.08, SD = 0.12, min= 0.91, max = 1.24)	Age 2 (N = 18, age M = 1.62, SD = 0.23, min = 1.36, max = 2.3)		
Joint engagement any length toys 1	27.67(15.87)	43.85(22.90)	t(22.07) = -2.14	0.044*
Joint engagement any length toys 2	27.09(16.78)	37.11(22.49)	t(20.89) = -1.30	0.208
Joint engagement >= 3 seconds toys 1	26.93(15.77)	43.04(23.32)	t(22.44) = -2.12	0.045*
Joint engagement >= 3 seconds toys 2	26.41(16.48)	35.95(22.70)	t(21.34) = -1.24	0.227

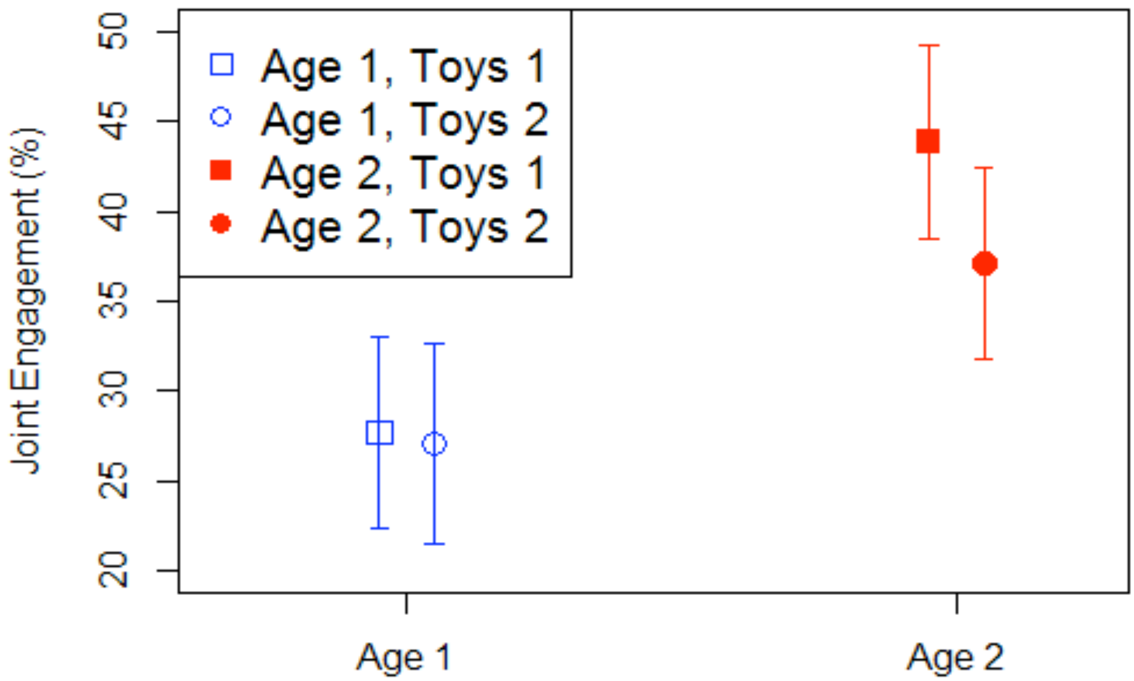

Figure 1.8: Joint engagement (with SEMs) at ages 1 and 2 with toys 1 and 2.

It is noteworthy that at age 1 the percentages of time in joint engagement with toys 1 (M = 27.67, SD = 15.87) and toys 2 (M = 27.09, SD = 16.78) were similar whereas at age 2 there is a decrease in the percentage of time in joint engagement from toys 1 (M = 43.85, SD = 22.90) to toys 2 (M = 37.11, SD = 22.49). The change in the percentage of time in joint engagement from toys 1 to toys 2 for age 1 (M = 0.58, SD = 16.60) and age 2 (M = 6.74, SD = 19.55) were not significantly different, two-tailed t-test with Welch's correction to degrees of freedom $t(18.71) = -0.86$, $p = 0.403$. Given that the order of toys 1 and 2 were not counterbalanced it is not possible to determine what is driving the difference in results with toys 1 (significant) and toys 2 (not significant); factors could include the type of toys, passing of time (i.e., subjects' fatigue), or different amounts of caregivers' scaffolding at the two ages.

Even though no significant difference was found in the percentage of time in joint engagement with toys 2 between ages 1 and 2, collapsing across the percentage of time in joint engagement is correlated between the two sets of toys, ages there is a positive correlation between the percentage of time, Pearson test r = .37, p = 0.001 (Figure 1.9). This suggests that infants who in relation to their age group performance had a high percentage of time in joint engagement with toys 1 also had a high percentage with toys 2.

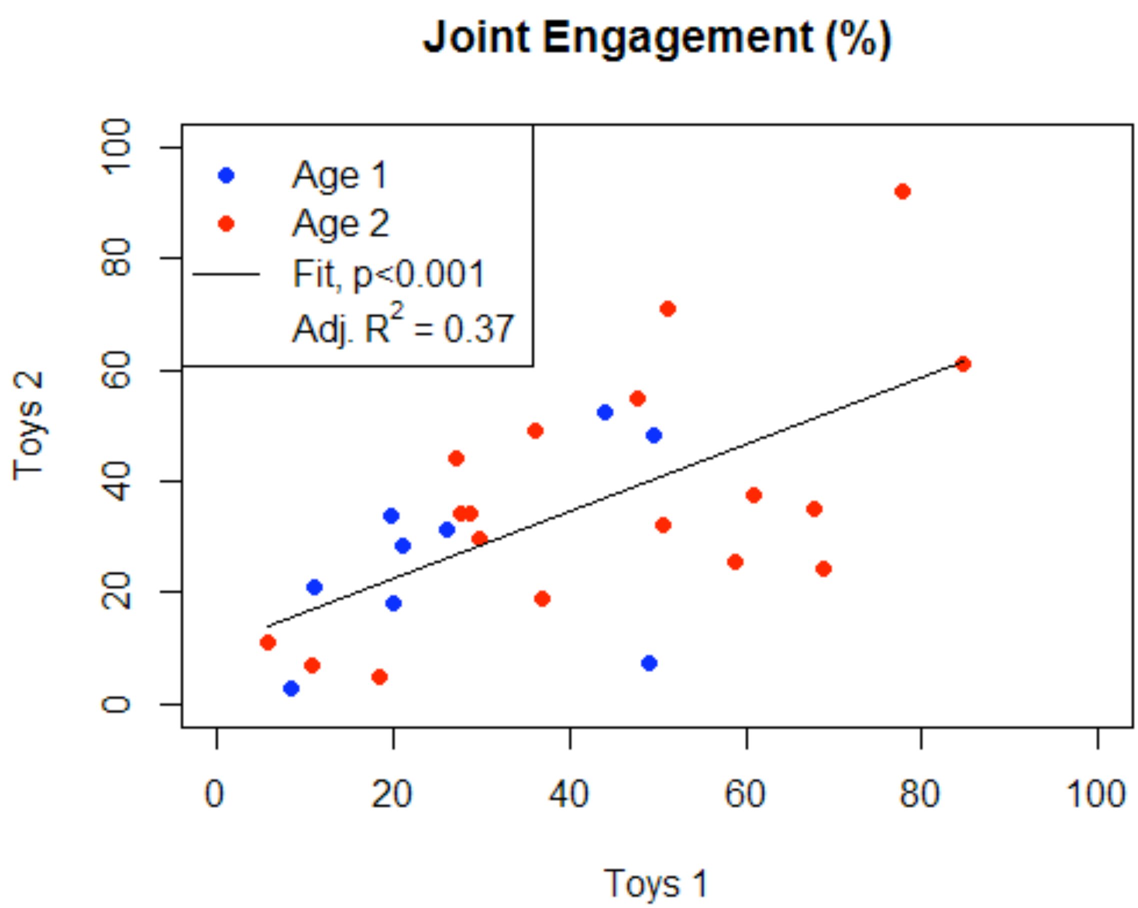

Figure 1.9: Scatter plot of participants' percentages of time in joint engagement, for toys 1 and 2, collapsed across ages. Regression results (with equivalent Pearson correlation) shown.

Age changes in the average duration of joint engagement events

Given that a significant change in average percentage of joint engagement was found regardless of the exclusion of episodes shorter than 3 seconds, age changes in average duration were done considering joint engagement events of any length.

Toys 1

A nearly significant trend was found between the average length of joint engagement events at age 1 (M = 13.04, SD = 5.82, N = 9) and age 2 (M = 33.97, SD = 42.32, N =18), two-tailed t-test with Welch's correction to degrees of freedom $t(18.21) = -2.10$, $p = 0.054$.

Toys 2

No significant difference was found between ages 1 (M = 13.22 , SD = 7.13, N = 8) and age 2 (M = 21.44, SD = 30.31, N = 18), two-tailed t-test with Welch's correction to degrees of freedom $t(20.44) = -1.09$ $p = 0.288$.

Table 1.4: Two-tailed t-tests (Welch's correction to degrees of freedom) results for comparison of average duration of joint engagement episodes at ages 1 and 2.

Metric	Duration of Joint Engagement Episodes, Mean (SD)		test-statistic	p-value
	Age 1 (N = 9, age M = 1.08, SD = 0.12, min= 0.91, max = 1.24)	Age 2 (N = 18, age M = 1.62, SD = 0.23,min = 1.36, max = 2.3)		
Average duration joint engagement any length toys 1	13.04(5.82)	33.6 (42.32)	t(18.21) = -2.10	.054.
Average duration joint engagement any length toys 2	13.22(7.13)	21.44(30.31)	t(20.44) = -1.09	0.288

Relationship between infants' time in joint engagement and visual levels

Infants' visual levels

Table 1.5 shows age 1 infants' reduction from visual acuity (VA) norms grouped into 4 bins—very mild, mild, moderate, severe—and infants' reductions from contrast sensitivity (CS) norms into 2 bins—within norm, below norm. Results of the visual evoked potential (VEP) and preferential looking technique (PL) are shown. Table 1.6 does this for age 2.

Table 1.5: Infants' reduction from VA and CS norms at age 1.

	VA Age 1			
	VEP		PL	
	N	%	PL	%
Very Mild	1	11.1	4	44.4
Mild	3	33.3	0	0
Mod	4	44.4	1	11.1
Severe	1	11.1	4	44.4

	CS Age 1			
	VEP		PL	
	N	%	N	%
Within Norm	1	11.1	3	33.3
Below Norm	8	88.9	6	66.7

Table 1.6: Infants' reduction from VA and CS norms at age 2.

	VA Age 2			
	VEP		PL	
	N	%	PL	%
Very Mild	6	33.3	10	55.6
Mild	6	33.3	3	16.7
Mod	6	33.3	2	11.1
Severe	0	0.0	3	16.7

	CS Age 2			
	VEP		PL	
	N	%	N	%
Within Norm	7	38.9	6.0	33.3
Below Norm	11	61.1	12.0	66.7

The average visual acuity reduction from norm based on the visual evoked potential at ages 1 ($M=0.55$, $SD = 0.31$, $N = 9$) and 2 ($M = 0.44$, $SD = 0.22$, $N = 18$) were not significantly different, two-tailed t-test with Welch's correction to degrees of freedom $t(12.25) = 0.98$, $p = 0.34$. Likewise, the average visual acuity reduction from norm based on preferential looking at ages 1 ($M = 0.54$, $SD = 0.67$, $N = 9$) and 2 ($M = 0.54$, $SD = 0.65$, $N = 18$) were also not significantly different, two-tailed t-test with Welch's correction to degrees of freedom $t(15.86)=-0.03$, $p = 0.98$ (Table 1.7).

The average contrast sensitivity reduction from norm based on the visual evoked potential at ages 1 ($M = 5.13$, $SD = 2.57$, $N = 9$) and 2 ($M = 5.41$, $SD = 2.53$, $N =18$) were not significantly different, two-tailed t-test with Welch's correction to degrees of freedom t(9.79)=1.35, p = 0.208. Likewise, the average contrast sensitivity reduction from norm based on preferential looking at ages 1 (M = 29.56, SD = 18.24, N = 9) and 2 (M = 37.95, SD = 30.06, N = 18) were not significantly different, two-tailed t-test with Welch's correction to degrees of freedom t(13.20)=0.78, p = 0.449 (Table 1.7).

These results suggest that the levels of visual impairment of both visual acuity and contrast sensitivity represented at ages 1 and 2 are comparable.

Table 1.7: Two-tailed t-tests (Welch's correction to degrees of freedom) results for comparison of infants' visual reductions from norms at ages 1 and 2.

Metric	Infants' Vision Reductions from Norms, Mean (SD)		test-statistic	p-value
	Age 1 (N = 9, age M = 1.08, SD = 0.12, min= 0.91, max = 1.24)	Age 2 (N = 18, age M = 1.62, SD = 0.23,min = 1.36, max = 2.3)		
VEP Visual Acuity	0.55 (0.31)	0.44 (0.22)	t(12.25) = 0.98	0.34
PL Visual Acuity	0.54 (0.67)	0.54 (0.65)	t(15.86)=-0.03	0.98
VEP Contrast Sensitivity	5.13 (2.57)	5.41 (2.53)	t(9.79)=1.35	0.208
PL Contrast Sensitivity	29.56 (18.24)	37.95 (30.06)	t(13.20)=0.78	0.449

Models of joint engagement

Participants and age

Some participants were longitudinal, and were therefore represented twice in the data, at both ages 1 and 2. Therefore, it was investigated whether a random or fixed intercept for participant would be necessary, neither of which were. Models with random intercepts for participants were not better than intercept-only models for toys 1 $X^2(1) < 0.001$, $p = 1.000$; nor toys 2 $X^2(1) = 0.99$, $p = 0.319$. Models with fixed intercepts for participants were also not better than intercept-only models for toys 1 $F(19,7) = 0.63$, $p = 0.80$; nor toys 2 $F(19,7)=2.33$, $p = 0.128$. Therefore, intercepts for participants were not included in further models.

Age was also not a significant linear predictor of joint engagement, compared to an intercept-only model, for toys 1 $F(1,25) = 1.37$, $p = 0.254$, nor for toys 2, $F(1,25)=1.37$, $p=0.254$, and was therefore not included in further models.

Relationship between independent variables

Collapsing across ages, there is a strong positive correlation in the two acuity measures, Spearman's rho correlation $r = 0.80$ (95% CI: 0.60, 0.90), $t(25) = 6.64$, $p < 0.001$ (not using a Pearson correlation because VEP data was not normal, although PL looked about Normal based on QQ-plots). Likewise, collapsing across ages, there is a strong positive correlation in the two contrast measures, Spearman's rho correlation, $r = 0.72$ (95% CI: 0.47, 0.86), $t(25) = 5.22$, $p < 0.001$ (not using a Pearson correlation because the data are not Normal) (Figure 1.10).

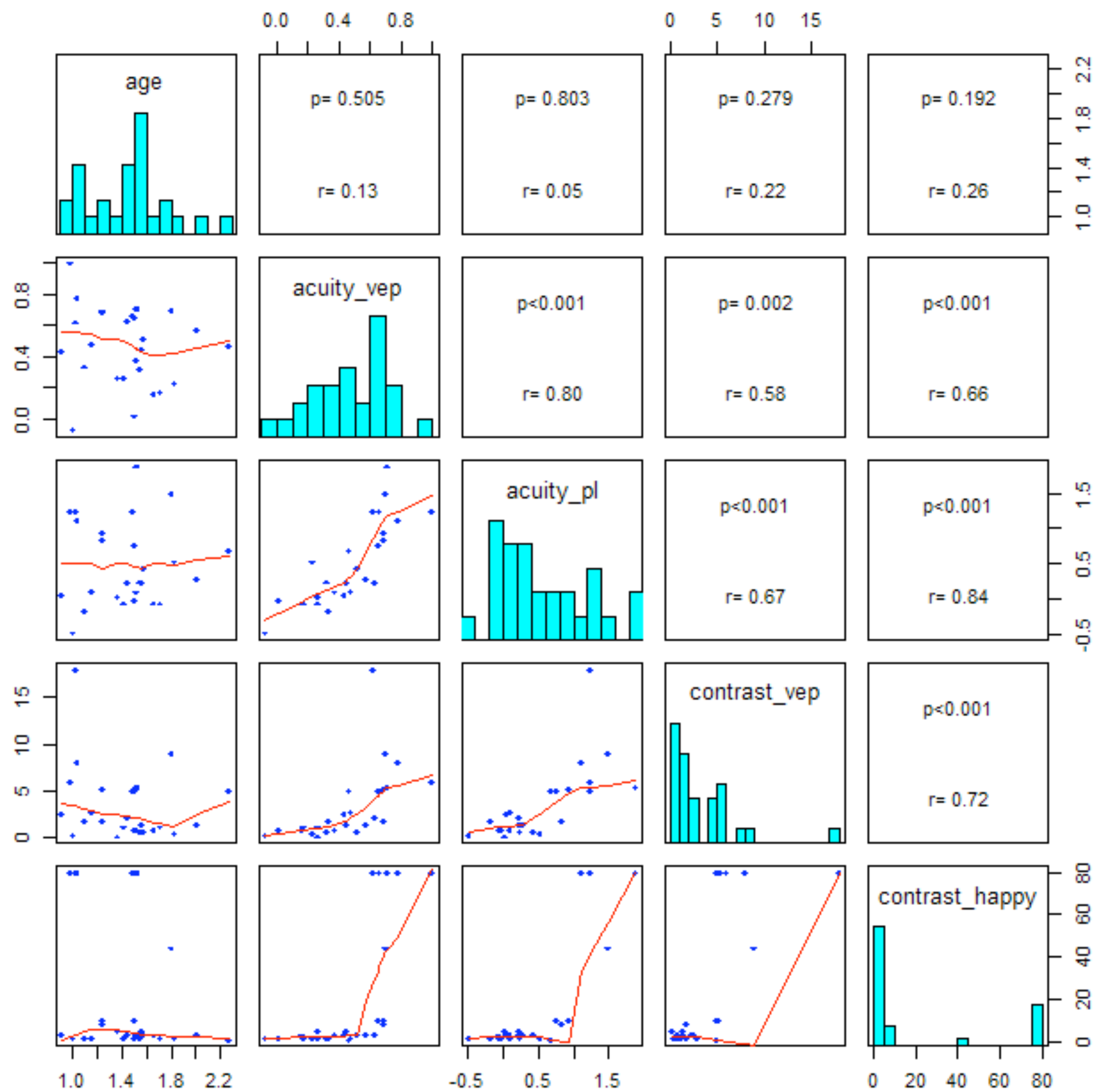

Figure 1.10: Relationship between pairs of variables. Lower-left: Scatter plots and LOESS (locally weighted polynomial regression) fits. Diagonal: histogram of responses. Upper-right: Spearman's rho correlation.
Age: infants' ages.
Acuity_vep: visual acuity measured with visual evoked potential.
Acuity_pl: visual acuity measured with preferential looking technique.
Contrast_vep: contrast sensitivity measured with visual evoked potential.
Contrast_happy: contrast sensitivity measured with preferential looking technique.

