CONFLICTING SIGNALS: HOW GAZE AND POINT CUES INFLUENCE INFANTS' ATTENTION-FOLLOWING

By

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CHAPTER I

INTRODUCTION

Over the course of the first year, infants become increasingly interested in objects in the environment (Kaye & Fogel, 1980; Trevarthen & Hubley, 1978). Gradually, this object-focused attention becomes embedded in social contexts as infants become sensitive to the referential, or object-directed, focus of social partners (Bakeman & Adamson, 1984). By their first birthday, infants follow others' attention to objects in the environment by using cues such as gaze shifts, pointing gestures, and verbal comments and encouragement (Carpenter, Nagell, & Tomasello, 1998; Deák, Flom, & Pick, 2000; Flom & Pick, 2003; Morissette, Ricard, & Gouin Décarie, 1995). The ability to follow another person's attention sets the stage for children to learn about the physical and social environment. For example, attention-following behaviors in infancy are important for learning language (Baldwin, 1995) and in toddlers, responsiveness to others' pointing gestures predicts vocabulary size (Harris, Barlow-Brown, & Chasin, 1995; Smith, Adamson, & Bakeman, 1988).

To follow attention, infants must shift their own gaze to monitor and respond to non-verbal and verbal cues that indicate the referential focus of a social partner (McDuffie, Yoder, & Stone, 2006). Non-verbal cues such as gazing and pointing indicate a person's focus of attention by "referring" to an object, event, or entity in the environment and providing directional information about the location of the referent. By 10 to 12 months of age, most infants shift their attention to follow an adult's head turn and gaze shift, referred to as gaze-following (Carpenter et al., 1998; Deák et al., 2000; Morissette et al., 1995). However, in everyday social interactions,

adults rarely direct others' attention by simply turning their head to gaze at an object (Adamson & Bakeman, 1984; Behne, Carpenter, & Tomasello, 2005).

In contrast, points are a natural way to direct another person's attention toward something in the environment (Triesch, Teuscher, Deák, & Carlson, 2006). Butterworth (2003) defined points as deictic gestures that are used to intentionally re-orient the attention of another person toward a referent. According to Rolfe (1996), a deictic point is defined by three characteristics: (1) it requires an audience and is produced for someone else's benefit; (2) the gesture is used to single out something that the receiver identifies as the referent; and (3) the location of the referent is seen as away from the pointing hand. Adamson and Bakeman (1984) observed that after infants' first birthdays, mothers increasingly use deictic points to direct their infants' attention to objects. Prior to this, the most frequent mistake infants make is to fixate on the adult's pointing hand or finger, rather than following the direction of the point toward the target object (Lempers, 1979; Morissette et al., 1995). However, by 12 months of age, the majority of infants follow pointing gestures toward distal targets (Butterworth & Itakura, 2000; Deák et al., 2000; Flom, Deák, Phill, & Pick, 2004; Leung & Rheingold, 1981; Lempers, 1979; Morissette et al., 1995; Murphy & Messer, 1977).

Year-old infants are significantly more likely to follow another person's head/gaze shift when it is accompanied by a pointing gesture. In one study, Deák et al. (2000) compared 12- and 18-month-old infants' attention-following in response to a parent's head/gaze shift presented alone or accompanied by a pointing gesture. In this task, parents called their infants by name to establish eye contact (eliciting attention) before indicating a designated target (directing attention). At both ages, infants were significantly more likely to follow attention when parents gazed and pointed than when a shift in gaze was the only cue. This demonstrates a robust

attention-directing effect of pointing independent of any eliciting effects because infants were attending to the parent at the onset of each trial. That is, increased attention-following in response to gaze and point cues cannot be attributed to infants failing to notice head/gaze shifts. Deák et al. (2000) also found that infants followed parents' gaze and point cues more frequently when target objects were distinctive (multi-colored polygons) as opposed to identical (blue squares). Looking and pointing at an object may be particularly effective for directing infants' attention in "busy" environments where there are often many unique objects to look at.

