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# Infant Behavior and Development



## Different patterns of contingent stimulation differentially affect attention span in prelinguistic infants

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### ABSTRACT

The ability to sustain attention influences different domains including cognitive, motor, and communicative behavior. Previous research has demonstrated how an infant's parent can influence sustained attention. The purpose of our study was to expose infants systematically to both sensitive and redirective patterns of behavior to examine how unfamiliar individuals could influence attention. Results revealed infants changed their patterns of looking with the unfamiliar individuals. Infants had longer durations of sustained attention when interacting with a sensitive unfamiliar individual who followed into their attentional focus as opposed to an intrusive person who led their attentional focus. This study demonstrates that infants discriminate patterns of contingency to persons seen for only a short period of time broadening the range of potential mentors for learning.

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To analyze an individual's social development involves uncovering how experience with different individuals affords different learning opportunities (West, King, & White, 2003). Although attention is most often studied with respect to perceptual and cognitive development, it also plays a social role, as it is instructive in learning how to use novel social information to reach functional decisions such as approach or avoid, move or stay, or give or take.

In the present study, we carried out a detailed examination of infant attention at 9 months of age, with special focus on the frequency and duration of sequences of infant attention with unfamiliar persons. We used unfamiliar adults to see if infants would respond to conventional patterns of social responsiveness when coming from a new source. If they did, it would strengthen the argument that infants are attending to the presence of a contingency instead of, or in addition to, a close social relationship between familiar ("attached") parents and infants. We exploited two attributes of parental behavior: sensitive and redirective responsiveness. Parental sensitivity is defined as contingent and appropriate responding to a child's behavior or focus of attention (Ainsworth, 1973; Baumwell, Tamis-LeMonda, & Bornstein, 1997; Bornstein, 1989). Parental redirectiveness or intrusiveness, on the other hand, occurs when the parent responds contingently but inappropriately to a child's behavior or attentional focus, interrupting or redirecting the flow of the child's attention (Ainsworth, Blehar, Waters, & Wall, 1978; Baumwell et al., 1997). For example, if a child picks up a toy duck, an individual responding sensitively may say, "Yes, that's a yellow duck," while an individual responding intrusively or redirectively may refer to another object altogether, redirecting the child's attention and saying, "Look at this toy plane." Therefore, in interactions with sensitive individuals, the child maintains the key role in guiding the topic of the interaction, while in interactions with redirective individuals, the social partner mainly controls the interaction and attempts to direct the child's behavior and attentional focus.

Much research has investigated the relationship between characteristic maternal responses and attentional, social, cognitive, communicative, and emotional outcomes in children. Researchers have found that while maternal sensitivity is typically

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associated with positive outcomes, maternal redirectiveness is either negatively associated with or shows no relation to developmental outcomes in children (De Wolff & van IJzendoorn, 1997; Landry, Smith, Miller-Loncar, & Swank, 1997; Stams, Juffer, & van IJzendoorn, 2002). Maternal sensitivity is related to security of attachment (De Wolff & van IJzendoorn, 1997) and positive social development (Landry et al., 1997; Stams et al., 2002) in infants, and it is thought that sensitive caregivers foster children's social development by responding appropriately to their children's actions, thus instilling a sense of social effectiveness and importance in the child (Landry et al., 1997; Lewis & Goldberg, 1969). In contrast, maternal redirectiveness is often associated with insecure attachment (Ainsworth et al., 1978) and negative social development or behavioral problems (Pettit, Harrist, Bates, & Dodge, 1991). Maternal sensitivity is also positively related to cognitive and communicative development (Baumwell et al., 1997; Landry et al., 1997; Stams et al., 2002; Tamis-LeMonda, Bornstein, & Baumwell, 2001), while maternal redirectiveness is correlated with poor communicative development as well as poor academic performance in the early school years (Della Corte, Benedict, & Klein, 1983; Snow, 1989; Tomasello & Farrar, 1986). Maternal sensitivity and attachment security predict positive social and cognitive development even in adopted children, indicating the importance of maternal responsiveness in infants' socio-cognitive development regardless of genetic relatedness (Stams et al., 2002).