Acuity and contrast

Based on the high correlations between acuity and contrast measures, it was likely that including all four variables, two for contrast and two for acuity, in a model that predicts joint engagement would produce problems with collinearity (this was confirmed through inspection of the design matrix's eigenvalues, several of which were close to zero). Therefore, forward model selection was used to build a predictive model of joint engagement (%), adding predictors in an order based on relative importance. Relative importance was calculated as R^2 partitioned by averaging over orders, as in Lindeman, Merenda, & Gold (1980, p. 119 ff), implemented in Gromping (2006; Table 1.8).

Table 1.8: Relative importance of acuity and contrast measures for predicting Joint engagement.

	Toys 1	Toys 2
Acuity VEP	4.83×10^{-2}	2.58×10^{-2}
Acuity PL	5.59×10^{-2}	3.08×10^{-2}
Contrast VEP	4.87×10^{-2}	2.58×10^{-2}
Contrast PL	11.66×10^{-2}	10.31×10^{-2}

For both sets of toys (1 and 2), the selected model of joint engagement included the single predictor of Contrast PL (Table 1.9). These models were significantly better than intercept-only models. Adding any of the other predictors to the models did not improve the model fits based on F-tests (all $p > 0.241$).

Table 1.9: Models of joint engagement.

Predictor	Toys 1			Toys 2		
	Est. (SE)	t-value	p-value	Est. (SE)	t-value	p-value
Intercept	44.37 (4.79)	0.27	< 0.001 ***	39.52 (4.57)	8.65	<0.001 ***
Contrast PL	-0.27 (0.12)	-2.18	0.039 *	-0.26 (0.12)	-2.22	0.036 *
	$F(1,25) = 3.76$, $p = 0.039$			$F(1,25) = 4.93$, $p = 0.036$		
	$R^2 = 0.17$, Adj. $R^2 = 0.13$			$R^2 = 0.16$, Adj. $R^2 = 0.13$		

* p < 0.05, ** p < 0.01, *** p < 0.001

To confirm that these results would not have changed based on the order of added predictors, models of joint engagement were constructed using only Acuity PL, which had the second greatest relative importance after Contrast PL, and these models were not significantly better than intercept only models: for toys 1, $F(1,25) = 1.23$, $p = 0.279$; for toys 2, $F(1,25) = 2.17$, $p = 0.153$.

1.4 Discussion

This study's results provide evidence that infants with various degrees of visual impairments participate in joint engagement by the end of the first year of life. All infants tested ranging in age between 10 months, 29 days and 2 years, 3 months, 8 days participated in joint engagement with their caregivers.

Results also show that between roughly the end of the first year and the middle of the second year, the percentage of time these infants and their caregivers were in joint engagement significantly increased. This shows how joint engagement in this population continues to develop after its emergence, at least in terms of how much they constitute of the total time of the dyad's free play.

Both of these results contribute to the understanding of what constitutes normative times of joint engagement development in this population, which can aid in the differential diagnosis between typical development in this group of children and delays that warrant intervention. It also contributes to the work of developmental interventionists, since part of their role is to inform parents of the known unique patterns of development their visually impaired infants may experience.

Despite the significant increase in the average percentage in join engagement with toys 2 from ages 1 to 2, two infants showed the opposite patterns as their percentages decreased, in one case by 20.26 points; in the other by 15.18 points. Several possible factors could be at play. One is that these infants were experiencing the developmental setback phenomenon described in the literature, which includes impacts on joint engagement. Others can be circumstantial factors such as caregivers' low stamina levels, which could have decreased their amount of scaffolding at age 2. These two infants were longitudinal; future analysis of this study's data will explore the factors associated with the observed decrease in joint engagement. For instance, on the matter of developmental setback, coding of these infants' later observations can determine if the decrease in joint engagement continued over time.

Comparisons between this study's results with previous ones that also reported percentages of time in joint engagement are problematic. First, previous research with samples of sighted infants investigated a different population. Comparisons between sighted and visually impaired children can shed light on the similarities and divergences between each groups of children's development. They can also advance our understanding of child development in general as it makes us realize how diverse pathways than the ones seen in sighted children lead to equivalent developmental outcomes. An interesting example of this is the research on social smile. Prior to studies with blind infants, the accepted view was that social smile was dependent on the visual perception of the caregiver's face. The fact the blind infants also presented social smile to their caregiver's voices and haptic cues has changed the field's understanding of social smile.

However, findings on sighted infants cannot be used as the standard against which to determine what is typical or abnormal in the development of visually impaired infants. As Warren (1978) argued, the environment to which the visually impaired child must adapt presents them with different challenges than the ones it presents to his sighted peers. If a blind child requires more time to understand that objects exist independent of his immediate perception of them, this is due to the different demands such cognitive understanding posits in a child who relies on haptic and auditory information. It is not a delay, and it is not atypical just because it is evident to observers at a later age than in sighted children.

Second, some previous studies in joint engagement used structured contexts that provided prompts to the dyad. Presumably such structured settings would likely increase the occurrence of joint engagement compared to free play settings as the one used in this study.

Keeping in mind these two caveats, Bakeman and Adamson's longitudinal study (1984) seems the most appropriate to draw comparison with the findings of this study. They used the coding protocol this study largely followed—although with some adaptations—and videotaped infants and their caregivers during free play, like this study did—although in sessions that lasted 10 minutes compared to the 30-minute sessions recorded in here. The following comparisons use calculations from this study considering episodes that lasted at least 3 seconds, since that was the coding rule followed by Bakeman and Adamson.

In their study, 12-month sighted infants engaged in coordinated joint engagement 3.6% of the time, and in passive 19.3% of the time, with a combined total of 22.9%. In this study, visually impaired infants at age 1 (M = 1 year, 28 days) spend a similar average percentage of time in joint engagement of 26.93% with toys 1, and 26.41% with toys 2.

In their study, 15-month old sighted infants' percentages of time in joint engagement were 11.2% and 23.1% for coordinated and passive respectively, which totaled 34.3%. At age 18 months, the oldest age reported, coordinated represented 26.6% and passive 21.5% of the time; which combined totaled 48.2%. In this study, visually impaired infants at age 2 (M = 1 year, 17 months, 15 days), participated in joint engagement 43.04% of the time with toys 1, and 35.95% with toys 2.

It should be noted that in this study, Bakeman and Adamson's protocol was adapted. For instance, episodes coded as passive joint engagement with the adapted protocol could have been coded as observing in the original protocol. A mean duration comparison between these studies is not possible since Bakeman and Adamson differentiated between coordinated and supported joint engagement episodes whereas this study did not.

This study chose to assess visually impaired infants' participation in joint engagement during free play episodes rather than in structured play or testing settings. Rather than using prompts to encourage infant and caregiver to initiate or respond to bids for joint engagement, the video taping setting aimed to allow the dyad to interact in the most naturalistic way possible given the constraints imposed by the cameras' presence. The data collected in this way contributes information regarding the amount of time and duration of single episodes in which these infants and their caregivers share interest in an external focus when left to their own devices. In contrast, providing prompts to the dyad can potentially over-estimate the amount of joint engagement these infants naturally participate in.

The use of a free play context can potentially underestimate the infants' joint engagement skills. Supported joint engagement requires an active partner who intentionally shares attention with the infant. Coordinated joint engagement is not as dependant on the partner's involvement for its initiation—i.e., the child can initiate—but it does require the partner's participation for its occurrence as an actual social triadic interaction. As discussed earlier, a child's bid for joint engagement that is not followed by the social partner does not constitute joint engagement as a social interaction. Given the bidirectional nature of joint engagement, it is possible for infants to participate in diverse amounts of it with different social partners. Thus, it should be noted that this study does not provide a full report on the infants' ability to participate in joint engagement. It is possible that some of the children's performances would be higher if paired with different social partners and/or if caregivers were provided with prompts.

This study found that infants' level of contrast sensitivity measured with the preferential looking technique, but not with the visual evoked potential, predicted the percentage of time infants spend in joint engagement. Compared to the visual evoked potential, which provides general information about the occipital response to visual stimuli; the preferential looking technique reports the child's behavioral use of vision (Watson, Orel-Bixler, & Haegerstrom-Portnoy, 2010). Thus, this study's finding suggests that the critical factor is how infants are behaviorally using their contrast sensititvity.

A possible explanation of this study's finding of a relationship between contrast sensitivity and joint engagement relies in this visual function's significance for both mobility and perception of facial expressions. Both of these are relevant for the development of joint engagement. Navigating the environment contributes to infants' understanding of object permanence and expands the opportunities within which they can share attention on an external focus with social partners. Discriminating facial expressions can make social partners more salient stimuli for infants and increase their ability to mirror a caregiver's facial expressions, facilitating non-verbal exchanges between them.

Given that a review of the literature indicated that in most, if not all previous research, infants' visual impairments were only described in terms of visual acuity reductions, this study's finding underscores the importance of expanding the visual functions reported when studying the development of this population of children.

Understanding better the role of contrast sensitivity in joint engagement can aid not only our theoretical understanding of child development, but can also have positive practical consequences. An over-reliance on visual acuity impairments can lead to infants whose visual reductions are most greatly related to contrast sensitivity to not qualify for services, or to have their behaviors misunderstood.

Future analysis of this study's data will focus on the joint engagement episodes and code them in ways that describe the interactions. This information can be relevant for interventionists, as it can identify the specific activities visually impaired infants and their caregivers can engage in as contexts for the development of joint engagement. Unstructured observations like the one used in this study can have an advantage over laboratory paradigms. The typical paradigms used to study joint engagement were designed for sighted children, and rely heavily on sighted behavior. Even if these situations are adapted for visually impaired infants by attempting to translate visual behaviors into non-visual ones, there is the risk of missing more idiosyncratic ways in which these infants achieve joint engagement, that are not easily foreseen by sighted researchers.

Another line of future research relates to the question of how to index coordinated joint engagement without relying on gaze switch. One alternative index in the literature is infant's speech that clearly identifies the social partner and relates it to the shared activity, for instance when the child says to the caregiver, "Mommy your turn," while giving the object to her. However, this is linguistically too advanced for the infants in this study's sample. This methodological restriction amounts to pre-verbal visually impaired infants not being a population in which coordinated joint engagement can be studied.

As a way to start exploring this question, when this study's coders identified an event as joint engagement, they made a preliminary coding decision as to whether they thought the episode was of the type supportive, coordinated, or both. The latter option was meant to encompass events in which the episode started as supported but then as the infant evidenced acknowledging the caregiver's participation in the shared activity, became a coordinated one. If the event was classified as coordinated or both, coders decided which overt behaviors on the part of the child indicated so to them.

The approach to the coding was that the infants' behaviors that index coordinated joint engagement are presumably a combination of actions and are not limited to one action that involves just one sense. When researchers study sighted infants and focus our attention on their gaze switching, we are presumably not attending to several other components of the child's behavior, such as the orientation of his body, the use of his hands, and his hearing behavior. In an attempt to capture this, coders had several codes that aimed at including behaviors that relied on all senses, plus they had the option to add new behavioral codes. One new behavioral code that clearly emerged was infants' emotional reactions in reference to the external focus, whether positive—e.g., laughing after an action is performed on the toy—or negative—e.g., crying while trying to recover a toy the caregiver had taken away. This is in line with the work of researchers who have highlighted the incidence of emotion in joint engagement.

The next step in this line of research will be to look at the combination of behaviors that emerges from this preliminary coding, and noting which ones tend to occur together and the combination of how many of them indicated most strongly to the coders that the joint engagement was coordinated. Perhaps a way to respond to the challenge of studying coordinated joint engagement in pre-verbal visually impaired infants is to develop an index that combines several components into one, rather than looking for a single non-visual equivalent to infants' gaze switch.

Lastly, the coding of this study's video showed a wide array of caregiver's use of objects and how they mediated their conventional use to their visually impaired infants. Joint engagement is a type of social interaction in which the social partner influences the infant's experience and involvement with an object. In these interactions, sighted infants have shown more functional use of objects. For this to take place, at least two events must be present: a more advanced social partner demonstrates to the infant the conventional use of the object; the infant perceives the social partner's actions with the object and attempts it himself. These elements are at risk if there is a mismatch between how the caregiver mediates objects and the learning styles of their infants who are visually impaired. Studies have found that a subgroup of children who are blind or severely visually impaired show a developmental stasis or regression starting roughly between 15 and 27 months of age. One of the reported outcomes is the loss of explorative and manipulative play behavior and the failure to emerge of more advanced skills. A reasonable question is whether difficulties in joint engagement are a contributing factor in this phenomenon. Future analysis of this study's data can investigate which caregivers' actions during episodes of joint engagement correlate to infants' higher playing skills—in particular their conventional use of objects.

This study aimed to contribute data that represented better the population of infants with visual impairments by including a wide array of visual handicaps. Further research should expand on this goal by including infants whose multiple disabilities include visual impairments. Preliminary data analysis of two subjects, who due to additional disabilities were excluded from the data reported in this study, provides some considerations for such future research. In terms of the video-recording setting, the arrangement of cameras might need to be modified when studying infants with severe multiple disabilities. These infants' responses can be extremely subtle and they will not be captured by video cameras that focus on the overall scene. Rather at least one video camera should be focused solely on the child and zoomed in on him as much as possible to capture subtle facial expressions and motoric movements. The coding protocol also would need to be accommodated to these infants' particular behaviors. For instance, one of the aforementioned excluded subjects took a comparatively longer time to fully switch her attention between foci; even though she would turn toward a toy the caregiver was showing to her, the infant would continue her prior manual manipulation of a different toy. A coding rule that addresses this situation is to consider the "added" behavior as the infant's attentional focus, in this case, the turning toward the object introduced by the caregiver is added to the child's prior manipulation of a different toy and it would be considered the current focus of the child's engagement. Decisions such as this are particularly relevant when the study investigates the duration of joint engagement episodes as it clarifies their onsets.

Study 2

Attachment patterns in infants with visual impairments based on the Strange Situation Paradigm

2.1 Background

An infants' attachment behavior is activated when he finds himself facing challenges or threats from the environment, such as encountering a non-familiar individual. It is manifested by seeking proximity and/or contact with his attachment figure (typically the main caregiver) through various signaling behaviors. These behaviors include smiling, crying, vocalizing, reaching, grasping, clinging, and following the attachment figure. An infant will show attachment behavior by the end of his first year of life if a particular caregiver has responded to the infant's signals . From an affective point of view, attachment formation signals that the infant has established an emotional bond with his caregiver (Bowlby, 1973, 1980, 1982; Weinfield, Sroufe, Egeland & Carlson, 2008).

According to attachment theory, as part of the human species' evolution, attachment became part of infants' instinctive behaviors because of its contribution to their survival in humans' environment of evolutionary adaptiveness—especially protecting them from predators. In today's human environment, attachment behavior continues to have a survival function. When in a dangerous situation, the infant's risk of harm decreases by remaining in proximity to the attachment figure. To survive, the child needs not only to move away from the danger's source but to also go toward the adult who is the most likely to protect him. Thus from an ethological perspective, it serves the human species' survival for children to identify such an adult—i.e., his attachment figure—to remain in her proximity and to actively seek proximity to her when they are in a threatening situation (Bowlby, 1973, 1982).

In Bowlby's (1980) conceptualization, attachment behavior is a goal-oriented system; it continuously checks the current state of affairs against its goal of proximity to the caregiver and it uses representational models of the infant's own capacities and the relevant features in the environment to plan and deploy behaviors conducive to the system's goal. At a given moment, the manifestation of attachment behavior varies depending on the infant's perception of threat, and of the attachment figure's accessibility and responsiveness. Thus, the more accessible the caregiver is and the less threatening the circumstances, the less attachment behavior the child will exhibit, and vice versa. The conditions that lead to the cessation of attachment behaviors vary depending on the level of arousal within the attachment system. The higher the arousal, the more physical contact and reassurance will be required from the attachment figure.

Attachment behavior relates to infants' exploratory behavior, which makes the child venture into the environment by means of visual exploration, manipulation, locomotion and play. Like attachment, exploratory behavior has a survival function as it promotes both learning about and adapting to the environment. The attachment figure acts as a "secure base" to which the child can physically return to or re-establish contact with through distant means—e.g., eye contact—between his explorations of the environment.

Development

Human newborns display several innate pre-attachment behaviors, including crying, smiling, and looking at human faces, which trigger others' caregiving behavior toward them. Attachment behavior is not innate but instead is dependent on a particular caregiver consistently responding to the infants' signals, beginning with his pre-attachment behaviors. As the child becomes attached, he develops an internal representation of elements relevant for attaining the goal of proximity to his attachment figure. This internal working model reflects the history of the infant's interactions with the attachment figure, and includes representations of relevant aspects of the infant himself, the attachment figure and the environment. The model is used to understand and predict the infant's relationship with the caregiver and environment, and to plan, monitor, re-calibrate, and terminate attachment behavior (Bowlby, 1982, 1973; Marvin & Britner, 2008).

The development of attachment unfolds in sequential phases during the first years of life (Bowlby, 1982; Marvin & Britner, 2008). During their first 8 to 12 weeks, infants do not have a mental goal of proximity to the caregiver, but display behaviors that have the predictable outcome of generating caregiving and affection from adults. Infants respond to stimuli in a manner that increases the probability of continued contact with other humans, for instance by preferentially attending to human faces and voices.

Next, infants begin to respond differently to familiar versus unfamiliar people, and to preferentially direct attachment behaviors toward main caregivers. Starting at 6 to 9 months of age, children consolidate attachment to just one or several particular caregivers, and display new attachment behaviors, most of which involve their newly acquired locomotion skills. For instance, infants use their attachment figures as a secure base for exploration; they venture into the environment, intermittently checking on attachment figure's presence, and re-gaining proximity/contact with her. Cognitively, children have internal images of the attachment figure independent of their current perception of her. They also have a mental image of the goal of proximity to her, and can mentally select the behaviors that are likely to achieve it.

From 6 to 18-24 months, infants increase their wariness toward unfamiliar people, and during the pre-school years use more sophisticated mental operations as they start to consider the attachment figure's goals and behavioral strategies. These cognitive abilities, combined with infants' developing conversational skills and ability to inhibit behavior, allow for caregiver and child to negotiate a plan for proximity, and for their relationship to become goal-oriented.