To explore the effects of "busy" environments on infants' attention-following, Deák, Walden, Kaiser, and Lewis (2008) designed an experimental setting containing multiple target objects (distal) as well as distracting toys (proximal), analogous to infants' typical social environment. Deák et al. (2008) proposed that in this type of setting, infants would be more likely to follow pointing gestures than head/gaze shifts without verbally eliciting infants' attention first (as in Deák et al., 2000). The researchers hypothesized that in environments with many distractions, infants may not notice subtle head turns/gaze shifts whereas points are more salient and may elicit infants' attention and facilitate subsequent attention-following (Deák et al., 2008). They found that in the absence of verbal cues, infants were significantly more likely to follow attention when the caregiver gazed and pointed rather than simply gazed at the target. Moreover, infants were more likely to follow silent gaze and point cues compared to when the caregiver called infants by name before turning to look at the target (e.g., "Ben, Ben" followed by a gaze shift). Thus, even when actively engaged with objects, infants disengaged and followed attention in response to a silent gesture without the benefit of a verbal cue.

It is clear that infants benefit from the addition of pointing gestures to gaze shifts when following others' attention. When a social partner points toward an object, infants may be

compelled to follow attention because a point is an intentional request to recruit and direct another person's attention (Deák et al., 2000). In addition, pointing is a more salient movement and a more spatially informative cue than head and eye movements alone (Butterworth & Itakura, 2000; Deák et al., 2008; Leekam, Hunnisett, & Moore, 1998; Triesch et al., 2006). Butterworth (1995, 2003) has argued that the ability to follow pointing gestures to distal targets depends on the development of an inborn geometric mechanism that emerges around 12 months of age. The geometric process allows the infant to select the pointing gesture (perhaps because of the salience of the motion) and use it to determine the precise location of the target object in visual space (Butterworth, 1995).

On the basis of his early experiments, Butterworth (1995) concluded that the geometric mechanism allows infants to extrapolate a straight (imagined) line or vector along the arm/hand of the adult to intersect with a potential target object in the environment. However, based on later investigations (Butterworth & Itakura, 2000), he proposed that pointing gestures act as long levers that carry infants' attention further (and more accurately) into the periphery than changes in head or gaze orientation (Butterworth, 2003). Regardless of the exact nature of the mechanism, this geometric account implies that point-following could occur independently of other attentional cues such as head/gaze shifts (Caron, Kiel, Dayton, & Butler, 2002). In fact, based on Butterworth's account, some have suggested that the attraction to follow pointing gestures might prevent infants from using head/gaze cues as indices of attention (Morissette et al., 1995).

On the other hand, there are reasons to expect that even when accompanied by a point, a change in head/gaze orientation may be an important factor that influences infants' attention-following. For example, a number of researchers have suggested that infants benefit from

redundant directional cues (Deák et al., 2000; Flom et al., 2004); infants may be more likely to follow attention when points are added to gaze shifts because the two cues provide redundant information about where to look. In addition to being a directional cue, gaze may also provide an attentional or referential signal in a way that pointing does not. Gaze is generally a reliable indicator of visual attention (Meltzoff & Brooks, 2006) and a person's gaze direction signals to a social partner that there is something interesting to look at (Moll & Tomasello, 2004). In addition, infants may have learned that a social partner cannot be expected to produce meaningful object-directed actions such as pointing if that person is not visually attending to the object (D'Entremont & Seamans, 2007; Doherty & Anderson, 1999). Thus, there are several reasons to suspect that gaze cues may affect infants' responses to pointing gestures.

Because gaze and point cues have been coupled in previous studies, little is known about the relative influence of the adult's head/gaze cues on infants' point-following. No previous attention-following studies have compared infants' responses to points accompanied by congruent gaze (i.e., looking and pointing at a target) and incongruent gaze (i.e., looking down while pointing at a target). However, some studies have examined how incongruent head/gaze cues influence children's abilities to follow an adult's point to find a hidden toy. In one study, Povinelli, Reaux, Bierschwale, Allain, and Simon (1997) compared chimpanzees and young children's (24 – 40 months) responses to an adult's non-verbal cues in order to find a hidden surprise. For successful performance, children needed to attend to the adult's cue(s), identify the referent, and infer its relevance in the context of the hiding-finding game. The experimenter indicated which of two boxes contained the hidden reward by: (1) looking at the correct container, (2) looking and pointing at the correct container, and (3) pointing at the correct container while looking down at the floor. Although the last set of cues may seem unusual,

Povinelli et al. (1997) hypothesized that children would be able to locate the hidden toy regardless of whether the adult pointed while looking at the target or looking down at the floor.