Experimental manipulations of social partner responsiveness have strengthened the argument that adult responsiveness influences different outcomes in infants. For example, Belsky, Goode, and Most (1980) not only used observational studies to document that maternal sensitivity positively correlates with more focused exploration between 9- and 18-month-old infants, but also demonstrated that experimentally increasing maternal sensitivity leads to more focused and competent object exploration by 12-month-old infants. van den Boom (1994) demonstrated similar results by exposing caregivers of 6-month-old infants to a 3-month-long intervention directed at increasing maternal sensitivity. When assessed at 9 months, the infants whose parents were assigned to the intervention condition (improving caregiver sensitivity) had more focused, more sophisticated object exploration than did the infants whose parents did not receive the intervention treatment (van den Boom, 1994). Riksen-Walraven (1978) also showed that increasing parent sensitivity, but not overall amount of stimulation, resulted in more focused exploration as well as a greater ability in infants to detect contingencies in 9-month-old infants.

While the effects of maternal responsiveness on infant attention are well-documented, the influence of other social partners on infant attention have been largely understudied. Parrinello and Ruff (1988) investigated possible influences of unfamiliar adults on 10-month-old infants. After measuring a baseline level of sustained attention, the researchers assigned infants to a low, medium, high, or no intervention group. The intervention consisted of a short exposure to an unfamiliar adult in which the frequency of object manipulations and energy displayed while manipulating objects varied by group. For example, infants in the high intervention group were exposed to the most object manipulations and the highest amount of enthusiasm and vigor. The researchers found that infants in the medium intervention group increased their duration of focused attention during the intervention significantly more than infants in the no intervention group (Parrinello & Ruff, 1988). This study demonstrates that even brief periods of exposure to novel social partners can influence infant attention, although it is unclear what aspect of the adult behavior was causing infants to increase their focused attention.

Although manipulations of maternal behavior showed attentional effects, mothers and infants possess such a long history with one another that they may also be using cues other than those targeted by the experimenter. What if we remove that familiarity? The current study aimed to explore the potential influence of unfamiliar adults on infant attention by systematically exposing 9-month-old infants to two unfamiliar adults who behaved either sensitively or redirectively. First, infants interacted with their parent in a naturalistic free-play setting and then infants were sequentially exposed to both sensitive and redirective unfamiliar adults. We predicted that infants would shift their attention more frequently and therefore have shorter durations of sustained attention, when interacting with the redirective individual than when interacting with the sensitive individual, supporting a causal role of temporal contingency on focused attention by infants.

## 1. Methods

### 1.1. Participants

Twenty-two 9-month-old infants (9 females, 13 males; mean age: 9.2 months, range: 8.5–10.0 months) participated in this study with their primary caregiver. Participants were recruited from a database comprising published birth records and were primarily Caucasian of middle socioeconomic status. The data from three infants were not included in the analysis; two infants became upset during the procedure and one infant's parent did not speak English during the procedure. Infants were given a small gift as compensation for their participation.

### 1.2. Apparatus/materials

Parents and infants were video recorded playing with a standard set of toys in a 3.9 m × 4.6 m playroom. The toys available to play with were a soft book, a dump truck, toy blocks, a school bus, two different pop-up toys, a toy duck, and a spinning toy with a mirror. Three wall-mounted Sony TR-100 camcorders recorded behavioral interactions from separate angles. The video feed was sent to a JVC video-cassette recorder (model SR-V530U) through a digital video mixer (Videonics MX-1 NTSC) and was displayed on a Panasonic color video monitor (CT-1384Y). Infant, parent, and unfamiliar adult vocalizations were also recorded. Infants wore a pair of overalls with a small wireless microphone (Telex Communications FMR-150) enclosed in a sewn-in seam and the transmitter in an external back pocket that allowed for the recording of infant vocalizations. Adult

vocalizations were recorded using a Sennheiser condenser microphone. The audio feeds were routed through a Eurorack MXB 1002 audio mixer to the video-cassette recorder.