Research studies with children who lacked a particular consistent caregiver in early development report an array of negative consequences. These include an inability to form attachment to new caregivers, or attachment formation but with long-lasting socio-emotional difficulties —i.e., issues understanding boundaries when interacting with strangers. A study compared 12-31-month old institutionalized infants who had spent a mean of 90% of their lives in Romanian orphanages and peers who had never been institutionalized. Whereas all non-institutionalized infants had a consolidated attachment system —latest stage of attachment development—, only 3 out of 95 of the institutionalized children did (Zeanah, Smyke, Koga, Carlson, & the BEIP Group, 2005). Under some conditions however, attachment can be developed after early social deprivation. A study assessed attachment behavior in 15-36 month old post-institutionalized infants, who had been adopted after spending a median of 94.3% of their lives in orphanages. By 7-9 months after adoption, 90% of these infants had formed attachments to their adoptive caregivers. However, compared to non-adopted peers, adopted children were more likely to exhibit disoriented or conflicted behaviors toward their attachment figures (Carlson, Hostinar, Milner, & Gunnar, 2014).

Strange Situation Paradigm

Ainsworth (1967) found evidence of the relationship between the attachment and exploration behavioral systems in infants living in country villages in Uganda. Infants whose attachment was deemed insecure (apprehensive lest caregiver is inaccessible or unresponsive) tended to remain in close proximity with the mother, exploring the environment very little or not at all. In contrast, those whose attachment was deemed secure would leave the mother's side to explore the environment. However, when Ainsworth later studied infants in Baltimore, she observed that nearly all babies, regardless of the security of their attachment, left their mothers to explore.

This observation led to the creation of the Strange Situation Paradigm (SSP), reasoning that heightening the infants' stress levels would allow for the observation of individual differences in attachment. The SSP is a standardized laboratory procedure that aims to activate infants' attachment behavior by presenting them with increasingly stressful circumstances. Specifically, the procedure takes place in a room new to the child, it involves an adult who is unfamiliar to the child (the "stranger") who attempts to interact with him, and separates the child from his caregiver (Ainsworth & Bell, 1970; Ainsworth et al., 1978).

The SSP protocol is as follows. Two chairs are on one side of the room, one for the caregiver and another for the "stranger," and a set of toys is on the other side. The unfamiliar environment and toys are meant to trigger exploratory behavior in the infant. At first, caregiver and child are in the room alone, and the caregiver—following previously provided instructions—attempts to interest the child in the toys. Then, the stranger comes into the room and interacts with the child while the caregiver is in the room. The caregiver subsequently leaves the child alone with the stranger. The caregiver comes back, comforts the child and attempts to renew his interest in the toys, as needed. Meanwhile, the stranger leaves the room. Eventually the caregiver leaves again; this time the child remains alone in the room. The stranger returns and attempts to comfort/play with the infant. Finally, the caregiver returns for a second time (Ainsworth, Bell & Stayton, 1971; Ainsworth et al., 1978).

Attachment patterns

The study of infants undergoing the SSP lead to the identification of patterns of attachment, based on four types of the infants' behaviors toward the attachment figure throughout the procedure, but particularly during the two times they reunited with her.

- Behaviors aimed at achieving contact with or gaining proximity to the attachment figure.
- Behaviors deployed in order to remain in proximity/contact with the attachment figure, regardless of who—child or caregiver—had initiated contact/proximity.
- Behaviors used to reject contact with or proximity to the attachment figure, again regardless of who had initiated it.
- Behaviors aimed at avoiding the attachment figure (Ainsworth et al., 1978).

To determine children's attachment patterns, observers code and score the presence, intensity and persistence of each of the four behaviors. Based on the resulting score profile and the coder's overall clinical impression of the infant, the pattern of attachment is classified. Attachment patterns thus refer to several distinctive behavioral strategies children demonstrate toward their caregivers when faced with a potentially dangerous situation, namely the SSP.

Three patterns and corresponding sub-types were identified (Weinfield et al., 2008). Infants classified as having a "secure" attachment—sub-types B1 through B4—clearly demonstrate a desire to interact and to be in the proximity of their attachment figure, and actively attempt to fulfill it. Whereas they may or may not be friendly with the stranger, they clearly prefer to be with their attachment figure. The children may or may not be distressed upon separation; if distress is present, it seems clear that it is due to the attachment figure's absence and not just because of being alone. Upon reunion, they greet their caregiver, show a positive emotional response, and if they had been distressed during separation, feel comforted and play fairly immediately. Although all secure subtypes meet this criteria, they differ in more subtle ways. For instance, B1 and B2 show more avoidant behavior than the other subtypes, with B1 showing the highest amount; B2 and B3 are the most competent in achieving proximity/contact, with B3 being the most competent; B4 shows the most resistant behavior (see appendix 3 for a comparison of secure sub-types).

Children classified as having an "avoidant" pattern—sub-types A1, A2—tend to avoid their attachment figure and show little or no tendency to interact with her. They also tend to avoid the stranger but can show less avoidance toward her. These infants show no distress during separation or if they do, it is only when left alone. Upon reunion, they do not greet the attachment figure, or if they do, the greeting is very tame. They either do not approach the attachment figure, start but do not complete the approach, or only approach after much coaxing. If they are picked up by the caregiver, they do not cling to her or do so only briefly; when put down they do not resist or do so but only momentarily. Avoidant subtypes differ in subtle ways, e.g., A1 shows more avoidant behavior than A2 (see appendix 4 for a comparison of avoidant sub-types).

Infants classified as having a "resistant" (also called ambivalent/anxious; subtypes: C1, C2) show ambivalent behaviors of an angry quality towards their attachment figures. They seek contact for instance by clinging to the attachment figure or struggling against her release, but also resist contact by pushing away from her, kicking, and/or throwing down toys she gives them. They fail to use their attachment figure as a secure base for exploration; they may not explore the room, or do so without seeming to enjoy it. They show distress during separation, and tend to respond positively upon reunion, but as during pre-separation this is intermingled with resistance behavior. Resistant subtypes differ in subtle ways, e.g., C2 shows a much more passive exploratory behavior than C1 (see appendix 5 for a comparison of resistant sub-types).

Types avoidant and resistant are both labeled “insecure” attachment patterns, as opposed to secure.

Disorganization

In later SSP studies, a small group of infants’ attachment patterns could not be classified. Main studied these cases and classified them within a fourth category, which she labeled disorganized/disoriented (Main & Solomon, 1986). Children classified in this group show, in the presence of the caregiver, contradictory behaviors and lack of orientation in the environment. Upon reunion with the attachment figure they display bizarre behaviors such as: dazed look, freezing of all movements, and stereotypes. This conflicting behavior is thought to be a result of the infant being in a frightening situation, which he cannot overcome because the attachment figure is perceived as frightening or is frightened herself, and thus is a source herself of fear for the child (Hesse & Main, 2000; Main, 1990).

Disorganization is not an attachment pattern on its own but rather it refers to a disruption in the infant’s attachment pattern, whether secure, avoidant or resistant. For instance, a child with a secure pattern who has no disorganization shows behaviors that are all consistent within the criteria for secure attachment, and therefore their behaviors during reunion with the attachment figure are predictable to the observer. In contrast, the behaviors of a child with a secure pattern who also shows disorganization are not all predictable to the observer based on his attachment pattern. Furthermore, the behaviors that are not predictable do not constitute a coherent behavioral system, giving the impression that the child lacks a behavioral strategy toward the caregiver at the moment.

Relationship to caregivers’ behaviors

How a given infant’s attachment behavior develops, and the specific pattern in which it becomes organized, is principally determined by the history of interactions the infant has with his attachment figure. The caregiver’s responses do not need to be of a specific quality, for instance whether the responses are sensitive or insensitive to the infant’s needs. As long as the same caregiver responds to the child, attachment develops (Bowlby, 1980; Sroufe, 1985).

Ainsworth et al., (1971) found relationships between infants’ attachment patterns and their mothers’ behaviors at home. Mothers of children who had a secure B3 attachment scored the highest in sensitivity, defined as the degree to which the mother attended to and interpreted the child’s signals; and when she didn’t give the child what he wanted, used communication rather than rejecting, ignoring or interfering with the child’s signals. Mothers of children who had avoidant attachment pattern displayed the most avoidance of physical contact with their infants, and scored highest in rejection, defined as difficulties integrating positive and negative feelings towards the child. Mothers of children who had insecure patterns A1 and C1 showed the most interfering behavior, which referred to issues viewing the child as a separate person, considering his wishes, and using strategies to ease the transition to times when the mother had to interfere with the child's wishes. Those of infants with insecure patterns A2 and C2 scored the highest in inaccessibility/ignoring, that is, were the least tuned-in to their children's state.

Research has continued to provide evidence in support of a relationship between infants' attachment patterns and their accumulated experiences interacting with caregivers. A meta-analysis found a modest association between attachment and sensitivity—effect size r = .24—and 12 out of 65 included studies fully supported the association (van IJzendoorn & Sagi-Schwartz, 2008). The stability over time of attachment patterns has been related to environmental changes that impact the attachment figure's quality of caregiving; for instance, the birth of a sibling which taxes the mother's availability to the firstborn, or socio-economical changes that contribute to parental depression (Thompson, 2000). Disorganization has been associated to parental maltreatment, maternal depression, and parental psychopathology (Lyons-Ruth, & Jacobvitz, 2008). Studies have started to consider gene-environment interaction models; for instance, infants who have both a DRD4 7-repeat allele and a mother who experiences unresolved loss/trauma show a 18.8-fold increase in the risk of presenting disorganization, compared to peers without these combined risk factors (Bakermans-Kranenburg & van IJzendoorn, 2007).

Relationship with other developmental skills

Based on observation and teachers' rating, pre-school age children classified as insecure were rated as more dependent on their teachers for help and attention than peers classified as secure. This difference was found again at ages 10 and 15 years. There is also evidence that pre-school and elementary school age children who were classified as insecure or disorganized showed more hostile/aggressive behavior toward parents and peers. Children classified as secure were characterized as sensitive to others' emotional cues and able to engage in dyadic affect regulation in which social partners help regulate each other's emotional states (Weinfield et al., 2008).

Evidence from longitudinal data has found that having a resistant pattern at 12 months of age predicted anxiety disorders in infancy and adolescence after accounting for newborn temperament and maternal anxiety (Warren, Huston, Egeland, & Sroufe, 1997).

A meta-analysis of seven studies found that children who had a secure attachment were more competent in the language domain—e.g., mean length of utterances, comprehension—than those who had an insecure one (van IJzendoorn, Dijkstra, & Bus, 1995). Children with a history of secure attachment are also reported to demonstrate more competent social problem-solving skills and to have a more positive self-concept in both implicit and explicit tests, than peers classified as insecure (Thompson, 2008). But there are also studies that have not found expected associations or have not replicated results from previous studies (Thompson, 2000).

A classification of disorganized attachment patterns has been associated with several negative outcomes including internalizing and externalizing problems, dissociative symptoms, issues managing stress, and school underachievement (van IJzendoorn, Schuengel, & Bakermans-Kranenburg, 1999; Lyons-Ruth, & Jacobvitz, 2008).

Attachment in infants with visual impairments

The literature in attachment tends to view the auditory and visual systems as having an especially important role in infants' pre-attachment behaviors and thus in the beginning of attachment formation. However, Bowlby also considers relevant infants' innate bias to respond to tactile and kinaesthetic stimuli arising from human arms and bodies (Bowlby, 1982).

Research has explored attachment development in children with visual impairments. Initial studies seem to have considered blind infants as a mean to investigate the role of vision in sighted children's emotional bonding to their caregivers. For instance, research on blind children were used as evidence of how eye-to-eye contact facilitates attachment formation and that vision is not a prerequisite for social smiling (Freedman, 1964; Robson, 1967).

Fraiberg (1970, 1977, 1979) went beyond studying blind infants as a natural experiment to study the role of vision, reporting the alternative pathways through which these infants formed attachment. The ten blind infants she observed smiled in response to their mother's voice by the 4th week of life, which was consistent with reports on sighted peers. She noted however that sighted infants' social smile in response to caregiver's face were fairly automatic and consistently triggered. In contrast, blind children's social smile in response to mother's voice was neither automatic nor regular, and required lots of vocal stimulation from her. In addition, whereas by 6-11 months sighted children were reported to show regular and rather exclusive smiles to familiar faces, blind children in that same age range did not smile regularly or exclusively to familiar voices.

The relevance of the haptic system for understanding attachment development in blind children is highlighted in several of Fraiberg's observations. The most consistent way to elicit a social smile in blind children was gross tactile or kinesthetic stimulation. Preisler (1990) also reported that in the 3 to 6 months age period the visually impaired infants she observed were more likely to smile when they participated in body-touching games and songs. In Fraiberg's study by 5-8 months blind infants demonstrated a preference for their caregivers; they more frequently manually explored parents' faces than that of strangers. Infants disliked touching strangers' faces and calmed down when they returned to exploring that of their parents.

Another pre-attachment behavior reported by Fraiberg was infants' reaching for their caregivers. She noted that whereas 5-month old sighted infants extend hands to mother relying on hand-eye coordination, the blind children did so between 10 and 16 months of age. She argued that the blind child, lacking the visual perception of caregiver, needs to achieve a certain level of object permanence before he can reach for mother on hearing her voice. In a related reflection, Troster & Brambring (1992) noted that compared to sighted peers, blind infants showed anxiety when separated from their mothers at later ages. They argued however that this differential onset did not need to be assessed as a developmental delay in attachment development but rather as an expected onset in a population in which experiencing separation from mother requires a more advanced stage in the understanding of object permanence than in sighted peers.

These observations call attention to how visual impairments' impact on the infants' cognitive development could influence attachment formation. The internal working model proposed by Bowlby requires the infant's representation of the caregiver as having permanence, that is, as existing independent of their availability to the infants' current perception. In arguing this, Bowlby references Piaget's theory (1952) on object permanence development. In Piaget's view several early visual depending experiences are crucial; infants' visual perception of objects from different perspectives, experiencing them disappearing and reappearing in different locations in space, and using eye-hand coordination to gain access and manipulate objects in ways that expand infants' perception of them. Following a Piagetian developmental framework, Bigelow (1986) concluded that compared to sighted peers, blind infants' understanding of object permanence is more cognitively constructed.

In the second half of the first year, blind infants showed differences in their vocal responses to familiar versus unfamiliar people; they would engage in extended dialogues with their mothers but not with strangers. Also during that period, when in the presence of a stranger blind infants vocalized to their mothers less or ceased vocalizations for several minutes or longer. This "quieting" reaction to strangers resembled the staring at stranger than sighted infants show prior to demonstrating full-formed stranger anxiety. Like their sighted peers, by 7-15 months blind children showed avoidance of unfamiliar people. Blind infants showed avoidance of unfamiliar people when the latter not only talked to them but also held them, thus providing them with haptic—and perhaps also olfactory—cues.

Fraiberg reported that not all indexes of stranger avoidance found in sighted infants were observed in the blind; specifically sobering and frowning were too tame or non-existent. Instead, blind infants' fear of strangers was evident through their whimpering, crying, screaming, motor resistance, and seeking of mother. Between 11 and 22 months of age, the blind infants started to protest when separated from their mothers, an onset that is about 6 months later than in sighted peers. Using a different methodology, a parental questionnaire, Dale et al. (2013) reported that 32 infants between the ages of 10 and 44 months with visual impairments showed attachment behavior and reacted differentially to strangers. Troster & Bambring (1992) used a socio-emotional developmental scale that combined parental report and observation of infants in test situations. Their findings showed that 2 out of 5 9-month old blind infants and 12 out of 17 12-month old infants showed an avoidance reaction when a stranger picked them up.

The impact of visual impairments on attachment cannot be understood based only on the observation of blind infants, but requires consideration of how these infants' idiosyncratic behaviors in turn have an effect on their parents' caregiving behavior. Preisler (1990) for example reported that in the age range of 3 to 6 months, the blind and visually impaired infants she observed reacted to mother's approach by increasing their motor activity—legs and arms waving—and making lip and tongue movements, but not all caregivers interpreted these behaviors as socially meaningful. For the formation of attachment, the caregiver must respond to the infants' cues. The lack of eye contact and visual attention, another pre-attachment behavior has been found to result in decreased visual attention and vocal responsiveness by the mother. Other characteristics attributed to these infants such as a limited range of facial expressions and difficulties mirroring caregivers' facial expressions have been associated with a lower rate of response to these children's signals by their social partners, both adults and peers (Rogers & Puchalski, 1984 Troster & Brambring, 1992; 1984; Warren, 1984).

If parents of children with visual impairments have difficulties recognizing their infants' cues, the consolidation of attachment and the pattern in which it becomes organized can be impacted. If a caregiver does not respond to her infant's cues, the dyad will not have the history of exchanges necessary for attachment formation. If caregivers to a greater degree miss their visually impaired infants' cues, these children will experience their parents as less sensitive to their needs, which will increase the likelihood of the attachment being organized as insecure. In terms of its development, some pre-attachment behaviors like reaching for mother may emerge at a later age than in sighted infants.

However, if caregivers manage to recognize their visually impaired infants' idiosyncratic cues, attachment formation will not face the same risks. Developmental intervention can aid parents in identifying their infants' signals and to respond to them in ways that their children can perceive. For instance, parents can learn that a way their infants show preference for them is by tactually exploring parents faces, and parents can continue the interaction by providing their children tactile stimulation. Also, parents can learn about the behaviors evidence shows emerge at a later age in infants with visual impairments. In this way parents for instance will not interpret their infants' later reach for them as a sign of deviance in attachment development. In line with this, Fraiberg (1979) reported that whereas the 10 blind infants she studied, who received intervention, showed attachment behavior in the first two years of life in ways comparables to sighted peers, older blind children she encountered in her clinical experience, who had not received intervention, did not show attachment.

The review of the literature found one study that applied the SSP to visually impaired infants which had a sample of 27; 14 had a chronological age between 12 and 48 months and 13 had a mental age lower than 48 months, although were chronologically older. Infants had an array of visual impairment levels; most had low vision (71%), followed by almost blindness (14%), blindness (11%), and near-normal vision (4%). Seventy-nine per cent of the sample had additional disabilities. The authors reported modifications of the SSP protocol: during the second episode the mother was allowed to actively interact with the child in order to mediate for him the environment—whereas in the standard protocol the caregiver is told to respond to the child if he initiates but not to actively seek interaction with him. Authors also added a consideration to the disorganization coding protocol in that they did not consider signs of disorganization behaviors which, although atypical in the general population of children, are within the norm of infants with visual impairments—e.g., repetitive movements such as swinging. Results showed that 6 infants, all of whom had additional disabilities, were deemed not classifiable due to their lack of movement and very subtle or nonexistent signals. Twenty-five percent of the sample could not be classified because their mental age was assessed to be below 12 months—it seems all these cases had additional disabilities. Ten infants were classified as having insecure attachment patterns, but the subtypes were not specified. There was no mention of secure patterns being found in the sample (Salvo, Falcetti, & Caldironi, 2001).