Both chimpanzees and children had difficulty locating the hidden reward when the experimenter only turned and looked at the container, indicating that gaze by itself may not be a strong enough cue to direct attention in this type of context (Behne et al., 2005; Povinelli et al., 1997). In contrast, chimpanzees and children were both able to locate the hidden toy when the adult looked and pointed at the correct container. As hypothesized, 2- and 3-year-old children successfully found the hidden reward when the adult pointed but looked down, whereas chimpanzees had difficulty selecting the correct container during these trials. Moreover, children were just as likely to find the hidden reward when the adult gazed and pointed at the correct container as when he pointed but looked down. Even in the youngest age group (24 – 30 months), the majority of children reliably chose the correct container when the adult looked and pointed (12 of 12 children correct) and when the adult looked down at the floor and pointed (11 of 12 correct). Povinelli et al. (1997) argued that these findings demonstrate the robustness and flexibility of young children's comprehension of pointing as an intentional referential gesture; that is, children seemed to understand that the adult's point was intended to direct their attention toward the correct container even when he looked down at the floor.

A comparison of infants' attention-following responses to pointing gestures with gaze oriented toward the target or with gaze oriented down is theoretically interesting because the direction of a person's gaze or point can each "refer" to an external object, event, or entity (Deák et al., 2008). Comparing infants' responsiveness to these types of pointing gestures is ecologically relevant because in everyday interactions people use points to indicate a referent of interest. Although adults often look and point together, it may not be uncommon for adults to

point toward something while looking elsewhere (Golinkoff, Hirsh-Pasek, & Hollich, 1999). As an illustration, imagine a mother driving with her baby in a car seat behind her. The mother might notice an airplane in the sky and say "Look at the plane!" and point to it while keeping her head and eyes oriented toward the road ahead. In situations like this, the mother's head/gaze direction indicates her immediate focus of attention (the road) but not the intended referent of her pointing gesture (the airplane flying overhead) (Lee, Eskritt, Symons, & Muir, 1998). Although it is not known how often infants experience these types of attention-directing cues, it may be a more common occurrence in busy environments such as in day care or with siblings.

The ability to follow points when gaze cues conflict may be a sophisticated skill that allows infants to respond to and interact with social partners, and may provide more opportunities for infants to learn about objects and people in the environment. When a social partner's referential cues conflict, adults may rely on sophisticated strategies in order to determine the location of the intended referent (Golinkoff et al., 1999). Infants may also follow attention when others' referential cues conflict. For example, if gaze and point cues conflict, infants may follow the adult's pointing gesture because the point is interpreted as an intentional request to direct infants' attention toward something in the environment, whereas gaze may be interpreted as a less intentional referential cue. Thus, similar to the toddlers in Povinelli et al.'s (1997) study, one-year-old infants may interpret others' points as intentional referential cues even when gaze cues conflict.

The main purpose of the current investigation was to determine whether one-year-old infants' responses to pointing gestures are influenced by the head/gaze orientation of the social partner. In the context of an attention-following task, infants played with toys while an adult periodically attempted to re-direct the infant's attention by pointing toward one of several distal

objects while either looking at the target (gaze-at-target plus point) or looking down at her lap (gaze-at-lap plus point). Thus, the direction of the adult's pointing gesture indicated the target object; the critical difference between the two types of pointing cues was the direction of the adult's head/gaze shift. In the gaze-at-target plus point condition, the adult pointed toward the target object and turned her head to look at the target. In the gaze-at-lap plus point condition, the adult pointed toward the target object but turned her head down to look at her lap. In addition, infants' attention-following was measured in response to simple head/gaze shifts (gaze-only), with the hypothesis that infants would be more likely to follow attention when points were added to shifts in gaze.

The primary hypothesis was that infants would be more likely to follow a social partner's pointing gesture when she looked at the object compared to when she looked down at her lap. A number of factors could contribute to such an effect. In the gaze-at-target plus point condition, congruent head/gaze cues could facilitate responding to the pointing gesture, perhaps because gazing and pointing provides redundant directional information (Deák et al., 2000; Flom et al., 2004) or because gaze is a necessary attentional signal in order to direct infants' attention. Alternatively, the adult's downward-oriented gaze might attenuate attention-following in the gaze-at-lap plus point condition, perhaps because pointing while looking down conveys that the object indicated by the adult's point is not worth looking at (Corkum & Moore, 1995) or because conflicting referential cues are simply confusing. Although the influence of these factors goes beyond available data in the current study, this result would provide evidence that infants' responses to points are influenced by head/gaze cues and that the combination of congruent cues is more effective than pointing while looking down in terms of directing infants' attention.