### 1.3. Procedure

Infants were observed for three 7-min periods, for a total of 21 min. During the first period, infants engaged in free play with their primary caregiver. During the second and third 7-min periods, infants were exposed to an unfamiliar female adult (one of the two experimenters EMA or JLM). The experimenters were instructed to interact with the infant in either a sensitive or redirective manner. During the sensitive condition, the experimenter commented on the infant's focus of visual attention (e.g., if the infant looked at a toy duck, the experimenter would say, "Yes, that's a yellow duck") or physically manipulated the toy on which the infant was focused. If the infant changed his or her attentional focus, the experimenter changed her focus of attention as well. During the redirective condition, the experimenter attempted to redirect the infant's attention by introducing new toys to the infant through physical manipulations and vocalizations (e.g., if the infant looked at the toy duck, the experimenter would begin playing with a pop-up toy, saying, "Look at this pop-up toy"). The experimenter was instructed to allow the infant to play with or visually focus on a toy for approximately 10–15 s before attempting to redirect their attention to a new toy. If the infant shifted their attention to the toy the experimenter was going to redirect with, the attempt to redirect was counted against the overall level of redirectiveness (see coding below). Thus, redirective behavior was successful only when the infant was not attending to a particular object and the experimenter shifted the infant's visual focus to a new object. Order of exposure to the redirective and sensitive individuals was counterbalanced across subjects, as was the identity of the redirective and sensitive individuals (both experimenters were sensitive for half of the subjects and redirective for half of the subjects).

During the periods of exposure to the unfamiliar adults (the second and third periods), the parent was instructed to sit in a chair in the same room as the infant and to fill out a demographics questionnaire and read magazines. They were instructed not to initiate engagement with the infant during these times. All parents followed instructions and only talked to their infant if they became upset or fussy.

### 1.4. Behavioral coding

To reduce the influence that the novelty of the playroom and the novelty of the unfamiliar individuals may have had on infant behavior, the first minute for each interaction period was not coded. Therefore, although the interaction periods lasted for 7 min, only the last 6 min of each interaction were coded.

#### 1.4.1. Adult behaviors

The frequency of sensitive and redirective behaviors was coded for the infant's parent, the redirective individual, and the sensitive individual. Adult vocalizations, physical manipulations of objects, and combinations of the two behaviors were classified as either sensitive or redirective, depending on the infant's focus of attention at the time the behavior occurred. A physical manipulation was coded when the adult touched an object. Additional physical manipulations were coded when the adult had their hands off the object for 0.5 s or more and subsequently touched the object again. Each vocalization was coded when the adult spoke. Additional vocalizations were coded when there was a 0.5 s break between speech streams. Vocalizations were classified as either sensitive or redirective depending on the infant's focus of attention. Sensitive vocalizations were coded when the adult vocalized about the object the infant was attending to or about the state of the infant (e.g. "Are you having fun playing with that toy?") Redirective vocalizations were coded when the adult vocalized about object the infant was not attending to in an interaction. Other vocalizations consisted of off-topic vocalizations (e.g. "I need coffee today"). A combination of both behaviors was coded when the onset of both vocalizing and physical manipulation of objects occurred within 0.5 s of one another.

#### 1.4.2. Infant behaviors

Duration and frequency for each shift in visual attention were coded for each infant during the sensitive and redirective unfamiliar play sessions. Focus of attention was defined as looking at the unfamiliar social partner (*look interactor*), looking at a toy the adult was playing with (*look engaged toy*), shifting attention away to a toy the adult was not playing with (*look disengaged toy*), looking at the parent (*look parent*) and looking around the room without a clear focus (*look disengaged other*). Look disengaged toy was coded when the infant focused on the toy without the aid of a social partner. Look engaged toy was coded when the infant focused on the toy the social partner was manipulating. For example, the infant could focus on a toy the social partner was not manipulating, then look up at the social partner, and finally look down at the same toy they had been focusing on. If the social partner looked at the toy when the infant was looking at the adult, then the third behavior would be coded as look engaged toy because the infant shifted their attention to the toy their partner was manipulating and/or focused on.

One coder categorized all infant looks and parent behavior while another coder categorized both the redirective and sensitive individuals' behavior. To assess reliability, 25% of the participants (all behaviors including looking and adult behaviors) were re-coded by an additional observer. The reliability coder was blind to both the purpose and hypotheses of the study. The average intercoder reliability for each group was 87% (range 79–94).

## 1.5. Statistical methods

Adult and infant behavior was analyzed using paired *t*-tests. When data were not normal, a square root or log transformation (adult behavior: square root; infant behavior: log) was used and normality verified using Kolmogorov–Smirnov tests.