Using the Adult Attachment Interview with blind adults, a study explored the effects of sighted mothers' reported high frequency of maternal directiveness and overprotection toward their congenitally blind infants. For instance, Behl, Akers, Boyce, &Taylor (1996) reported that mothers of children with visual impairments were more physically involved with their children, used more controlling strategies, and spoke more to them than did the mothers of fully sighted peers. The Adult Attachment Interview asks adults questions regarding their early experiences with their attachment figures. Based on the discourse characteristics of the adults' responses—e.g, coherence, lapses in reasoning—their mental states about attachment are classified. Studies have shown that the Secure-Free-autonomous state of mind is a protective factor against psychopathological risk, whereas the other three classifications are significantly correlated to clinical status. Eleven of the 15 participants reported a significant degree of directiveness and overprotection by their mothers. However, the obtained percentage of Secure/Free-autonomous stated of mind was similar—or even higher compared to some studies—to that observed in sighted population at low psychopathological risk. The study's results did not find that maternal directiveness and over-protection necessarily have negative consequences for personality development. The study's blind adults reported experiencing such maternal directiveness and overprotection as encouraging and functional if they were accompanied by an affective, loving, and supportive attitude (Ardito, Adezanto, Dell'Osbel, Izard, & Veglia, 2004).

Study 2 aims

This study has two main goals.

The first goal is to apply the SSP in a sample of infants with visual impairments, without additional disabilities.

This study tests the applicability of the SSP in a population—infants with visual impairments—other than the one the procedure was originally applied to—sighted infants. The literature review conducted for this study revealed one published study that used the SSP in a sample of infants with visual impairments, some of which had additional disabilities (Salvo, Falcetti, & Caldironi, 2001). This study's sample is different in that it only include visually impaired infants without additional disabilities. There is also antecedent of the SSP being applied to populations other than the sighted. For instance, a meta-analysis of 16 studies on attachment in children with autism reported on four that used the SSP (Rutgers, Bakermans-Kranenburg, van IJzendoorn, & van Berckelaer-Onnes, 2004).

One question is whether the procedure can trigger attachment and exploratory behavior in infants with visual impairments. To do this the SSP presents the child with information aimed to trigger the attachment behavior—mother's absences and returns, stranger's presence—and the exploratory behavior—toys in the room. If this information is not presented in a way that is perceivable by infants with visual impairments, the SSP will fail to trigger attachment and exploratory behavior, which would impede its use as a means to classify these children's attachment patterns and disorganization status.

Another question is whether the SSP coding protocol could lead to misconstructions of the behaviors infants with visual impairments display when their attachment system is activated. These infants may demonstrate attachment in ways not recognized in the coding guidelines. For instance, the child may attend to his attachment figure by lowering his face in order to pick up auditory cues from her, which could be wrongly construed as "avoidance." In addition, some of these infants' behaviors are developmental adaptations that can be misunderstood as abnormal. For example, the child may exhibit repetitive movements which to him serve a function—e.g., information pick-up—but which observers might deem as stereotypical in sighted infants, and thus be coded as "disorganized."

The second goal of the study is to report the distribution of attachment patterns and prevalence of disorganized attachment found in the sample of infants with visual impairments, without additional disabilities.

Only one published study was found that reported the distribution of attachment patterns based on the SSP. More applications of the SSP on this population are needed. This study will address this research need in a sample that, unlike the aforementioned study, includes only infants with visual impairments without additional disabilities.

The distribution of attachment patterns is susceptible to cultural variations; consistent with its origin in human evolution, children's attachment behaviors must adapt to the environment they grow in with its prevalent caregiving practices and valued infants' behaviors (van IJzendoorn & Sagi-Schwartz, 2008). A child with visual impairments must adapt to an environment that differs from that of sighted peers. He has unique adaptive needs for establishing an emotional bond with his caregiver and learning about his environment. The question is whether these unique adaptive needs impact the distribution of attachment patterns in infants with visual impairments.

These particular adaptive needs could potentially have an effect on the normative times of attachment development in infants with visual impairments and as a consequence on the ages at which their attachment system can be observed when they undergo the SSP. One example of this line of thinking is the pre-attachment behavior of reaching for the caregiver. Fraiberg noted that whereas 5-month old sighted infants extend hands to mother relying on hand-eye coordination, the blind children she observed did so between 10 and 16 months of age. She argued that the blind child, lacking the visual perception of the caregiver, needs to achieve a certain level of object permanence before he can reach for his mother upon hearing her voice. The representation of the caregiver as having permanence is part of the internal working model proposed by Bowlby.

To fulfill its goals, this study applied the SSP to a sample of 20 infants with visual impairments, without additional disabilities. Instructions were added to the SSP protocol to make the relevant information more salient and perceptible to infants with various degrees of visual impairments.

The classification of attachment and disorganization was conducted by coder 1 who has no clinical experience with infants with visual impairments but is a certified and experienced SSP coder. The reliability sample was coded by a trained SSP coder who has 6 years of clinical experience with these children. The discrepancies between the two coders will be discussed in order to explore how familiarity with the population impacts the results obtained from the SSP.

2.2 Methods

Participants

The same 20 infants that participated in study 1 constitute study 2's sample. As reported earlier, the sample consisted of 20 infants with visual impairments without additional disabilities. Of these, 10 were females and 10 were males. Due to the low incidence of this population of infants, they were recruited either as longitudinal (N = 7) or cross-sectional subjects (N = 13), per their caregiver's preference. For infants and their caregivers' demographic information of infants, refer to the method section of study 1.

Infants' ages at the time of assessment were divided into two age groups, depending on whether ages were closest to either 12 months (age 1) or 18 months (age 2). Nine infants (6 females, 3 males) were observed at age 1, average fractional age of 1.05 or 1 year, 18 days (SD = 0.11). Eighteen infants (10 females, 8 males) were observed at age 2, average fractional age of 1.61, or 1 year, 7 months, 12 days (SD = 0.24). Seven infants (6 females, 1 male) were assessed at both ages.

Table 2.1: Study 2 subjects' ages.

Subject Number	Age 1 N = 9 M = 1.05 SD = 0.11 Minimum Age = 0.9 Maximum Age = 1.27			Age 2 N = 18 M = 1.61 SD = 0.24 Minimum Age = 1.32 Maximum Age = 2.33		
	Years	Months	Days	Years	Months	Days
1	0	11	23	1	6	21
2	0	10	25	1	4	29
3	---	---	---	2	3	29
4	1	0	5	1	6	1
5	1	3	8	1	6	21
6	1	0	9	1	6	20
7	---	---	---	1	6	14
8	1	0	10	1	6	1
9	---	---	---	1	5	1
10	1	2	13	---	---	---
11	1	0	2	1	6	10
12	---	---	---	1	9	11
13	---	---	---	2	0	10
14	---	---	---	1	7	13
15	---	---	---	1	9	19
16	---	---	---	1	6	4
17	1	0	2	---	---	---
18	---	---	---	1	6	5

19	---	---	---	1	7	22
20	---	---	---	1	3	26

Procedures

Strange Situation Paradigm

A total of 27 Strange Situation Paradigm (SSP) were conducted and video recorded in the Clinical Research Center at the UC Berkeley School of Optometry. Prior to the start of the procedure, the lead investigator conducted a brief meeting with the caregiver in a room adjacent to the one in which the SSP was to later be performed. In this meeting, the lead investigator explained the procedure to the caregiver, gave her instructions for each of the SSP's episodes, and answered her questions. The caregiver was shown the TV/VHS monitor on which they would be able to view a live image of their infant in SSP room throughout the procedure, from a spy camera located in the protocol room. The infant remained with the caregiver during this overview interview.

The SSP consists of 8 episodes, which occur sequentially, back-to-back, and total to about 20 minutes (Table 2.2).

Table 2.2: Summary of the Strange Situation Paradigm episodes
*Episode is curtailed if the baby is highly distressed

Episode	Participants	Duration	Behavior highlighted by episode
1	Mother, baby, experimenter	30 sec approx.	Introduction to the room by experimenter
2	Mother, baby	3 min.	Exploration of strange environment with mother present
3	Stranger, mother, baby	3 min.	Response to stranger with mother present
4	Stranger, baby	3 min (*)	Response to separation with stranger present
5	Mother, baby	Variable	Response to reunion with the mother
6	Baby	3 min (*)	Response to separation when left alone
7	Stranger, baby	3 min (*)	Response to continuing separation, and to stranger after left alone
8	Mother, baby	Variable	Response to second reunion with mother

Given that the SSP was designed for fully sighted children, the lead investigator added instructions to the protocol in order to facilitate infants' perception of the relevant aspects of the procedure: entrance and exit of caregiver and stranger, presence of toys in the room, and stranger's bids for interaction with the infant. Special considerations have been used when the SSP has been applied to a population of children other than the sighted. In studies with autistic children, coders have considered children's own baseline behavior prior to separation from the attachment figure when determining the presence and intensity of disorganized behaviors versus behaviors that although atypical are typical in autism (Capps et al., 1994; Naber et al., 2007). When testing infants with pervasive developmental disorders, stereotyped behaviors have been excluded from the coding of disorganization (Willemsen-Swinkles, Bakermans-Kranenburg, Buitelaar, van IJzendoorn, & van Engeland, 2000).

Prior to data collection, these accommodations were discussed with attachment researcher Prof. Alan Soufre, University of Minnesota at Minneapolis. A description of the SSP episodes (Ainsworth et al. 1971) and the added instructions used in this study are described below (Table 2.3).

Table 2.3: Strange Situation Paradigm instructions

Episode	Instructions
1	Caregiver and infant are introduced to the room by the experimenter. Then, the experimenter leaves them in the room.
2	The caregiver sits in the chair and the baby is allowed to explore the environment. The caregiver can help and comfort the child, as she deems appropriate. *Added instructions for caregiver*: "You may activate toys, help the child touch and hear them, in order to make sure that your child has noticed the toys. Please use any means you normally use to have your child be aware of the presence of toys".
3	The stranger enters the room. For the first minute of the episode, the stranger sits in her chair quietly. For the second minute, she chats with the caregiver. For the third minute, the stranger attempts to play with the infant. *Added instructions for stranger*: "Before entering the room knock in the door, once in the room say hello to caregiver. Make sure to make noise with your steps and when you sit so that the infant has enough cues to realize that you have entered the room. When interacting with the infant, talk to the child before approaching or touching him, so that you warn him of your presence. Have toys make noise to alert child of their presence. You may also bring toys to children's hands so that they can touch the toys".
4	The caregiver leaves the room and the infant stays in the room with the stranger. During this episode the stranger continues to attempt to play with the child. The stranger can sit back in the chair if the child is fine playing independently. If the child becomes very distressed and cannot be comforted

	by the stranger, the episode is curtailed. *Added instructions for caregiver*: "Let your child know that you are leaving the room as you would regularly do, you may talk to or touch your child".
5	The caregiver enters the room, pausing for a moment at the door. This gives the baby time to approach the caregiver. The caregiver's instructions are to comfort the baby and renew the baby's interest in toys. Meanwhile, the stranger leaves the room. *Added instructions for caregiver*: "If you think your child typically needs your verbal greeting more than once for him to notice and locate you in the room, you may repeat your greeting at the door. If your child seems to want to approach you and you know that he needs sound cues to locate you can, you can continue to talk to your child once you are inside the room. If your child is not yet independently moving in space, walk into the room and stand at a distance from your child where he could reach for you with extended arms".
6	The caregiver leaves, and the baby stays alone in the room. If the infant becomes too distressed, this episode is curtailed. *Added instructions for caregiver*: "Let your child know that you are leaving the room as you would regularly do, you may talk to or touch your child."
7	The stranger enters the room and attempts to comfort and play with the baby. If the child is too distressed this episode is curtailed. *Added Instructions for the stranger*: "Use the means the caregiver used to signal that you have returned into the room. Also, if child is not mobile, approach the child so that you are at a distance where child can reach for you with extended arms (just like mom was recommended to do)".
8	The caregiver returns. The caregiver's instructions are to comfort and get the baby re-interested in toys. *Added instructions for caregiver*: "If you think your child typically needs your verbal greeting more than once for him to notice and locate you in the room, you may repeat your greeting at the door. If your child seems to want to approach you and you know that he needs sound cues to locate you can, you can continue to talk to your child once you are inside the room. If your child is not yet independently moving in space, walk into the room and stand at a distance from your child where he could reach for you with extended arms".

Video recording setting

The procedure was administered in a 13 by 9.5 foot room in the Clinical Research Center at the UC Berkeley School of Optometry. The SSP room was equipped with two video cameras for data recording and one wide angle "spy" camera for live video monitoring of the SSP room activity in an adjacent room. The room was extensively "child proofed" and the cameras were hidden from the infant's view. In the SSP room, two chairs were placed side-by-side on a floor rug, with a side table holding a stack of magazines between them. The chair closest to the entry door was labeled "parent". A container of toys was placed in the center of the rug. Toys were chosen taking into consideration infants' absent or reduced visual abilities, and thus included toys that afforded a diversity of sensory experiences. Specifically: a toy with 4 fine motor operated pop-up figures; 3 different rattles; 2 baby books (one of them had textures); 3 bells of different color and sound; a rolling green car; a musical ball; 2 cubes with different textures in each of their sides; and several big Lego pieces (Figure 2.1).

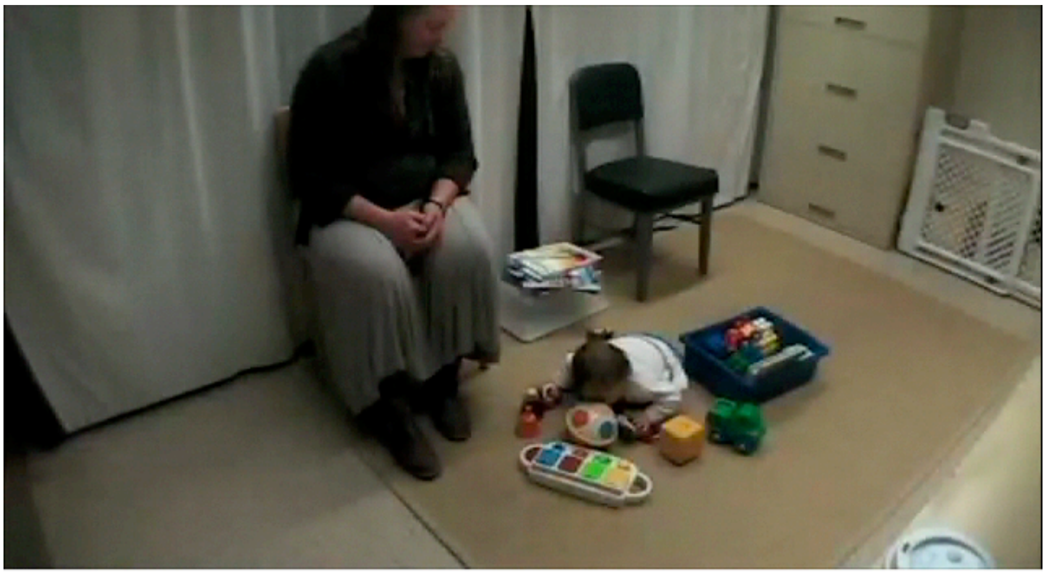

Figure 2.1: Toys used in Strange Situation Paradigm.

Strange Situation Paradigm setting

Two hidden video cameras, one by the room's entry door, and a second one at the other end of the room, captured the entire scenario. Videotapes from these cameras were used to code the attachment pattern. The room also had a hidden wireless spy camera whose image was displayed and recorded on a TV/VHS monitor located in an adjacent room. The spy camera allowed for the lead investigator to observe the SSP as it was developing. It also allowed the caregiver to see her infant when she was outside the room. Videotapes from this camera were not used in coding attachment.

The role of the stranger was performed by research assistants who had been trained by lead investigator. This training included:

a. The research assistant reviewed a detailed written protocol and met with the lead investigator for discussion and clarification of any questions.

b. The research assistant enacted the stranger's instructions in the room where the procedure was to take place and under the supervision of the lead investigator.

During episode 3, the lead investigator knocked on the door once to signal to the stranger when to start to converse with the caregiver, and when to start interaction with the infant.

At the end of episodes 4 and 6, the investigator knocked twice to signal the caregiver it was time to say good-bye to her infant and leave the room.

When the caregiver was outside the SSP room, she remained in the interview room and could see the image from the spy camera and thus see her infant during the two separations. If the infant became too distressed during any of the two separations, the episode was curtailed and the caregiver was instructed to go back to the room.

Codes

The SSP videos were coded using protocols developed for the classification of attachment patterns secure, ambivalent, avoidant, and for disorganization (Ainsworth et al., 1979; Main & Solomon, 1986).

Attachment patterns: secure, avoidant, resistant

The attachment pattern—i.e., secure, avoidant, resistant—is determined based on four types of infants' behavior during the two reunions with the attachment figure: contact and proximity seeking, contact maintenance, resistance, and avoidance. The coder must determine all of the infants' behaviors that can be classified as one of those four categories, and then assign a score that represents all of the observed behaviors under each type of behavior. The possible scores range from a lowest of 1 and a highest of 7. Below behavioral examples of a lowest, middle and highest score are provided (Ainsworth et al., 1979).

Table 2.4: SSP behavioral codes scores examples.

	Score		
Behavior	1	4	7
Contact/ Proximity Seeking	Infant does signal desire for contact/proximity (e.g., he does not reach or cries for caregiver). Infant accepts contact passively –e.g., without clinging- when the caregiver picks him up.	Infant shows desire for contact/proximity (e.g., reaches for caregiver crying) but he does not achieve contact on his own and waits for the caregiver to pick him up.	Infant achieves physical contact solely based on her actions (e.g., walking toward and climbing onto caregiver), without needed caregiver's assistance. Infant maintains contact for at least 15 seconds.
Contact Maintenance	Child shows no protest when caregiver stops contact.	Infant is held for less than a minute, when caregiver ends contact, infant protests tamely (e.g., brief reach) but does not actively attempts to regain contact.	During contact that lasts over 2 minutes, infant actively and persistently tries to remain in physical contact (e.g., clings to attachment figure, strongly protests if put down and climbs back on caregiver).
Resistance	Infant accepts contact without any protest toward the caregiver.	Isolated resistant behaviors without a pervasive angry mode, e.g., infant twice rejects toy given by caregiver without showing any other angry behavior toward her.	At least two strong resistant behaviors such as: repeated hitting of caregiver, pushing away and squirming to get down when picked up.
Avoidance	Infant does not avoid caregiver upon her return (e.g., infant turns to look at mom immediately after she hears her voice).	Infant does not greet caregiver after her return for up to 30 seconds but then responds to mother outstretched arms by reaching to ward her.	Infant does not respond to caregiver's repeated bids for interaction and instead focuses on playing.