This study had the secondary purpose of examining how verbal cues influence infants' attention-following, which was assessed in a controlled setting designed to simulate natural competition for infants' attention with proximal non-target toys for infants to play with as well as multiple distal target objects. Previous research has shown that verbal cues are particularly important in this type of busy experimental setting in order to elicit infants' attention away from the distracting non-target toys and re-direct infants' attention toward distal objects (Deák et al., 2008). Returning to the car example described earlier, when the mother points out a plane flying overhead to her baby in the backseat, the infant could be enjoying a toy or occupied with a sibling and may not notice the mother pointing or may choose to ignore it in favor of continuing a previous activity. To ensure that her baby notices and follows her point, the mother might call her baby's name or say "Look at the plane!" to supplement her pointing gesture.

Four-month-old infants' attention is captured for longer periods of time by the sound of their own name than by another name (Mandel, Jusczyk, & Pisoni, 1995), and toddlers seem to know that their name refers to them (Stipek, Gralinski, & Kopp, 1990). In a recent attention-following study, Deák et al. (2008) found that 15- and 21-month-old infants were more likely to follow attention when a caregiver called their name (e.g., "Ben, Ben!") before shifting gaze to look at a target, compared to silent gaze shifts. They also found that infants were more likely to follow attention when the caregiver said "Look at the [familiar object label]!" rather than when the caregiver called the infant's name prior to shifting gaze toward the target (Deák et al., 2008).

Compared to when they hear their names called, infants may be more likely to follow attention after hearing "Look at the [label]!" because the directive statement "Look at the…" followed by an object label is a clear signal that the adult intends to re-direct the infant's attention to something in the environment. Previous research has suggested that infants

understand that certain words and phrases are used to refer to objects. Namy and Waxman (2000) found that 17-month-old infants were more likely to associate an object with a word when it was preceded by "Look at the…" than when the word was produced in isolation, suggesting that infants expect adults to use directive "look" statements and labels to refer to objects. Infants also seem to understand that unfamiliar words can refer to objects. Baldwin and Markman (1989; Study 1) found that infants looked longer at a single unfamiliar object when a nearby adult labeled the object (e.g., "This is a snorkel. See the snorkel?"), compared to when the adult was silent. Moreover, infants showed no increase in attention to the speaker, only to the object the speaker referred to, suggesting that infants understood that the label referred to the object (Baldwin & Markman, 1989). Thus, certain types of verbal cues have a deictic function (Wales, 1979), analogous to pointing.

When an object and its label are familiar to infants, labeling the object helps infants to identify the intended referent (Deák et al., 2008). When an object is unfamiliar, labeling (e.g., "Look at the modi!") cannot help infants to identify the intended referent (Flom & Pick, 2003). In these situations, although non-verbal cues are essential for infants to follow the speaker's attention, verbal cues may have an effect even without specifying the referent. For example, in a busy environment, hearing any type of verbal cue might prompt infants to look away from a previous activity or focus of attention and try to determine the speaker's intended referent. It may be easier for infants when the speaker utters an imperative ("Look") followed by a label because infants understand that the speaker is referring to an object. Furthermore, some word-learning theories suggest that hearing a novel label prompts infants to search for objects (Golinkoff et al., 1999; Mervis & Bertrand, 1994); hearing an unfamiliar label for an object might prompt infants to try to locate the labeled referent.

On the other hand, previous research has found that verbal cues (unspecified) do not significantly increase attention-following in one-year-old infants beyond the effects of gazing and pointing (Deák et al., 2000; Flom & Pick, 2003). Similarly, Baldwin and Markman (1989; Study 2) found that verbal cues with unfamiliar object labels did not add to the effectiveness of gaze and point cues when directing infants' attention toward an object. They did, however, find that infants spent more time examining the previously labeled novel object during a subsequent play period. Similar effects were found by McDuffie et al. (2006) when labeling was compared to non-labeling verbalizations (e.g., "Look! I have a modi!" vs. "Look! See what I have?"). Baldwin and Markman (1989) concluded that whereas pointing helps infants to identify the object of interest, providing a novel label serves to enhance infants' interest in that object. However, it may be that in previous studies, verbal cues did not have a measurable effect on attention-following because infants were already attending to the adult and few alternative objects were present when the adult pointed to indicate the target. In busier environments, though, verbal cues might have a significant effect when added to gaze and point cues.