### 1.5.1. Adult behavior

The frequency of behavior was compared across the sensitive and redirective individuals. We compared the frequency of adult vocalizations, manipulation of objects, and combinations of the two behaviors between the two individuals to ensure the script was properly followed. To test whether the sensitive and redirective individuals responded within a normal caregiver range, we compared the behavior of the top 25% sensitive and redirective parents in our study. The top 25% sensitive and redirective parents were calculated by dividing the total number of sensitive (or redirective behavior) by the total number of behaviors recorded.

### 1.5.2. Infant behavior

The frequency and duration of infant attention shifts were compared across the sensitive and redirective individuals. In addition, visual attention measures were combined for average duration and frequency of shifts as either engaged or disengaged sequences. Engaged sequences were defined as infant looks towards each social partner (*look interactor* or *look parent*) and/or the toy she was holding (*look engaged toy*). Disengaged sequences were defined as infant looks at other toys in the room (*look disengaged toy*) and/or just away from the social partner (*look disengaged other*). The total number of shifts and total amount of time were recorded for each engaged and disengaged sequence. For example, during an engaged sequence, an infant may shift between looking at the toy the adult was playing with as well as looking at the adult. We calculated a mean duration and mean number of visual shifts for engaged and disengaged sequences during each 6-min period for each infant.

Significance levels were set using Bonferroni corrections for each behavioral category (frequency of attentional shifts:  $\alpha = 0.0125$ ; duration of attentional shifts:  $\alpha = 0.0125$ ; adult behavior:  $\alpha = 0.0125$ ; duration and frequency in sequences:  $\alpha = 0.025$ ).

## 2. Results

### 2.1. Adult responses

A comparison of the redirective and sensitive unfamiliar persons reveals both individuals followed the scripts provided during the experiment (Fig. 1). The sensitive individuals responded significantly more frequently with sensitive behaviors than did the redirective individuals ( $t(18) = 24.05$ ,  $p < 0.001$ ), specifically with sensitive combinations of vocalizations and object manipulations ( $t(18) = 74.13$ ,  $p < 0.001$ ). The redirective individuals not only responded with significantly more redirective behaviors ( $t(18) = 83.29$ ,  $p < 0.001$ ) but also responded significantly more frequently overall ( $t(18) = 10.28$ ,  $p < 0.001$ ),

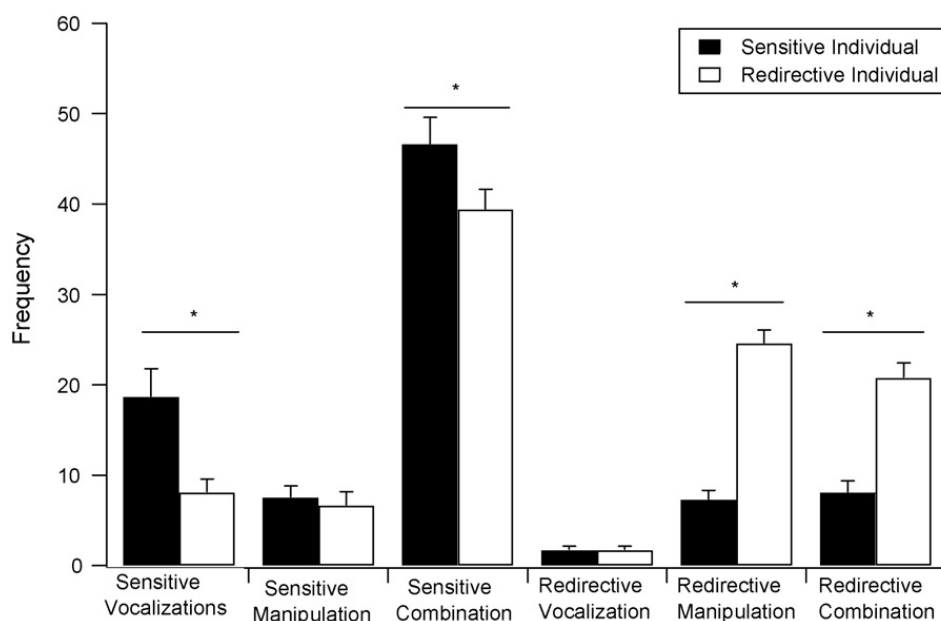
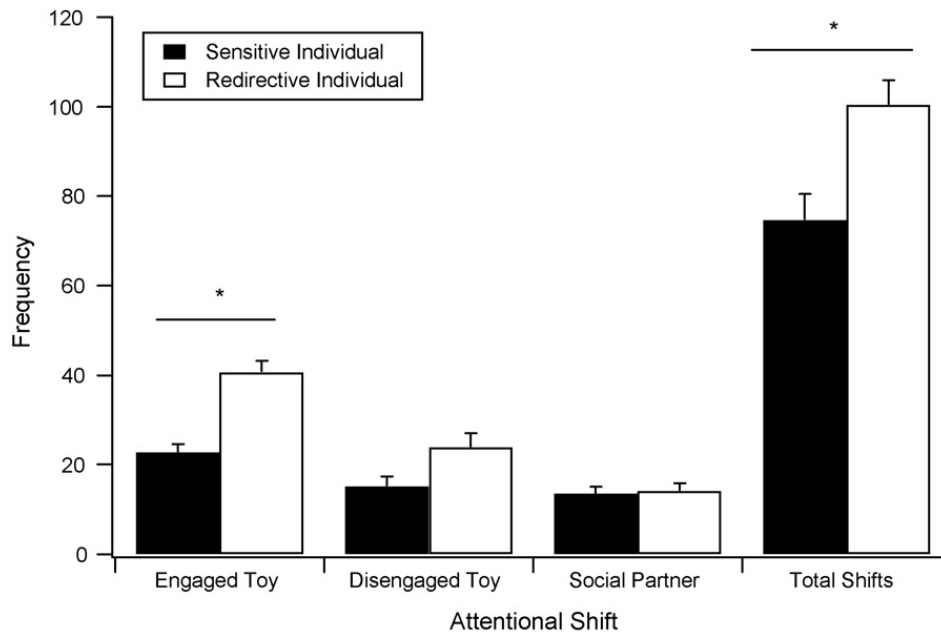