Coding and scoring are based specifically on the children's behavior during the two reunions with the attachment figure. However, the infants' behavior throughout all SSP episodes informs the coding. For instance, in deciding between ambivalent subtypes C1 and C2, the coder considers the behavioral exploration of the infant in all episodes (C2 shows a much more passive exploration of the environment than C1).

Disorganization

The coding protocol for disorganization used in this study was obtained from the Institute of Child Development of the University of Minneapolis at Minnesota. It groups infants' behaviors into 7 categories:

1. Sequential display of contradictory behavior patterns. For instance: the child was highly distressed during separation, crying strongly by the door without been able to turn his attention elsewhere. Yet, immediately upon reunion the infant stops crying, moves away from the caregiver, and sharply averts her gaze from her. In this example, the infant displays strong attachment behavior immediately followed by strong avoidance behavior.
2. Simultaneous display of contradictory behavior pattern. For instance, upon reunion the infant approaches the attachment figure with his head sharply averted from her. In this example the child displays proximity-seeking and avoidance behavior at the same time.
3. Undirected, incomplete, and interrupted movements and expressions. For example: infant cries for an extensive period of time without looking, approaching or signaling in any other way to the caregiver; child reaches for the caregiver and withdraws hand quickly before touching parent, without rationale; upon reunion infant begins to approach the attachment figure but falls prone in depressed (huddled) posture.
4. Stereotypes, asymmetrical movements, mistimed movements, and anomalous postures. For instance: extended body rocking; asymmetrical creeping when approaching caregiver upon reunion; unpredictable bouts of activity; child assumes prone posture for more than 20 seconds, unless infant is clearly tired.
5. Freezing, which consist on the holding of movements, gestures or positions in a posture that involves active resistance to gravity. For example, infant stands with arms held out waist-high and to sides. Stilling, which consists of the child remaining in a resting posture –i.e., it does not involve active resistance to gravity- without any clear focus of attention. Slowed movements and expressions; for example: the child has a dazed facial expression especially when unexpected, for example during contact-seeking behavior.
6. Direct indices of apprehension regarding the parent. For instance: upon reunion, the child immediately responds to parent's entrance by jerking back with fearful expression.
7. Direct indices of disorganization or disorientation. For example: immediately upon parent's return, the child raises hands to mouth with a clearly wary expression.

The listed examples of behaviors are not exhaustive, that is, the observer can code a behavior not described in the protocol if it conceptually meets the criteria of any type of disorganized behavior.

The infants' behaviors throughout all of the SSP's episodes informs the coding decisions; however, only behaviors displayed when the attachment figure is present in the room can be coded as disorganization. For example, when determining if the infant shows a sequential display of contradictory behaviors, the coder may have to consider the child's behavior when the caregiver was not in the room. If a child was extremely distressed during separation, did not get comforted by the caregiver, remained at the door calling for his mother, and then immediately upon reunion shows strong avoidance, this would could be coded as disorganization. However, if a child showed the same avoidant behavior upon reunion but previously, during separation, had not shown distress and had played with the stranger, this would not be considered disorganization.

Each coder created a written record of the behaviors coded as disorganized, including its description and time of occurrence in the video. Each of these behaviors was scored in a scale from a lowest of 1 and a highest of 8. The protocol identifies behaviors that the coder should consider stronger indicators of disorganization. For instance, behaviors that occur immediately upon reunion with the attachment figure are stronger indexes and receive a higher score.

A score of 1 was given if what superficially seemed disorganization could be explained in other terms. A middle score of 5 was given if no strong indexes were observed and the ones observed were strong enough or completely lacking an alternative explanation. A score of 8 was given when several strong indicators, or one very strong indicator and several intense exhibitions of at least one other index, were present.

Coding procedures

A first coder, certified for the coding of attachment patterns avoidant, secure, ambivalent attachment patterns and disorganization by the Institute of Child Development, University of Minneapolis at Minnesota, coded all of the cases. For reliability purposes, a second coder (the lead investigator) coded 30% of the SSP videos (N = 8). The second coder underwent SSP coding training at the University of Minneapolis at Minnesota, and had clinical experience working with infants with visual impairments with the Blind Babies Foundation (www.blindbabies.org). The first coder did not have any prior experience with visually impaired infants. Both coders were masked to the infants' visual status.

Each coder watched the videos from the two cameras that recorded the SSP as many times as he deemed necessary in order to identify and assign a score to the infant's avoidance, contact and proximity seeking, resistance, contact maintenance, and disorganization. Additionally, the coders kept a written record of the behaviors each coded as signs of disorganization, including a description of the behaviors and the time they were observed in the SSP video.

No videos included in the reliability sample were "recycled." That is, none were re-coded after the coders' first attempt did not reach reliability.

Data analysis

Reliability of coders

In order to measure reliability of the coders, Cohen's kappa was calculated for the codes security/insecurity, and organized/disorganized. The bias and prevalence indexes and maximum kappa were calculated to complement the information provided by the kappa value. Lastly, the accuracy of the coders was calculated based on the code's base rates and the obtained kappa.

Distribution of attachment patterns

In order to examine the distribution of attachment patterns in the sample, percentages were calculated for each type of attachment—i.e., secure, insecure-avoidant, insecure-ambivalent. The distribution of disorganization in the sample was examined by calculating the percentage of attachment patterns considered disorganized, and the percentage deemed organized.

It should be noted that in order to expand the comparison of the attachment classifications from a coder with no clinical experience with infants with visual impairments and another with such clinical experience, this study's second coder will continue to classify the SSPs not included in the reliability sample reported here. Due to this, results are presented for the sample as a group, without identifying the attachment pattern of individual infants.

2.3 Results

Reliability statistics

All 27 Strange Situation Paradigm (SSP) video recordings were coded by the first coder. The second coder (lead investigator) coded 30% of the sample (N = 8).

Each SSP corresponded to an event to which coders had to assign two codes: secure or insecure, and disorganized or organized. This allowed for the use of the original Cohen's kappa calculation since it assumes that coders make decisions about pre-determined units and that the number of decisions made by each coder is the same as the number of tallies in the kappa table. (Bruckner & Yoder, 2006; Bakeman & Quera, 2011; Sim & Wright, 2005; Viera & Garrett, 2005; Yoder and Symons, 2010).

For security of attachment the Kappa value was 1 (Table 2.5). The maximum kappa was 1. The values of kappa range from -1 to 1. A value of 0 signifies that coders agreed at no more or less than chance would allow for. Values below zero indicate agreement below chance—i.e., potential systematic disagreements between observers; positive values represent agreement above chance with a value of 1 being perfect agreement.

The bias index was 0 and the prevalence index was 0.25. The base rate of the code secure was .63, and that of insecure was 0.38. Considering the base rates and the obtained kappa of 1 it was estimated that observers' accuracy was above .99 (Bruckner & Yoder, 2006; Sim & Wright, 2005).

Table 2.5: Kappa result, security of attachment.
1 Value of kappa.
100% Agreement.
Numbers in cells represent attachment pattern classification.

		Coder 2		
		Secure	Insecure	Totals
Coder 1	Secure	5	0	5
	Insecure	0	3	3
	Totals	5	3	8

For disorganization of attachment, the kappa value was .6 (Table 2.6). The maximum kappa was .6. The bias index was 0.13 and the prevalence index was 0.63. The base rate of the code organized was .8, and for disorganized was .2. Considering the base rates and the obtained kappa of .6, it was estimated that observers' accuracy ranged between 0.9 and 0.95 (Bruckner & Yoder, 2006; Sim & Wright, 2005).

Table 2.6: Kappa result, disorganization of attachment.
0.6 Value of kappa.
78% Agreement.
Numbers in cells represent attachment pattern classification.

		Coder 2		
		Organized	Disorganized	Totals
Coder 1	Organized	6	1	7
	Disorganized	0	1	1
	Totals	6	2	8

Attachment patterns

In all but 1 case of the 18 SSP collected at age 2, the first coder determined that an attachment pattern could be determined from the observed infants' behaviors. In one case the attachment pattern was deemed non-codable. After excluding that case the mean fractional age was 1.62, or 1 year, 7 months, 17 days (SD = 0.25). All SSP cases collected at age 1 were deemed codable by the first coder.

At age 1 the distribution of attachment patterns shows that 56% (N = 5) of them were classified as secure; of these one infant had sub-type B1, and four had sub-type B2.

Twenty-two percent (N = 2) of the infants' patterns were classified as insecure- avoidant subtype A2, and 22% (N = 2) of the patterns were coded as insecure-ambivalent; of these 1 had subtype C1 and 1 had subtype C2 (see Figure 2.2).

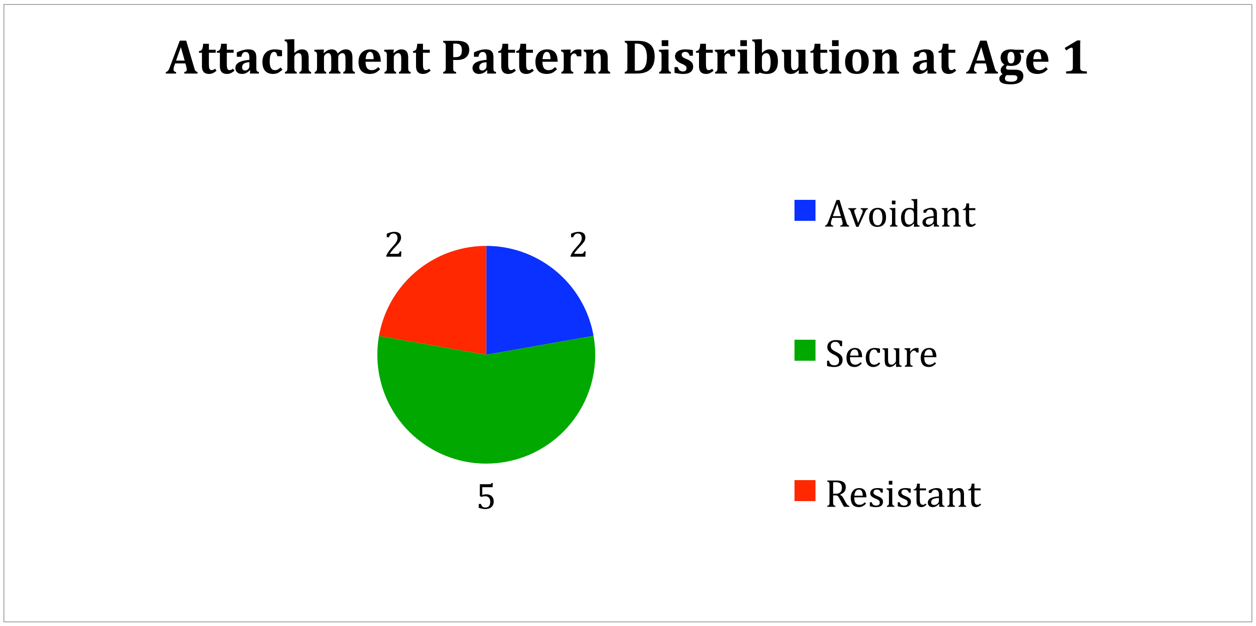

Figure 2.2: Attachment patterns distribution at age 1.
Colored areas represent percentages.
Values represent number of cases.

At age 2 a higher percentage, 70% (N = 12) of the sample's attachment patterns were classified as secure. Of these, 4 children had sub-type B2, 4 had sub-type B4, 3 had subtype B3, and 1 had sub-type B1 (see Table 2.7). Of the insecure patterns, 18% (N = 3) were avoidant, 2 of them A2 and 1 A1; and 12% were resistant (N = 2), both C1.

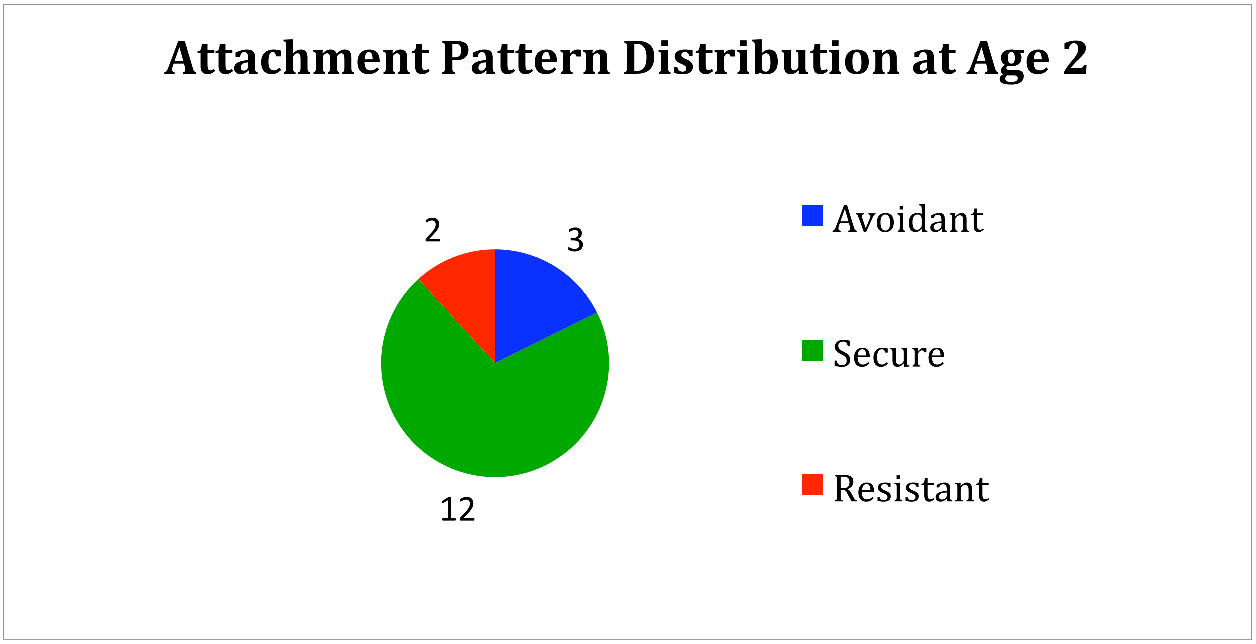

Figure 2.3: Attachment patterns distribution at age 2.
Colored areas represent percentages.
Values represent number of cases.

Of the seven infants that underwent the SSP at both ages, five showed the same attachment patterns at both ages, and two infants changed classification.

Table 2.7: Subjects' attachment patterns at ages 1 and 2.

Attachment Pattern		Age 1 N = 9 M = 1.05 SD = 0.11 Minimum Age = 0.9 Maximum Age = 1.27	Age 2 N = 17 M = 1.62 SD = 0.25 Minimum Age = 1.32 Maximum Age = 2.33
Avoidant	A1	0	1
	A2	2	2
Secure	B1	1	1
	B2	4	4
	B3	0	3
	B4	0	4
Resistant	C1	1	2
	C2	1	0

Disorganization

At age 1, 7 infants were coded as organized, and 2 as disorganized, representing 78% and 22% of the sample respectively (Figure 2.4). At age 2, 16 were deemed organized, and 1 was coded as disorganized, representing 94% and 6% of the sample respectively (Figure 2.5). Of these, 1 child was coded at both ages, meaning one child was coded as disorganized at age 1 and as organized at age 2.

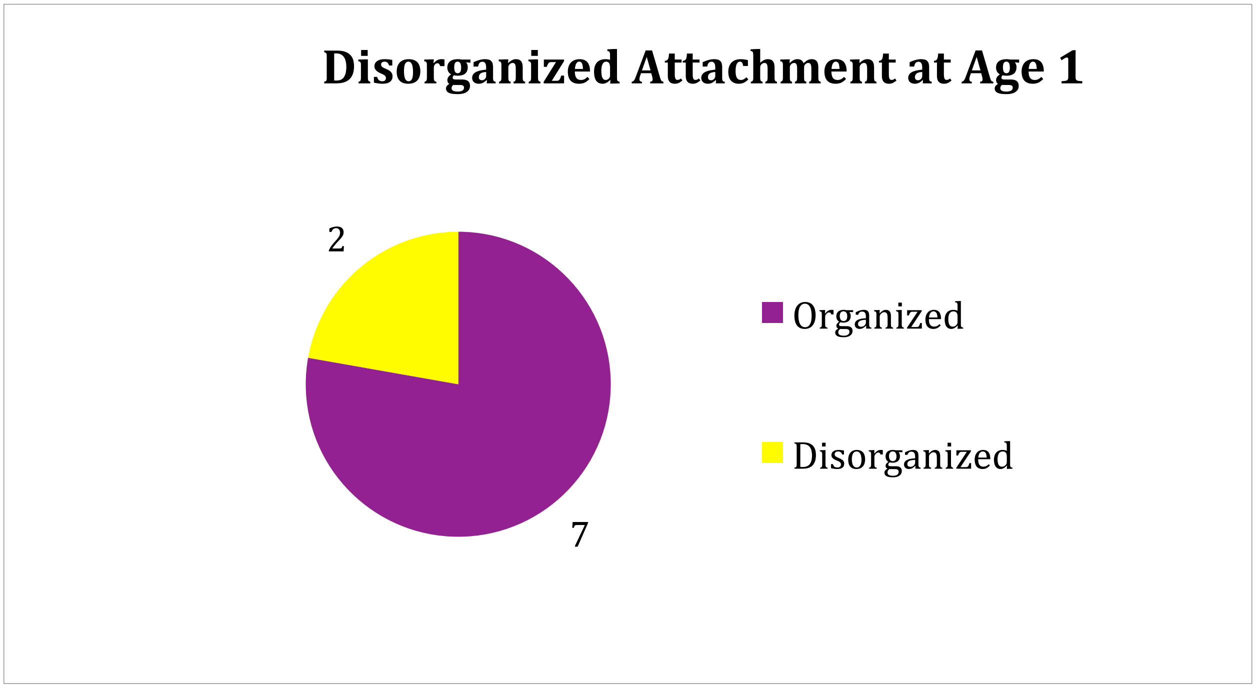

Figure 2.4: Disorganized attachment patterns at age 1.
Colored areas represent percentages.
Values represent number of cases.