Even if the addition of verbalizations to gaze and point cues does promote attention-following, it is not known whether verbal cues will have similar effects when the speaker gazes down at her lap while pointing toward an object. In this condition, the adult's downward-oriented gaze could reduce the facilitative effects of verbal cues. For example, Deák et al. (2008) found that when a caregiver labeled a familiar object (e.g., "Look at the bunny!"), infants were more likely to follow attention when the caregiver had a clear view of the target, compared to when the caregiver turned but covered her eyes with one hand. In both conditions, infants could have accurately located the referent labeled by the adult without using gaze cues because both the target objects and their labels were familiar to the infants (Deák et al., 2008). However, infants

were less likely to look at the labeled object when the caregiver's gaze was blocked, suggesting that the facilitative effects of verbalizations may be attenuated when the speaker does not look at the object. Thus, infants may not benefit from the addition of verbal cues when the adult gazes at her lap while pointing toward an object.

In summary, the ability to follow another person's pointing gesture even when that person's gaze conflicts may be a sophisticated skill that allows infants to interact with others and learn about objects in the environment. In the current study, infants played with toys while an adult periodically attempted to re-direct the infant's attention toward one of several distal objects. Three types of non-verbal cues were used to re-direct infants' attention: (1) gaze toward the target (*gaze-only*), (2) gaze and point toward the target (*gaze-at-target plus point*), and (3) gaze down at lap and point toward the target (*gaze-at-lap plus point*). Non-verbal cues were presented silently and combined with different types of verbal cues. Infants' responses to these combinations of non-verbal and verbal cues were analyzed to determine whether the addition of points to gaze shifts increased attention-following and whether infants were more likely to follow points toward targets when the adult also gazed at the target than when she gazed down at her lap. In addition, infants' responses to silent attention-directing trials were compared to trials with the three different verbal cues to determine whether the addition of each type of verbal cue promoted attention-following. Responses to verbal cues with and without labels were also compared to assess whether labels facilitated attention-following more so than other types of verbalizations. Finally, infants' looking behaviors during trials in which they did not follow attention were examined to determine where infants looked when they did not look at the target indicated by the adult.

Research Questions

The current study addressed the following questions within the context of an attention-following task in which an adult attempted to re-direct infants' attention by shifting gaze toward the target object (gaze-only), shifting gaze and pointing toward the target (gaze-at-target plus point), or shifting gaze down at her lap and pointing toward the target (gaze-at-lap plus point):

1. Does pointing facilitate attention-following when the adult gazes and points toward the target, compared to when she only gazes toward the target?
2. Are infants more likely to follow an adult's point toward a target when she also gazes at the target, compared to when she gazes down at her lap?
3. For each type of non-verbal cue, does calling infants by name increase attention-following relative to silent cues?
4. For each type of non-verbal cue, does saying "Look at the [unfamiliar object label]!" increase attention-following relative to silent cues?
5. For each type of non-verbal cue, does calling infants by name and saying "Look at the [unfamiliar object label]!" increase attention-following relative to silent cues?
6. For each type of non-verbal cue, are verbal cues with labels more effective than those without labels in terms of facilitating attention-following?
7. Where do infants look when they do not follow the adult's attention to the target?
8. When infants do not follow the adult's attention, are infants more likely to look at the adult's lap during gaze-at-lap plus point trials compared to gaze-only and gaze-at-target plus point trials?

CHAPTER II

METHOD

Participants

Thirty-eight infants (13 girls, 25 boys) between 12 to 23 months of age participated. Three infants were excluded due to experimenter error. The other 35 infants (12 girls, 23 boys) were Caucasian (n = 32) and multi-racial (n = 3) (see Table 1 for chronological ages). Infants were recruited from birth records in Davidson County, TN. All infants had older (typically-developing) siblings. None of the infants had a family history of autism or mental retardation in first degree relatives. English was the primary language spoken in the household. Informed consent was obtained from parents prior to participation.

Target Stimuli and Experimental Setting

Children were tested in a 2.4 m × 8.1 m room. Along one wall of the room, clear shelves were placed 0, 100, and 190 cm high in each of three columns spaced 2.7 m apart. The center column was aligned with a child-sized table (61 cm^2) positioned 2 m from the wall, at which children were seated in a child-sized chair facing the stimulus wall (see Fig. 1). Eight of the nine shelves held target stimuli; the lowest shelf in the center column was occluded by the table and was therefore left empty (see Fig. 2). Target stimuli were sixteen novel objects that were approximately equivalent to each other in size and complexity, but varied in both color and shape (see Fig. 3). Objects were roughly similar in size to child-sized toys such as a stuffed animal (less than 20 cm in height) and were clearly visible to infants when placed on the stimulus wall.