Fig. 1. Frequency of sensitive and redirective individuals behavior (mean + S.E.M.).



**Fig. 2.** Frequency of infant attentional shifts with the sensitive and redirective individuals (mean + S.E.M.).

in particular with redirective object manipulations ( $t(18) = 108.37, p < 0.001$ ) and redirective combinations of vocalizations and manipulations ( $t(18) = 44.91, p < 0.001$ ).

To test whether the sensitive and redirective individuals responded within a normal caregiver range, we compared the behavior of the top 25% sensitive and redirective parents in our study (based on the first 7-min play session with their infant) to the behavior of the two unfamiliar individuals. When comparing the sensitive unfamiliar individual with the top 25% sensitive parents, there was no difference in proportion of sensitive behavior (proportion of sensitive: parent = 0.84, sensitive unfamiliar individual = 0.80;  $t(18) = -1.678, p = 0.111$ ). Likewise, when comparing the redirective individual to the top 25% redirective parents, there were also no differences in proportion of redirective behaviors (proportion of redirective: parent = 0.43, redirective unfamiliar individual = 0.44;  $t(18) = 0.964, p = 0.348$ ).

## 2.2. Infant attention

### 2.2.1. Frequency of infant attention shifts

Overall, infants shifted attention significantly more frequently when interacting with the redirective individual than when interacting with the sensitive individual ( $t(18) = 3.92, p < 0.001$ ; Fig. 2). Infants also shifted attention to toys with which the unfamiliar person was engaged (look engaged toy) significantly more frequently when interacting with the redirective individual than with the sensitive individual ( $t(18) = 7.74, p < 0.001$ ). There was a trend for infants to shift their attentional focus more frequently to toys the unfamiliar individual was not interacting with during the redirective versus the sensitive individual ( $t(18) = 2.25, p < 0.025$ ). There were no differences in frequency of attentional shifts to the redirective versus sensitive individual.