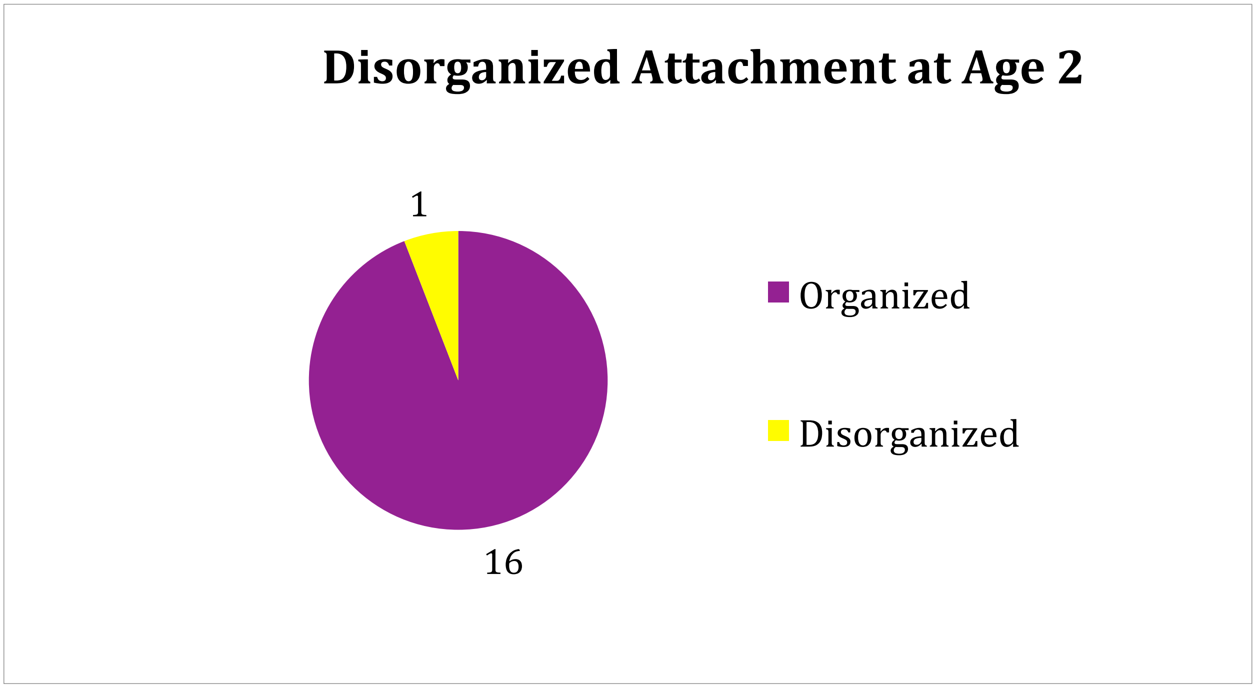

Figure 2.5: Disorganized attachment patterns at age 2.
Colored areas represent percentages.
Values represent number of cases.

2.4 Discussion

This study provides evidence that the Strange Situation Paradigm, with the additional instructions as described in the procedures section, can be successfully applied to infants with various levels of visual impairments. All but 1 of the 27 SSPs collected were deemed classifiable by a certified and experienced SSP first coder. Note that this coder did not have previous experience with this population. Therefore, if infants with visual impairments display idiosyncratic behaviors during the SSP, an experienced coder can nonetheless interpret them with respect to the procedure's coding protocol. In contrast, in a study by Salvo et al. (2001), 18 out of 27 SSPs were deemed unclassifiable, all of which seem to have been with infants who had additional disabilities. This sharp discrepancy between the two studies in the number of infants whose attachment patterns could be classified highlights the developmental differences that can be found between visually impaired children with and without additional disabilities.

Regarding the ages at which infants with visual impairments deploy attachment behavior during the SSP that coders can classify, this study shows that all 9 infants tested at a mean age of 1 year, 18 days had patterns that were classifiable. This suggests that infants with visual impairments can consolidate an attachment system and organize it into a pattern by the end of the first year of life. Of the 18 infants tested at a mean age of 1 year, 7 months, 17 days, 17 had patterns that were classifiable, and only 1 was deemed non-classifiable. Due to ongoing data coding and the need to have coder 2 remain unbiased, it is not possible to report here the reason the one case could not be classified. Possible explanations include: the attachment system has not yet formed, the infant did not perceive the attachment figure's absences or returns during the SSP, or extremely unusual behaviors on the part of the child. The ages of the children whose attachment patterns were successfully classified ranged from 10 months, 25 days to 2 years, 3 months, 29 days. This information contributes to the understanding of normative times for attachment development in this population.

The successful rate of patterns classified in this study was the product of the application of the SSP with the additional instructions designed to increase the likelihood that relevant information for the activation of the attachment and exploration systems would be perceived by the infants. The added instructions differed between this study and that of Salvo et al. (2001). In both investigations, parents were instructed to introduce the toys in the room to their infants rather than only be responsive after infants' bids for interaction. The purpose of this modification in both studies was to assure through mother's mediation that the infants notice the presence of toys in the room—information relevant for activating the exploratory system.

In addition, this study included other special instructions. To help the child notice the entrance of the stranger in episode 3, she was to knock on the door before entering the room, once inside say hello to the caregiver—but not converse with her further—and take noisy steps on her way to the chair. Of interest at that point in the procedure is the child's reaction to the stranger's presence prior to her interaction with the caregiver, that is, while the stranger remains a more ambiguous stimuli for the child. If the infant does not notice the stranger's entrance such behavioral responses are not tested. Also, caregivers were to knock in the door before entering the room and were allowed to continue talking to the child if they felt he needed it to locate them in space in order to move toward her, should he want to do so. And before leaving, caregivers were instructed to say good-bye to their infants as they would normally do. Although this study did not have a control group of infants which underwent the SSP without additional instructions, the successful rate of classifiable attachment patterns suggests that the described adaptations are useful and that future research with this population would benefit from implementing them.

One aspect of the protocol that was not modified was the duration of the infant's separations from their attachment figures. This is relevant since it is conceivable that, particularly for infants who routinely are separated from their caregivers—e.g., in daycare—a 3-minute separation is not stressful enough to activate the attachment system. Fraiberg (1977) raised a related point when she observed that compared to blind infants, sighted peers can be accustomed to more frequent perception of the caregiver's presence. Even if the sighted child does not intentionally turn to look at the caregiver to check on her presence, and even if the caregiver remains silent, she can still be present in the child's visual field. In comparison, a blind child who is not in physical contact with the caregiver relies on the caregiver's vocalizations and other auditory cues of her presence, which can be more intermittent than what visual perception can afford. If blind infants are accustomed to a more intermittent perception of their caregivers' presence, they might require a longer time without perceiving the caregiver before displaying attachment behavior. Troster & Brambring (1992) compared the reactions of sighted and blind infants to their mother's departure, noticing that while protest was frequently observed in 12-month old sighted children, it was seen in none of the 5 9-month and 6 of the 17-month old blind infants they studied.

The classification of 26 out of the 27 tested infants attests to the successful activation of their attachment systems. Even in cases in which there was no clear indication upon the caregiver's departure as to whether the child's apparent lack of reaction was due to the way his attachment system was organized or to not noticing her exit, infants displayed attachment behavior upon reunion. One of the most severally visually impaired infants in this study did not react to her mother leaving the room, even though she approached the child and said good bye before exiting. After about 2 seconds, the child turned his upper body and extended his arms toward the chair mom had been previously sitting on. When he obtained no response, he insisted for some time, adding vocalizations. Eventually the child desisted and instead of going back to playing as he had done prior, he started to rock his body back and forth. In this case, even though the infant did not show distress when mom left the room, after enough time passed during which he had no evidence of the mother's presence despite his attempts to regain contact with her by performing actions that would have triggered mother's behavior if she would have been present, the child's playing behavior lowered in quality. A decrease in the complexity of play after separation from the caregiver is recognized in the SSP coding protocol as a signal of distress. Thus the three seconds separation was enough in this case for the infant to perceive his mother's absence.

The question that still remains, however, is whether a 3-second separation affords the visually impaired child the same level of stress as it does to sighted peers. The amount of stress can have an impact in the deployment of attachment, as Bowlby (1980) posited. The conditions that lead to the cessation of attachment behaviors vary depending on how aroused was the attachment system; the more aroused, the more physical contact and reassurance will be required from the attachment figure.

Studies with sighted children are reported to find most patterns of attachment to be secure—although numbers vary considerably across samples within a population—with up to 40% reported as insecure. A review of 1,584 SSP of US children showed that 67% qualified as secure, 21% as avoidant, and 12% as resistant (van IJzendoorn & Sagi-Schwartz, 2008). This distribution is comparable with this study's findings; at both ages tested, the majority of the patterns were coded as secure and insecure patterns represented up to 44% of the sample. At age 1, 56% (N =5) were classified as secure, and 44% as insecure (N = 4). At age 2, 70% (N = 12) of the patterns were classified as secure, and 29.41% as insecure. Of the 7 infants that underwent the SSP at both ages, 5 showed the same attachment pattern at both testing times, and 2 two infants changed classification.

In terms of the secure patterns subtypes' distribution, this study found that the most represented were B2 (N =4) at age 1, and B2 (N = 4), B3 (N = 4), and B4 (N = 3) at age 2. B1 was the least represented at both ages (N = 1). The higher prevalence of B2 and B3 is in line with findings from studies with sighted children, which initially reported B3 as having the highest frequency, whereas more contemporary ones report subtype B2 as the most represented (A. Sroufe, personal communication, February, 2014). Of all attachment patterns—secure and insecure—subtypes B2 and B3 infants show the highest ability to accomplish contact/proximity to the caregiver. The fact that most infants at each age tested were classified as B2 and B3, suggests that infants with visual impairments can actively and successfully deploy proximity seeking behaviors.

Of the insecure patterns, avoidant and ambivalent were close to equally represented at age 2—N = 3 and 2 respectively—and equally represented at age 1—each type N = 2.

Of the insecure-avoidant subtypes, A1 was the least represented—N = 0 at age 1, and N = 1 at age 2. At both ages 2 patterns were classified as A2. Of all secure and insecure patterns, infants classified as A1 show the most avoidance of the caregiver. A question regarding the application of the SSP to infants with visual impairments was whether they would notice when their caregivers returned to the room. If this study's infants had difficulties noticing mothers' return, more avoidant behaviors could have been coded. Behaviors coded as avoidant are an artifact if they are caused by the infant failing to perceive their attachment figure during reunion, which could lead to more patterns been classified as avoidant. This does not seem to be the case in this study.

Of the insecure-ambivalent subtypes the most represented across ages 1 and 2 was C1—2 out of 2 at age 1; 1 out of 2 at age 2.

In studies with sighted children, the percentage of attachment patterns classified as disorganized varies according to the sample of infants tested. A meta-analysis found that in middle-class, non-clinical groups the percentage was 14%, whereas in low-socioeconomic samples the percentage was 24% (Lyons-Ruth & Jacobvitz, 2008). In this study at age 1, 2 out of 9 infants were coded as disorganized (22%); at age 2 1 out of 17 were coded as disorganized (N = 6%). One child classified as disorganized at age 1 was at age 2 classified as organized.

The coding of the reliability sample—30% of the SSP videos, N = 8—allowed for comparison between the classifications given by two coders that differed in their experience with the population of visually impaired children. No difference in coding was found regarding security of attachment as coders were reliable in all eight cases.

Discrepancies existed in two cases regarding the coding of disorganization. In one case, coder 1 who didn't have experience with population coded the attachment as disorganized, whereas coder 2 who had clinical experience working with these infants considered it as organized. The discrepancy could be due to coders' different interpretations of an idiosyncratic behavior in this population. Both coders noted that two times after having been playing contentedly with toys, the child started to cry, and continued to do so without turning his face or body to the attachment figure. Both coders also considered this a behavior that could be considered under the category of "seemingly undirected movements and expressions." Under this category, the coding protocol lists as an example times when the child cries extensively in the caregiver's presence without any move or look toward her.

The discrepancy between the coders was in the score they gave to the behaviors. Coder 1 gave it a score of 7, which as the highest possible score mandates a classification of disorganization. The second coder gave these behaviors a code of 4.5, which left it to the coder to determine whether it was enough evidence to warrant a classification of disorganization. Coder 2 considered the following factors. First, the coding protocol states that this behavior is not necessarily disorganized if the caregiver is already nearby and attentive. The coder deemed this to be the case, since the child was playing near the caregiver; when the child cried, the caregiver several times talked to him, making comments that reflected the child's apparent emotional status, e.g., "don't be mad, it's OK."

Even though the child continued crying, he seemed to attend to the caregiver's speech, at times vocalized himself to which his mother replied, and eventually stopped crying. The child did turn his face to the attachment figure at other times during the SSP, thus this was a behavior available to him. It is possible that the conditions under which visually impaired infants are impelled to turn their faces or bodies toward their caregivers are somewhat different so that even in contexts of distress, the perception of the caregiver's caring voice is sufficient re-assurance for them. Additionally, this was the only behavior the child demonstrated that warranted the consideration of a D classification.

In the second case, the coders' disagreement did not seem related to idiosyncratic behaviors shown by visually impaired infants. The discrepancy had to do with the scoring of behaviors in which the child showed rapid changes in affect, specifically from being seemingly content to very upset. Whereas coder 2 considered these events enough evidence of disorganization, coder 1 considered that they were not lacking in rationality and could be explained as tantrums due to the child's frustration with toys.

Of significance is that this study's results are from a sample that included an array of visual levels, with visual acuity reductions from norm ranging from very mild to severe and roughly 67% being below the contrast sensitivity norm and the rest above the norm. This suggests that this study's findings of the applicability of the SSP with added instructions and the observation of a formed attachment system in the ages tested in this study are not restricted to a particular level of visual impairment.

Study 3

Exploring the relationship between joint engagement and attachment in infants with visual impairments

3.1 Background

Theoretical relation between attachment and joint engagement

As explained in Study 2, the attachment system is related to the exploration system of an infant. The attachment figure acts as a secure base to whom the child can return and reconnect with through distant means in between his ventures into the environment. In this way, the child is re-assured that a source of protection is available and responsive to his needs should he get into a threatening situation. This sense of security helps him move away from the caregiver's side and learn about the environment beyond his most immediate surroundings. From this perspective, the existence of an attachment figure, and within that, how much the child can use her as a secure base, will have consequences in the amount and characteristics of the child's explorations.

Because of this relationship, the initial coding of the Strange Situation Paradigm included the child's exploratory behavior in the room. (For a description of the SSP protocol, see the Methods section of Study 2.) However, results showed that these exploratory behaviors did not significantly differentiate between the patterns of attachment that emerged from the application of the procedure. Consequently, the most current SSP coding protocol does not include a dimension for exploratory behavior (Ainsworth et al., 1978). However, the description of the patterns and their subtypes do consider how exploratory behavior differs between them. For instance, during reunion, subtype secure B3 is characterized as being able to return to play and exploration after being comforted by the attachment figure, whereas B4 has a more difficult time returning to exploration and may remain playing while on the caregiver's lap and not explore the room.

To participate in joint engagement, the child must attend to the social partner and to the environment where the object or event of shared interest resides. Besides their relation to exploration of the environment, attachment patterns also differ on how infants deploy attention to their caregivers. Disorganization of attachment disrupts infants' attention to both caregiver and environment. This begs the question as to whether and how attachment relates to joint engagement.

There is evidence that a children's ability to use locomotion to explore their surroundings increases their opportunities to share their emotions with their caregivers across a distance in reference to the new objects and events they encounter in their distant explorations (Campos et al., 2000). If due to insecure attachment, the child ventures less into the environment, the dyad will have fewer opportunities to call each other's attention to an external focus, and the latter will be limited to what the dyad can perceive while stationary.

Attending to an external focus of attention however is not enough, for instance even if the child does a great deal of exploration. If the nature of his emotional bond to the caregiver is so that he tends to ignore her, the dyads' participation in joint engagement can also be reduced. The frequency and intensity of the child's avoidance of the attachment figure is one of the behavioral dimensions coded in the SSP and which differentiates between attachment patterns.

Another dimension refers to the child's attempts to achieve contact/proximity with the caregiver. Contact can be established physically and also across a distance, for example by initiating joint engagement; calling the caregiver's attention to an object to share it or to request help with it. Children can differ on the strategies they deploy to achieve contact/proximity, including their use of joint engagement. Contact maintenance, another behavior coded in the SSP, refers to how much the infant actively remains in contact after this has been established, regardless whether him or the caregiver initiated it. If contact has been initiated by a joint attention bid, for instance, by the caregiver offering a toy to the child, the length of the shared focus will vary depending on how active is the child maintaining contact. Children with lower levels of contact/proximity seeking behavior are likely to engage in shorter episodes of joint engagement.

To consider how different attachment patterns could relate to joint engagement patterns in which security is compromised seems like a good starting point. Children classified as avoidant do not overtly pay attention to the attachment figure, even while she repeatedly attempts to interact with him. This characteristic is visible throughout the SSP and not only upon reunion. In some cases these children may even be less avoidant of the stranger than of the caregiver. A child who does not overtly pay attention to the caregiver seems less likely to initiate joint engagement or to respond to the attachment figure's bids for it. Avoidant infants are thought to be paying attention covertly to the caregiver with the purpose of avoiding her. This attentional demand is thought to tax their attention resources to the detriment to the attention they pay to objects in the environment. In theory then, high avoidance would intervene with a child's attention to external foci and with his initiation of and responsiveness to joint engagement bids.

Children classified as resistant show mixed feelings toward the attachment figure, evidenced by behavior that alternates between seeking contact/proximity and subsequently rejecting it. If the contact established with the caregiver included an external focus of attention—e.g., collaborative play with toy—the child's tendency to reject contact would result in shorter joint engagement episodes. Subtype C1 is characterized by striking passivity in their exploration of the environment; the less the infant encounters objects in the environment, the fewer opportunities the dyad will have to attend to the same external focus and the more joint engagement will depend on the caregiver's initiation.

Whichever the attachment pattern, disorganization of it will alter the child's ability to orient his attention to the current state of affairs, including his ability to attend to both caregiver and environment. Characteristic of disorganization is the assessment that the child's behavior seems rational to the observer if he assumes that the child fears the attachment figure. Fearing what his attachment system identifies as the source of protection and the target of the proximity goal, his behavioral strategy collapses. Also characteristic of disorganized behaviors are lack of rationality, unpredictability, incongruence and disorientation. A child whose attention and behavior has broken down presumably is in a psychological state less conducive to sharing attention on an external focus with his caregiver.