### 2.2.2. Durations of infant attention shifts

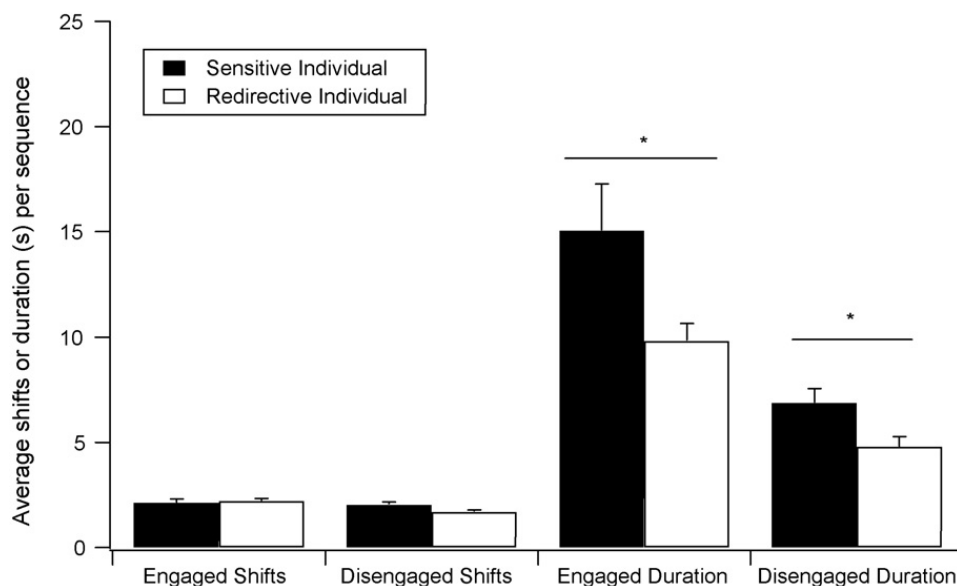
There were no differences in total duration for any of the attentional shifts for the sensitive versus redirective individuals (duration engaged toy:  $t(18) = 0.26, NS$ ; duration disengaged toy:  $t(18) = 0.64, NS$ ; duration interactor:  $t(18) = 0.26, NS$ ; total duration engaged:  $t(18) = 0.07, NS$ ).

### 2.2.3. Engaged and disengaged sequences

Infants had, on average, more attentional shifts during disengaged sequences with the sensitive compared to the redirective individual, however there were no differences in frequency of attentional shifts during engaged sequences between the two individuals (disengaged:  $t(18) = 2.508, p < 0.022$ ; engaged:  $t(18) = -0.737, NS$ ; Fig. 3). Infants, on average, had longer durations of engaged and disengaged sequences with the sensitive than the redirective individual (engaged:  $t(18) = 2.638, p = 0.017$ ; disengaged:  $t(18) = 3.937, p < 0.001$ ).

## 3. Discussion

This study examined the influence of sensitive and redirective responding by unfamiliar persons on infant visual attention. We found that infants had, on average, longer durations of both engaged and disengaged sequences with the sensitive than



**Fig. 3.** Average duration and frequency of attentional shifts in engaged and disengaged sequences with the sensitive and redirective individuals (mean seconds + S.E.M.).

the redirective individual. This finding indicates that in the sensitive condition, the type of social stimulation extended beyond the dyadic interaction into disengaged sequences as well. However, there were no differences in the total amount of time the infants spent engaged with the redirective and sensitive individuals. Infants shifted their attentional focus more frequently when interacting with the redirective than with the sensitive individual. In addition, the average number of shifts per disengaged, but not engaged sequences, was higher during the interactions with the sensitive than the redirective individual.

We found that infants not only shifted attention to toys the experimenter introduced more frequently in the redirective than in the sensitive condition, but also showed a trend toward shifting their attention more frequently to toys the experimenter had not introduced in the redirective condition. This finding may indicate that the greater frequency of attentional shifts was due to the redirective experimenters introducing more toys than the sensitive experimenters. However, the frequency of attentional shifts persisted outside of the dyadic interaction indicating the type of social stimulation was not constrained to the dyadic interaction.