Individual differences have been reported in children's joint engagement skills, both within a population and among diverse ones. One possible factor for these differences is infants' early socio-emotional experiences with their caregivers (Claussen, Mundy, Mallik, and Willoughby, 2002; Mundy, Kasari, & Sigman, 1992; Raver & Leadbeater, 1995). The study of this idea can shed light into the processes involved in the reported connections between attachment and infants' cognitive and emotional outcomes (see Study 2). Since studies have also found associations between joint engagement and better emotional and cognitive skills (see Study 1), it is plausible that earlier impacts of attachment in joint engagement mediate the relationship between attachment and developmental outcomes at later ages (Claussen at al., 2002; Roggman et al., 1998).

One hypothesis is that infants' participation in joint attention is influenced by how rewarding they have experienced it to be (Claussen et al., 2002). Presumably, a caregiver that is less sensitive to the child's signals will be more likely to miss or ignore his bids, or to respond to them in a way that is less than optimal—e.g., mistimed responses, engagement shorter than what is desired by the child. The child then will associate negative emotions to his attempts at sharing attention, and decrease his motivation to pursue them. And vice versa, a child who interacts with a caregiver that is responsive to his attempts to share attention, will associate them with rewarding events, and be more motivated to engage in such interactions.

The putative impact of early caregiver-child experiences can be proposed not only for coordinated but also supported joint engagement, particularly considering the active role the caregiver must play in the latter. In it, the shared nature of the engagement with the object is primarily carried by the caregiver, and unlike in coordinated joint engagement the child's attention may remain mostly on the external focus without overtly acknowledging the caregiver's role in the shared activity. Presumably, a caregiver who is less sensitive to the child's needs and signals will be less likely to initiate joint engagement, to initiate less frequently, or in ways that are less in-tune with the child—e.g., when the child's internal state is not optimal to share attention.

Research

Studies have provided mixed results on the question of a relationship between joint engagement and attachment, both in terms of how and which specific patterns have an impact, and how global or specific is the influence on joint engagement. Some studies find significant results based on security status, while others note differences but do not reach significance. Some studies report effects in the overall frequency of joint engagement and others found narrower connections, such us effects found in children's ability to initiate joint engagement but not to respond to a social partner's bids for it.

Attachment researcher Mary Main (1983) studied the relationship between infants' attachment patterns and their play behavior. Although she did not specifically measure joint engagement, she reported that compared to children who at age 12 months were classified as insecure, those coded as secure when tested at age 21 months significantly more often responded to an experimenter's bid for interaction by playfully throwing a ball back to him while looking at the experimenter. This behavior could be regarded as responding to a social partner's bid for joint engagement.

Other studies have also reported an association between security of attachment and joint engagement. Infants coded as having a secure pattern at age 12 months significantly more frequently initiated toy exchanges with their mothers at 14 months, compared to those with insecure attachment. Mother–infant co-orientation to toys was significantly less frequent in cases of avoidant attachment patterns compared to secure (Roggman, Langlois, & Hubbs-Tait, 1987). Mother's sensitivity scores when infants were 6 months old—a behavioral measurement associated with secure attachment—has been reported to predict their children's ability to share attention with an experimenter at 9 months of age (Gaffan, Martins, Healy, & Murray, 2009).

A study that compared 2-year old typically developing infants and peers from several clinical groups—autism spectrum disorder, mental retardation, language delay, pervasive developmental disorder non-otherwise specified—found that the relationship between attachment and joint attention varied depending on which group of infants were considered (Naber et al., 2007). Authors differentiated between "basic joint attention" skills to which they attributed an onset between 6 and 12 months—e.g., pointing out objects to others, checking others' gaze direction towards objects; and "associative joint attention" which encompassed later emerging behaviors—e.g., follow pointing, looking in the eye-direction of the social partner to verify her behavior.

Considering all children in the sample, with typical and atypical development, those who had a secure attachment had a significantly higher frequency per minute of both basic and associated joint attention, than peers with insecure patterns. This relationship, however, was not found within the clinical groups. Authors hypothesized this might be related to the lower cognitive abilities in children in the clinical groups, which may impose limits to the development of joint attention and override the positive influence of security of attachment. The authors also noted that the small number of secure attachment in the clinical groups might have impacted its found lack of a significant relationship to joint attention.

Again when considering all children in the sample, those with disorganized attachment showed a significantly higher frequency of basic and associated joint attention, than peers with organized patterns. When considering only the clinical groups and only those with autistic spectrum disorder, those with secure attachment showed a significantly higher frequency of basic joint attention, but there was no significant difference for associated joint engagement. In children with autistic spectrum disorder however, after controlling for age and developmental level, security and disorganization of attachment did not contribute to the prediction of joint attention beyond the variance explained by the number of autistic symptoms.

A relationship between security of attachment and joint attention has also been reported within disorganized patterns. In one study of the attachment patterns of 15 children with autism, 40% were coded as secure and 100% as disorganized. Joint attention was measured in structured play interactions within which the social partner—mother or experimenter—used prompts. Joint attention was coded only when children engaged in it with the purpose of sharing an experience, but not when requesting the social partner for assistance with the object. The latter type of interaction was instead coded as "requesting," but still involved the child's use of gaze, pointing and showing to direct the social partners' attention to the object. Compared to peers with disorganized insecure attachment, those with disorganized secure patterns showed a significantly higher frequency of requesting behavior with both mother and experimenter. They also showed a significantly higher response to the experimenter's bids for joint attention (but not to mother). No significant difference was found based on security status for infants' frequency initiating joint attention. However, the authors note that this could be due to the very low frequency of initiating behaviors in all observed children (Capps et al., 1994).

A negative relationship between disorganization and joint attention was also reported in a study whose sample included mothers from two cultural backgrounds—Euro-American and Central American. They were tasked with teaching their infants three actions involving an object. In both cultural groups, children classified as having disorganized attachment spent less time with their mothers sharing attention than those classified as secure, but this difference was only significant for the Central American dyads. Whereas in this group, infants with insecure and insecure patterns spent similar amounts of time in joint attention, in the Euro-American group infants classified as insecure spent a relatively higher amount of time in it. It should be noted that the study defined joint attention as times when child and mother directed their attention to the teaching object, but it is not clear whether an index such as infants' gaze switch was required for its coding (Scholmerich, Lamb, Leyendecker, & Fracasso, 1997).

A relationship between disorganization of attachment and specific joint attention skills was found in a longitudinal study of infants at risk for developmental-behavioral morbidity—i.e., cocaine exposed. Joint attention was measured when infants were 12 and 18 months old using a structured protocol that included prompts to trigger joint attention. Twenty-eight out of the 56 infants had a disorganized attachment pattern. These infants, compared to those who had an organized attachment pattern showed a significantly lower frequency of actions to initiate joint attention by making eye contact, showing a toy, and pointing at 18 months of age but not at 12. They also displayed a significantly lower frequency of actions aimed at requesting from the social partner aid to obtain or reactivate an object. In contrast, no significant difference was found in the frequency infants responded to the experimenter's bids for joint attention—e.g., turning to look in the direction of his pointing—between children with disorganization and those without it. The relationship between disorganization and joint attention was found even after taking into account infants' expressive vocabulary scores, which authors used as an index of infants' mental representation skills. A trend analysis showed that at age 18 months, infants with both insecure attachment patterns had lower mean results for initiating joint attention compared to secure ones. Although not significant, infants with a secure attachment responded to a higher percentage of the experimenter bids for joint attention than those with insecure attachment patterns (Claussen et al., 2002).

A related line of research has looked into the relationship between attachment and infants' theory of mind. This inquiry makes sense given that Bowlby's conceptualization of the attachment working model's development included the child's ability to represent the caregiver's goals and to differentiate them the infant's own goals (Bowlby, 1982). As reviewed in Study 1, in some perspectives joint attention is thought to involve a beginning understanding on the part of the child of others as having mental states, although not as complex as the understanding involved in infant's theory of mind by age 4 years. For instance, unlike the understanding of false belief—used in paradigms to assess theory of mind—joint attention does not require the child to differentiate between his own and others' beliefs about a shared situation. Also as previously reviewed, evidence has shown a positive correlation between higher joint attention and successful completion of false belief tasks. One hypothesis is that infants first start learning about mental states in early social experiences in which caregivers communicate understanding of their infants' mental states. For instance, given interactions in which caregivers reflect the children's emotion, infants associate representations of their self-experience of the emotion and of their caregivers' reactions to the infants' affective display and eventually label these affective self-experiences as emotions or desires. Evidence in support of a relationship between attachment and theory of mind shows that a higher percentage infants with secure attachment compared to insecure pass false belief tests—e.g., 82 versus 46% respectively (Fonagy & Target, 1997). See Table 3.1 for a summary of the findings.

Table 3.1: Findings on the relationship between attachment and joint engagement.
(*)Age M = 25.7 months SD = 6. Measurements took place between 20 and 30 months of age.

Author	Population	Attachment Variable	Finding
Main, 1983	Typical N = 40	Secure v/s Insecure at 12 months	Significantly higher response to experimenter's bids at 21 months
Roggman et al., 1987	Typical N = 37	Secure v/s Insecure at 12 months	Significantly more frequent toy exchange with mom at 14 months
Gaffan et al., 2009	Typical N = 59	Mother Sensitivity at 6 months	Predicts sharing attention with experimenter at 9 months
Scholmerich et al., 1997	Typical N = 69	Disorganized v/s Secure at 13 months	Significantly less time in joint attention at 4,8, 12 months (only in Center-American dyads, not in European-American
Capps et al., 1994	Autism N = 15 Mental age M = 24.1 SD =9.9	Disorganized Secure v/s Disorganized Insecure	Significantly higher requesting and responding to bids. No significant difference initiating.
Claussen et al., 2002	At risk (cocaine exposed) N = 56	Disorganized v/s Organized at 15 months	Significantly lower initiations of sharing and requesting at 18 but not 12 months. No significant differences in responses to experimenter's bids for joint attention.
Naber et al., 2007	Typical & clinical groups N = 78 (*)	Secure v/s insecure	In whole sample: significantly higher frequency of joint attention. No effect in clinical groups.
		Organized v/s disorganized	In whole sample, only clinical groups, only autism: significantly higher frequency of joint attention.

Study 3 aims

This study explored the relationship between attachment patterns and joint engagement in a sample of infants with various levels of visual impairments. For this purpose, eighteen infants with visual impairments were video-recorded during 30-minute free plays with their caregiver. These videos were coded for joint engagement and percentages were calculated of the time infants and caregivers participated in it. Infants' attachment patterns were classified based on their performance in the SSP. Data analysis compared percentages in joint engagement between secure and insecure attachment patterns.

To our knowledge this is a question that has not been investigated in this population. As showed by the review of the literature, the relationship between attachment and joint engagement can differ depending on the population studied. Thus, researching this in visually impaired infants can serve to expand the understanding of these children's development and also to deepen the knowledge of the ways attachment and joint engagement relate.

Unlike previous research that focused on joint attention, which in Bakeman & Adamson's terminology (1984, 2014) is labeled coordinated joint engagement, this study looked at the relationship between attachment and joint engagement without differentiating between supported and coordinated types. In this way, this study expanded the question to the relationship between attachment patterns and infants' coordination of attention to both social partner and external focus of mutual interest, whether or not the child overtly acknowledged the caregiver's role in the shared activity. As reviewed in Study 1, after the emergence of coordinated joint engagement, passive joint engagement continues to occur and does not decrease in the percentage of time it occurs. Theoretically neither one is considered as qualitatively better, and both have been associated with positive outcomes in development. Thus, it is relevant to include supported joint engagement when researching the connections between attachment and infants' ability to share an external focus of attention.

It is also interesting given evidence that attachment selectively relates to infants' initiations of joint engagement but not responses to initiations by social partners. Initiating joint engagement requires a more active role on the part of the child than responding to a bid for it. This begs the question whether an effect of attachment pattern would still be observed when supported joint engagement is included, given that it requires less active participation from the child than coordinated joint engagement and is always initiated and sustained by the caregivers' actions.

3.2 Methods

Participants

The same 20 infants that participated in studies 1 and 2 constituted this study's sample. As reported earlier, the sample consisted of 20 infants with visual impairments without additional disabilities. Of these, 10 were females and 10 were males. Due to the low incidence of this population of infants, they were recruited either as longitudinal (N = 7) or cross-sectional subjects (N = 13), per their caregiver's preference. For infants and their caregivers' demographic information, please refer to Study 1.

Procedures

Strange Situation Paradigm

The same 27 SSP reported in study 2 are used in this study. As reported earlier, infants' ages at the time of assessment were divided into two age groups, depending on whether ages were closest to either 12 months (age 1) or 18 months (age 2). Nine infants (6 females, 3 males) were observed at age 1, average of 1 year, 18 days (SD = 1 month, 12 days). Eighteen infants (10 females, 8 males) were observed at age 2, with an average of 1 year, 7 months, 12 days (SD = 2 months, 23 days). Seven infants (6 females, 1 male) were assessed at both ages.

Home visits

Home visits were scheduled the closest possible to the time of the SSP measurement. Due to scheduling issues, two infants at age 1 were videotaped at home more than 2 weeks from the date of their SSP. For each of these children, we included one home visit before and one after their SSP. The total number of home visits reported in this study is thus 29. The age mean and SD at age 1 was calculated twice, one time with the home visit in which these two infants had a younger age than at SSP ("younger age 1"), and a second time with the home visit in which they had an older age ("older age 1"). In Table 3.2 for subjects 1 and 6 ages among parenthesis correspond to the home visit after the SSP, and ages not within parenthesis correspond to the home visit done before their SSP.

Nine children were tested at age 1. Younger age 1's mean was fractional age of 1.03 or 1 year, 12 days (SD = 0.13), and for older age 1 was 1.08 or 1 year, 28 days (SD = 0.11). Eighteen children were tested at age 2; the mean was 1.62 or 1 year, 7 months, 15 days (SD = 0.23). The same seven children were that underwent the SSP at ages 1 and 2 were observed at home at both ages.

Table 3.2: Study 3 subjects' ages at home visits.
( ) = age at home visit done after SSP

Subject Number	Age 1 N = 9 Younger M = 1.03 SD =0.13 Older M = 1.08 SD = 0.11			Age 2 N = 18 M = 1.62 SD = 0.23		
	Years	Months	Days	Years	Months	Days
1	0 (1)	10 (1)	27 (25)	1	6	25
2	0	10	29	1	5	1
3	---	---	---	2	3	8
4	1	0	12	1	5	26
5	1	2	28	1	6	9
6	0 (1)	11 (1)	9 (4)	1	6	4
7	---	---	---	1	6	7
8	1	0	1	1	6	0
9	---	---	---	1	5	9
10	1	2	26	---	---	---
11	0	11	23	1	6	3
12	---	---	---	1	9	18
13	---	---	---	2	0	5
14	---	---	---	1	7	26
15	---	---	---	1	9	28
16	---	---	---	1	6	23
17	1	0	10	---	---	---
18	---	---	---	1	6	22
19	---	---	---	1	8	16
20	---	---	---	1	4	11

Excluding the two infants whose home visits were not within 2 weeks of their SSP, the mean difference in days between home visit and SSP1 was 8.6 days (SD = 2.8). Including those infants, the following results are obtained: If we include for both children the home visits that took place before the SSP, we obtain a mean of 12.89 days (SD = 8.95); if we instead include the home visits that took place after the SSP, we have a mean of 16.44 days (SD =18.44)

At age 2, 2 infants' home visits happened at least 17 days from the SSP. Excluding these two infants, the average difference between measurements was 8.67 (SD = 5.29). If we include these two infants the average difference is 10.29 (SD = 6.77).

Data Analysis

In order to determine if there was a significant difference in the percentage of time in joint engagement between children whose attachment patterns were classified as secure versus those coded as insecure —avoidant and ambivalent grouped together—, two-tailed t-test with Welch's correction to degrees of freedom were performed. Comparisons were performed separately for toys 1 and 2 at both ages 1 and 2. All calculations were done with the R Statistical package (The R Foundation for Statistical Computing, Vienna, Austria).

3.3 Results

Relationship between joint engagement and security of attachment at age 1

Toys 1

Considering either younger age 1 and younger age 2, there was no significant difference in the percentage of joint engagement between infants who had secure versus insecure attachment patterns. The results from the two-tailed t-test with Welch's correction to degrees of freedom were for age 1 younger = $t(3.81) = 0.17$, $p = 0.876$; for age 1 older = $t(3.97) = -0.27$, $p = 0.800$ (Table 3.3).

Toys 2

As with toys 1, all comparisons were not significant. The results from the two-tailed t-test with Welch's correction to degrees of freedom were for age 1 younger = $t(4.06) = 2.06$, $p = 0.11$; for age 1 older = $t(4.69) = 1.11$ $p = 0.321$ (table 3.3).

Relationship between joint engagement and security of attachment at age 2

Toys 1

The relationship between the percentage of time infants participated in joint engagement and the security status of their attachment pattern was not significant. The result of the two-tailed t-test with Welch's correction to degrees of freedom was = $t(6.90) = 0.94$, $p = 0.38$ (Table 3.3).

Toys 2

As with toys 1, there was no significant difference in the percentage of time infants with a secure versus insecure attachment pattern spend in joint engagement. The result of the two-tailed t-test with Welch's correction to degrees of freedom was = t(5.11) = -0.32, p = 0.761 (Table 3.3).

Table 3.3: Two-tailed t-tests (Welch's correction to degrees of freedom) results for comparison of percentage of time in joint engagement at ages 1 and 2.

SSP1 Younger M = 1.03 SD =0.13	Percentage of Time in Joint Engagement. Mean (SD)		test-statistic	p-value
	Secure N = 5	Insecure N = 4		
Toys 1	31.56(9.37)	29.53(22.86)	t(3.81) = 0.17	0.876
Toys 2	42.89(9.69)	19.90(22.56)	t(4.06) = 2.06	0.11
SSP1 Older M = 1.08 SD = 0.11	Secure N = 5	Insecure N = 4	test-statistic	p-value
Toys 1	26.19(10.28)	29.53(22.86)	t(3.97) = -0.27	0.800
Toys 2	32.84(12.37)	19.90(20.56)	t(4.69) = 1.11	0.321
SSP2 M = 1.62 SD = 0.23	Secure N = 12	Insecure N = 5	test-statistic	p-value
Toys 1	42.39(22.89)	38.19(23.09)	t(6.90) = 0.94	0.38
Toys 2	37.19(18.23)	42.11(32.17)	t(5.11) = -0.32	0.761

3.4 Discussion

This study did not find a significant difference in the percentage of time in joint engagement between infants with secure and insecure attachment patterns. Previous findings regarding the relationship between security of attachment and joint engagement have been mixed, with some observing significant effects (Naber et al., 2007), others noticing differences that do not reach significance (Claussen et al., 2002), and even others reporting that the effect varies depending on cultural background (Scholmerich et al., 1997).