This study also documented specific sensitive and redirective behaviors by the infants' parent and by the unfamiliar adults when interacting with the infants. The manipulation of unfamiliar adult responses was successful; both the parents and sensitive individuals responded more frequently with sensitive behaviors than with redirective behaviors, while the redirective individuals responded with approximately the same number of redirective and sensitive responses. Therefore, while the redirective adults did not respond with redirective behaviors the majority of the time, they did respond with more redirective behaviors than either the sensitive individuals or the parents. However, the unfamiliar adults also differed on other dimensions, with the redirective individuals responding more frequently overall than the sensitive individuals and also vocalizing less frequently while manipulating objects more frequently. One potential concern, therefore, is that the increased frequency in attentional shifts during the redirective condition may not have only been influenced by more frequent redirective responses, but also by the greater frequency of responses overall or, in particular, the greater frequency of object manipulations. Future studies should control both the response frequencies and types of behaviors with which the unfamiliar adults respond, varying only the type of response (redirective or sensitive). Other studies, however, support the idea that it is the sensitive or redirective nature of responses and not the overall frequency of response that influences focused exploration by infants (Riksen-Walraven, 1978). Riksen-Walraven (1978) instructed parents to either increase the overall amount of stimulation they provided their 9-month-old infants or to increase their sensitive responsiveness to their infants. The study found that while increased stimulation influenced infant rates of visual habituation, increased sensitivity heightened focused exploration and the ability to detect contingencies by infants. Because focused exploration is closely tied to focused attention, this study supports the idea that the redirective nature of responding, and not the increased frequency, most likely caused infants to shift their attention more frequently.

Regardless of whether the greater frequency of visual attention shifts was due to more redirective responses or more overall stimulation when interacting with the redirective individual, the fact that infants were affected by these differences in responses during only 7 min of exposure demonstrates the extent to which social partners can shape infant attention. Because infants are in frequent contact with their parents, there is ample opportunity for the style of parent responsiveness to shape infant attention. Bornstein and Tamis-LeMonda (1997) have shown that parent responsiveness at 5 months predicts a variety of developmental outcomes at 13 months, including attention span, language comprehension, and symbolic play. Additionally, interventions targeting parent responsiveness show that increased sensitivity by parents results in other

outcomes related to focused attention, such as more sophisticated exploratory competence and more competent, advanced play by infants (Belsky et al., 1980; Riksen-Walraven, 1978). It is likely that infants whose mothers respond to their focus of attention learn to attend to relevant aspects of their environments and are thus able to process information more effectively than are infants with redirective mothers (Tomasello & Farrar, 1986). Therefore, these interactions with parents may establish patterns of behavior that extend to novel interactions outside the family, thereby exerting long-lasting effects on the ability to sustain attention that may last into adulthood. For example, infants whose mothers score high on sensitivity measures and low on redirectiveness are more likely to engage in joint attention episodes with unfamiliar individuals (Hobson, Patrick, Crandell, Garcia Perez, & Lee, 2004), highlighting the extent to which interactions with parents may generalize to infant behavior outside the dyad.

While it is clear that social partners affect infant attention development, other studies have pointed to biological predispositions that may also influence an infant's ability to focus attention (Colombo et al., 2004; Matheny, 1980, 1983). Matheny (1980, 1983) has shown that identical twins display higher concordance than same-sex fraternal twins on task orientation, a measure of sustained attention, and that developmental changes in task orientation over time also show higher concordance in identical twins. Colombo et al. (2004) investigated a relationship between maternal levels of DHA, a long-chain polyunsaturated fatty acid found in the retina, and measurements of infant attention. They found that maternal levels of DHA at birth correlated with increased levels of focused object exploration and less distractibility by infants across the first two years of life. The development of infant attention, however, is most likely not only the result of environmental influences or of innate predispositions but instead reflects a complex dynamic interaction between the two factors. Parrinello and Ruff (1988) demonstrated that less attentive infants, as measured during a baseline period, were more susceptible to attempts by unfamiliar social partners to encourage attention to objects than were highly attentive infants. While the more attentive infants were not influenced by the adult intervention, the less attentive infants had longer durations of attention to objects as well as more sequences of focused attention. In combination with the current study, it appears that while unfamiliar social partners can influence infant attention in a very brief period of time, the way in which social partners exert that influence may depend on specific characteristics of the infant.

By manipulating sensitive and redirective social behaviors, this study demonstrated that visual attention in 9-month-old infants differs after brief exposure to variation in response patterns by unfamiliar adults. Sustained attention underlies processes of information gathering and cognition (Choudhury & Gorman, 2000), and therefore is important to virtually all aspects of behavior and learning. Focused attention may play a constructive role in early word perception, for example, by giving the infant systematic feedback that looking will consistently reveal a stable vocal or manual response and help solve the indeterminacy problem of targeting names to specific properties of novel stimulation (Quine, 1960). In contrast, redirective stimulation may add to the problem because it devalues an infant's attentional focus, leaving to chance any combining of developing words and objects and actions.

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