Of note, several of the previous studies that found a relationship between attachment and joint engagement measured joint engagement at a later age than the one at which they assessed infants' attachment patterns—ranging between 2 and 11 months later. In the Claussen et al. (2002) study, for instance, infants' attachment patterns were assessed at age 15 months. The relationship between disorganization and a significantly lower number of initiations of joint attention only occurred when infants were tested at age 18 months but not at 12 months.

In this study, for the majority of cases (N = 22; 85%) the joint engagement measurement took place a mean of 8.6 days after the SSP. In the remaining four cases the joint engagement measurement took place more than 2 weeks from the SSP. This study thus had a smaller lapse of time between measurements than previous studies that have reported relationships between attachment and joint engagement. In infancy, development can be accelerated in short periods of time and thus differences in time of testing between studies or in the subjects within a study can impact the results.

Attachment behavior is thought to be observable at age 12 months, unless there is social deprivation. Joint engagement emerges between 9 to 12 months, but it does not become consolidated until months later, at about 18 months of age or onward. Given this difference in the age of consolidation of both developmental behaviors, it is possible that the time of testing of joint engagement has an impact on a studies' ability to find a significant relationship with attachment. One possibility is that the effects of attachment on joint engagement are not clearly observable until children have commenced to participate in joint engagement more readily and routinely. And if so, future studies with visually impaired infants need to consider the question of what the normative time for the consolidation of joint engagement in this population might be, a matter that is a topic of research and not yet established.

The SSP results from this study's sample showed that 3 out of 17 tested infants had disorganized attachment patterns. This frequency was not large enough to test whether there was a significant difference in the percentage of time in joint engagement between infants with organized and disorganized attachment patterns. Previous studies had found significant differences between organized versus disorganized patterns as well as between disorganized versus secure. This study could not contribute new results to this line of findings. Based on the frequency of disorganized attachment found in this research, future studies that aim to pursue this inquiry in infants with visual impairments should plan on larger sample sizes than the one used in this study.

The lack of a relationship found in this study does not preclude further research on the question of the relationship between joint engagement and attachment patterns in infants with visual impairments. Although not all studies seem to clearly report the criteria by which they coded joint attention, several of them requested infants' gaze switch between the social partner and the object of shared interest. This corresponds to coordinated joint engagement, which was not coded separately from supported joint engagement in this study. Furthermore, preliminary analysis of this study's videos seems to indicate that dyads spent a larger proportion of time within supported rather than coordinated joint engagement. It is possible that if there was an effect of attachment in infants' percentage of time in coordinated joint engagement it could have been washed out by a lack of effect with percentage of time in supported joint engagement.

In some previous studies, the coding was further specified to discrete attention-sharing skills, with significant findings reported for some and not others. For instance, Claussen et al. (2002) reported an effect in initiating joint attention but not in responding to bids for it. This study however did not code for such behavioral dimensions.

Future analysis of this study's data will continue to explore the relationship of joint engagement and attachment by reviewing the already-identified joint engagement episodes and coding separately those that are supported and those that are coordinated. This will allow for analysis between the sample's attachment patterns and each type of joint engagement separately.

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Appendixes

Appendix 1

Joint Engagement Coding Protocol

This coding protocol is adapted from: Adamson, L. B., Bakeman, R., Russell, C. L, & Deckner, D. F. (1998; rev 10/2000). Coding Symbol-Infused Engagement States. Technical Report 9. Developmental laboratory. Department of Psychology. Georgia State University.

This scheme segments the child's activity into distinct and mutually exclusive periods. These periods characterize different ways the child might be engaged with objects and/or people. The coder's task is to determine the sustained focus of the child's interest in people and objects and then to code the child's engagement state.

Class: Engagement State

Code: Joint Engagement

Joint engagement occurs when the child actively engages with the same object or event that the partner is attending to. The term joint is key to these items. It refers to a shared topic. Thus, for a child to be considered in joint engagement, he or she must be attending to the same object or event as the caregiver. Joint engagement may also occur when the topic is in the here and now or when it is partially or fully present through symbols. In Adamson, Bakeman, Russell, & Deckner's protocol (2000) joint engagement needed to last at least 3 seconds. In this protocol however there is no minimum length required to code a state as joint engagement.

A child cannot be in a state of joint engagement if the partner is not involved. It may be helpful to think of joint engagement as triadic since it involves the child, a shared object, and a partner. The partner's participation is usually evidenced by active manipulation of the object although it may also be conveyed by communicative acts that are related to the shared event. There may be times when a child is seeking joint engagement but the partner is not engaged with a shared object. There are also times when a caregiver is merely narrating the child's actions ("background chatter") and not actively engaged in a shared activity. In such instances, the child is not in a state of joint engagement.

The child must indeed be actively involved with a shared topic that focuses on objects and events over and above the social interaction per se. Joint engagement is not credited when the caregiver and child engage in dyadic play (e.g., a game of peek-a-boo) that does not include a shared focus other than their mutual activity. When there appears to be a topic beyond the social interaction, be sure that there are clear indications that the child is engaged with the shared topic.

Partners may act in ways that make it appear that the child is sharing an object or an event even when the child's attention is elsewhere. They may also attract attention so that the child watches their display or demonstration without fully engaging with it. Adamson et al., protocol (2000) considered that in such cases the child is considered in a state of non-joint engagement. In this protocol however, if the caregiver intentionally calls the child's attention to the object and the child switches his attention from its previous focus to the object, this is coded as joint engagement. In other words, for this scenario to be coded as joint engagement, the child does not need to manipulate the object. But if the child on his own switches his attention to the caregiver's engagement with the object, without the caregiver having had called the child's attention to it, this should be coded as non-joint engagement.

Also be careful not to assume that a child is jointly engaged with the topic of a partner's speech and gestures if the only indication of their involvement is that they seem to be listening to the partner. It is important that there be clear indications that the child is engaged with the same specific topic on which the partner is focused.

Joint engagement does not require the caregiver's engagement with the object to change the action the child is performing on the object. Rather it has to influence the child's experience with the object. Influencing the child's experience with the object can consist on:

a. The caregiver drawing the child's attention to the object, for example: the child is mouthing a rattle, mom shakes a bowl with cubes in front of child, the child reaches for the bowl, grabs it and brings it to her mouth.
b. The caregiver joining the child in a shared activity with the object, after the child was already engaged with the object. For example, the child is moving a toy car back and forth. Mom comes in and starts hitting the car with a toy truck. This changes the experience the child is having with the object and child and mom are participating in a shared activity with it. Yet the child does not change his action on the object.
c. The caregiver influencing the action the child is performing on the object. For example: the child is mouthing a ring, the mother demonstrates how to place the ring in a stack, the child stops mouthing the ring and puts it on the stack.

An episode of joint engagement can involve one or more of these scenarios.

To start a new joint engagement event the coder needs more evidence than to continue coding one that had already started. Joint engagement can consist of parent and child actively participating in a turn taking sequence. For instance, the shared activity can involve that caregiver and child take turns manipulating the object while the other observes. In such setting child and caregiver may at times be engaged without touching the object, for instance when one observes the other's action. This may seem as a sequence of non-joint engagement events (e.g., child focuses on object, child focuses on caregiver, and so on) but instead is an episode of joint engagement with turns. Be mindful that some children and some activities may require participants to take turns longer than 3 seconds If the event is not part of the shared activity and it lasts at least 3 seconds code as a separate non-joint engagement event.

Joint engagement with twin sibling: twin's intentionality to engage in joint engagement needs stronger evidence than from caregiver. For instance, sometimes the caregiver intentionally attempts to call the child's attention to the object by placing it in the field of view of the child, not looking or talking to the child at the moment. This same behavior alone from a twin sibling would not be enough evidence.

Always remember that we are interested in the infant's joint engagement. When choosing when to begin and end coding for infant's joint engagement, decisions should be based on the infant's behavior. If the infant watches mom bang on a drum and then child bangs on drum, and then mom bangs again but child walked away right after his turn, stop coding when the child abandons the activity, not when mom finishes her turn. However, there may be rare instances when it is the child who tries to elicit engagement, but the adult does not reciprocate. This should not be coded as an engagement state.

Joint engagement examples:

- Caregiver and child take turns rolling a ball.
- The parent and child face a puzzle on the floor, and take turns putting pieces together.
- The parent demonstrates the way a toy works and then the child immediately imitates her action on the object.
- The child places a jar in mom's open hand, waits for her hand to open the jar.
- The parent places a doll in child's hands, the child yells and pushes the doll away.
- The child, seated on mom's lap, actively looks at the book while it is reads to him.
- The mother dangles beads in front of the child while speaking with a heightened affect, seemingly in attempt to elicit a response from the child. The child responds by laughing.
- The child is labeling objects of shared involvement, and/or mimicking the words of the caregiver with regard to an object.
- The child bangs his hand onto the same toy that the mother is manipulating and then orients his face to the caregiver, repeatedly.
- The child holds up a toy plane, shows it to the mother, and then moves it through the air while the mother acknowledges their shared focus by laughing and saying "zoom."

Joint engagement non-examples:

- The child sits in the mom's lap while the mom reads a book to him, but the child is playing with another toy.
- The child looks at caregiver looking at a book. The caregiver is only focused on the book.

Rules for Beginning Code Joint Engagement

Start code when child's experience with the object seems clearly influenced by the caregiver's engagement with the object.

If the caregiver actively calls child's attention to the object (e.g., shaking it in front of him, verbally calling attention to it, placing it near the child so that she can perceive it), and then the child switches his attention to it, code as joint engagement. Begin coding when the child starts to switch her attention toward the object. But, if the caregiver makes toy available to child as part of her "housekeeping" (e.g., taking toys out of bag but without trying to engage child with them), code as non-joint engagement.

If the child is already attending or acting on the object, and the caregiver influences the child's engagement with it, start coding joint engagement when the child's engagement with the object starts to change. For instance:

- The child is only observing the object but not manipulating it, the caregiver demonstrates to the child how to manipulate the object, start coding when caregiver starts demonstration.
- The child is manipulating the object, the caregiver demonstrates to the child a different way to use the object, start coding joint engagement when caregiver starts demonstration.

If the joint attention episode is started by the infant, start coding at the beginning of the first index shown by the child, for instance: start when child begins giving toy to the caregiver. But if the child's attention to the object before calling caregiver's attention to it lasts less than 3 seconds, include it in the joint engagement event. In such case start coding from the time the child starts to attend to the object.

If the caregiver was playing with the toy without intending to call the child's attention and the child on his own starts observing her actions with the object: if the caregiver notices and the acts in a way that influences the child's experience of the piano (e.g., teaches the child how to play the piano); start coding joint engagement since the caregiver changes her action.

Rules for Ending Code Joint Engagement

Stop coding joint engagement when the child starts to attend only to object and mom stops scaffolding child's engagement with it. But, if the caregiver continues to scaffold, and thus influence the child's engagement with the object, continue coding as joint engagement.

If the child attempts to stop the caregiver from engaging him with an object (e.g., pushing it away, vocally protesting), stop coding joint engagement when child ends the action.

If the joint engagement episode involves turns, for instance caregiver and child take turns manipulating the object while the other observes, stop coding at the first turn the child starts to only focus on the object, even if the caregiver continues attending to the child's action with the object.

If the caregiver intentionally called the child's attention to the object; the infant switched his attention from its previous focus to the object; and the caregiver is no longer influencing the child's experience with the object (e.g., caregiver is only observing, narrating what the child is doing, holding the object as a table could do), stop coding joint engagement once the caregiver is no longer influencing the child's experience with the object. For example: the mother has a toy piano on her lap, the child is starting to crawl away, the caregiver activates the piano trying to engage the child with it, then the infant turns in the direction of the toy piano. Stop coding once child's attention is on the piano and the caregiver is no longer acting on it. In this scenario the caregiver influences the child's experience with the object by calling his attention to it but not afterwards. But, if the mother continues playing the piano as the child crawls toward it, continue coding until the caregiver is no longer playing with the piano. In this case, joint engagement continues because the caregiver remains influencing the child's experience with the object.

Code: Non-Joint Engagement

This code refers to states (lasting at least 3 seconds) in which the child shows any of the following:

No apparent engagement with a specific person, object, or symbols. The child may be unoccupied, may be scanning the environment as though searching for something with which to be engaged, or may be flitting between foci without committing to any. Include segments in which the child is involved with food as food and not as an object (e.g., munching on a cookie while looking around). Also include segments when the child is crying or having a tantrum and is not focused on any particular object or person.

Attention to the caregiver's activity. The child's observation of the caregiver's activity can occur through any sensory channel, not only vision. The caregiver did not call the child's attention to her activity.

Engagement in object play, exploring or playing with object(s) by himself. The partner may attempt to engage the child during object play, but the child ignores her.

Enngagement with another person only. For examples: the caregiver tickles the child and the child appears to be reacting to the partner's activity.

The child's seems to only focus on her own body movement, whether whole body or parts of it.

Non-joint engagement examples:

- The caregiver is singing, child listens to her.
- The child watches parent put beads into a cup. The caregiver did not call the child's attention to her action.
- The child feels with her hands how the caregiver is pressing on toy. The caregiver did not call the child's attention to her action.
- The child is playing with beads while the parent narrates his actions.
- The child engages in solitary play with a slinky and says "slinky".
- Child shakes head and this is not a communicational gesture to the caregiver.
- Child lifts a hand and places it in front of his eyes and starts waiving it.

Non-joint engagement non-examples:

- The child is playing with beads, and following the parent's directions what to do with them.
- The child attends to the parent who is reading a book, and scratches on the page the parent had just scratched.

Appendix 2

Demographic survey

1. What is your relationship to the child? Are you his/her (choose one)

1. Biological Mother	5. Biological Father	9. Other (please explain)
2. Adoptive Mother	6. Adoptive Father	______________________________
3. Foster Mother	7. Foster Father	
4. Stepmother	8. Stepfather	

2. In which month and year were you born? Month: _______ Year: _________

3. What is the highest level of education you have completed?
1. No formal schooling
2. Primary school
3. Middle school
4. Some high school
5. High School Diploma/GED
6. More than high school (e.g., technical school, vocational school, certification, some college, associate degrees)
7. Bachelor's degree
8. Master's Degree
9. Doctorate (JD, MD, PhD)

4. What is your ethnic or racial background?
1. African American
2. Asian
3. Hispanic
4. Native American
5. White
6. Other, please explain: ____
7. More than one race, please explain: ____

5. What is your child's ethnic or racial background?
1. African American
2. Asian
3. Hispanic
4. Native American
5. White
6. Other, please explain: ____
7. More than one race, please explain: ____

6. What language(s) is/are spoken at your home? Please explain:
____
____

7. Please estimate your total family income for the 12 months prior to the date you entered our study. Think about your combined family income from all sources, including jobs and self-employment for you and other adults who contribute to household expenses, as well as money from other sources like welfare, disability benefits, and child support. What is your best guess for this amount?
1. Less than or equal to $5,000
2. $5,000 – 10,000
3. $10,001 – 15,000
4. $15,001 – 20,000
5. $20,001 – 25,000
6. $25,001 – 30,000
7. $30,001 – 35,000
8. $35,001 – 40,000
9. $40,001 – 45,000
10. $45,001 – 50,000
11. $50,001 – 55,000
12. $55,001 – 60,000
13. $60,001 – 65,000
14. $65,001 – 70,000
15. $70,001 – 75,000
16. $75,001 – 80,000
17. $80,001 – 85,000
18. $85,001 – 90,000
19. $90,001 – 95,000
20. More than $95,001

8. At the time that you entered our study, how many people were living in your home? Please provide a number for:
1. Adult relatives (including yourself): ________
2. Adult non-relatives: ________
3. Siblings of your child –who is participating in our study-: ________
4. Other minor relatives (excluding your children): ________
5. Minor non-relatives: ________

9. At the time you entered our study were you receiving any type of assistance from government programs? Examples of such programs include: WIC, Food Stamps, Child care subsidy/voucher, Welfare, Public housing/Section 8/housing vouchers, Social Security Income or SSI, Unemployment benefits, Public Health Insurance -such as Medi-cal, Medicaid, Healthy Families-.
1. Yes
2. No

Appendix 3

Comparison of secure attachment patterns' subtypes

B1	B2	B3	B4
Smiles, shows interest in caregiver, but does not especially seeks proximity. Interest in maintaining contact with caregiver across distance upon reunion.	Greets, approaches caregiver, seems to want contact, but less than B3. Does not seek as much across-distance interaction as B1.	Responds to return although may cry rather than smile. Very clear desire to be in proximity with mother, actively approaches her.	Clear desire for proximity not only during separation. Entirely preoccupied with caregiver even with her present. Little exploration. Upon reunion, shows greeting mixed with contact-resisting behavior.
Does not specially seek contact with mother. If picked up, does not cling or protest release.	Tends to accept contact if picked up, but does not cling or resist release as strongly as B3.	Actively seeks physical contact with mother. If contact established, tends to cling, and strongly resists release.	Actively seeks to maintain physical contact by clinging and resisting release.
Little or no distress during separation.	Little or no distress during separation.	May or may not be distressed. More active in seeking contact and resisting release than B1 and B2.	Clearly disturbed in separation episodes.

Appendix 4

Comparison of avoidant attachment patterns' subtypes

A1	A2
No greeting upon reunion, or just look/smile.	Mixed response upon reunion; greeting and avoidance.
Does not approach, the approach is abortive, or only after much coaxing. Avoids caregiver throughout reunion.	Upon reunion, tendency to approach intermingled with marked avoidance
If picked up does not cling, does not resist being put down, may squirm to be put down.	Mixed feeling when picked up (turn face away, cling only momentarily, squirms to be put down). If put down, may resist momentarily.

Appendix 5

Comparison of resistant attachment patterns' subtypes

C1	C2
Tends to respond positively upon reunion (reaching, mote active approach).	Unable to actively achieve proximity/interaction even pre separation. Abortive approach attempts. More likely to signal than to actively approach.
Highly ambivalent: seeks contact but also shows angry contact-resisting behavior.	No active seeking of contact, if established fails to maintain it.
Distressed during separation.	May or may not be highly distressed.
May explore pre-separation but does so less enthusiastically than A or B. Exploration shows anxiety and/or anger.	Passivity, striking inability to use mother as a secure base.