The objects were constructed so that they did not resemble any objects that would be familiar to young children. Pilot testing indicated that none of the novel objects resembled real objects that could be readily labeled by children or adults and that none of the novel labels sounded similar to English words.

Table 1

Numbers and percentages of infants by chronological age

Chronological age (months)	Number	Percentage
12	7	20.0
13	4	11.4
14	3	8.6
15	3	8.6
16	5	14.3
17	3	8.6
18	2	5.7
19	1	2.9
20	1	2.9
21	2	5.7
23	4	11.4

Figure 1

Configuration of experimental room

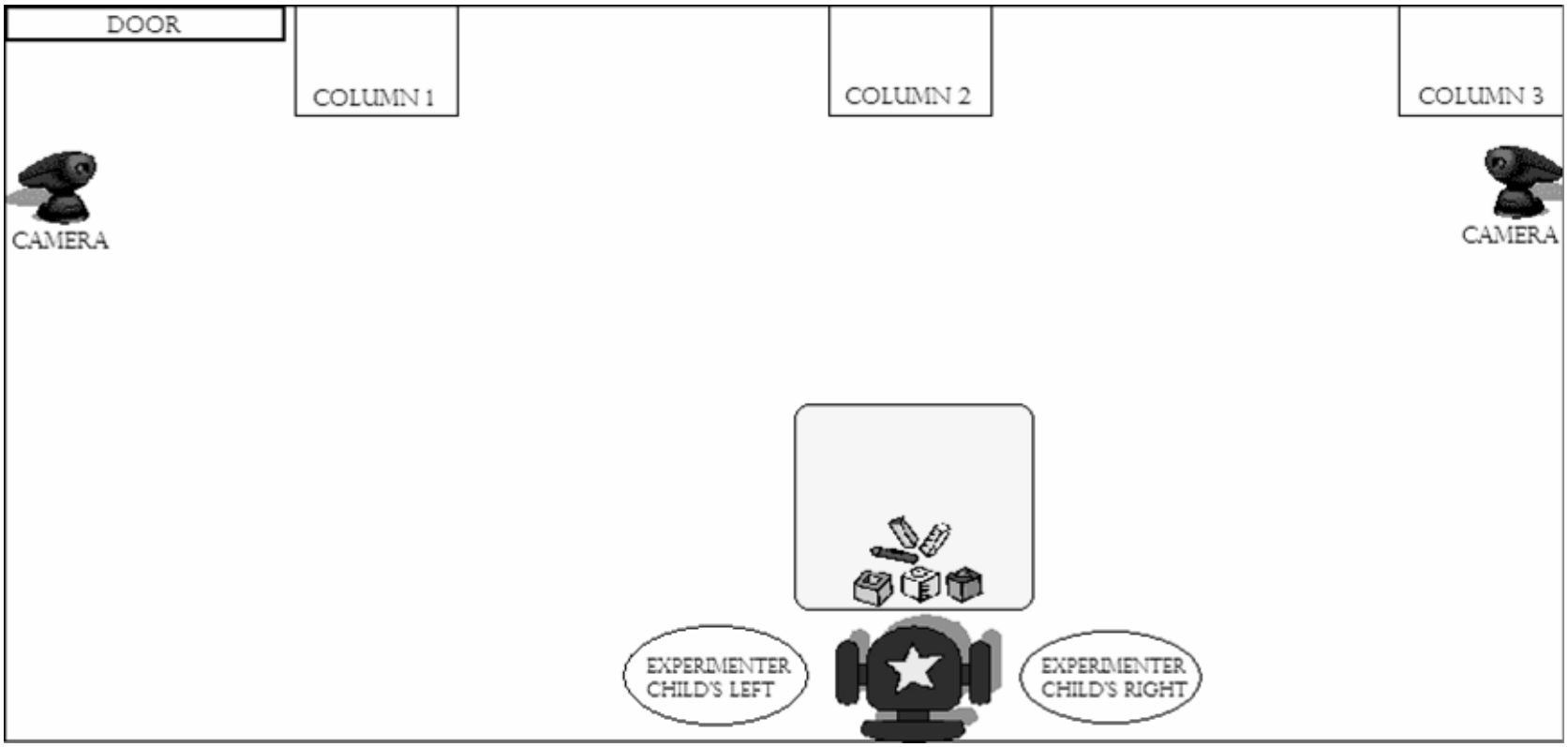


Figure 2

Configuration of stimulus wall

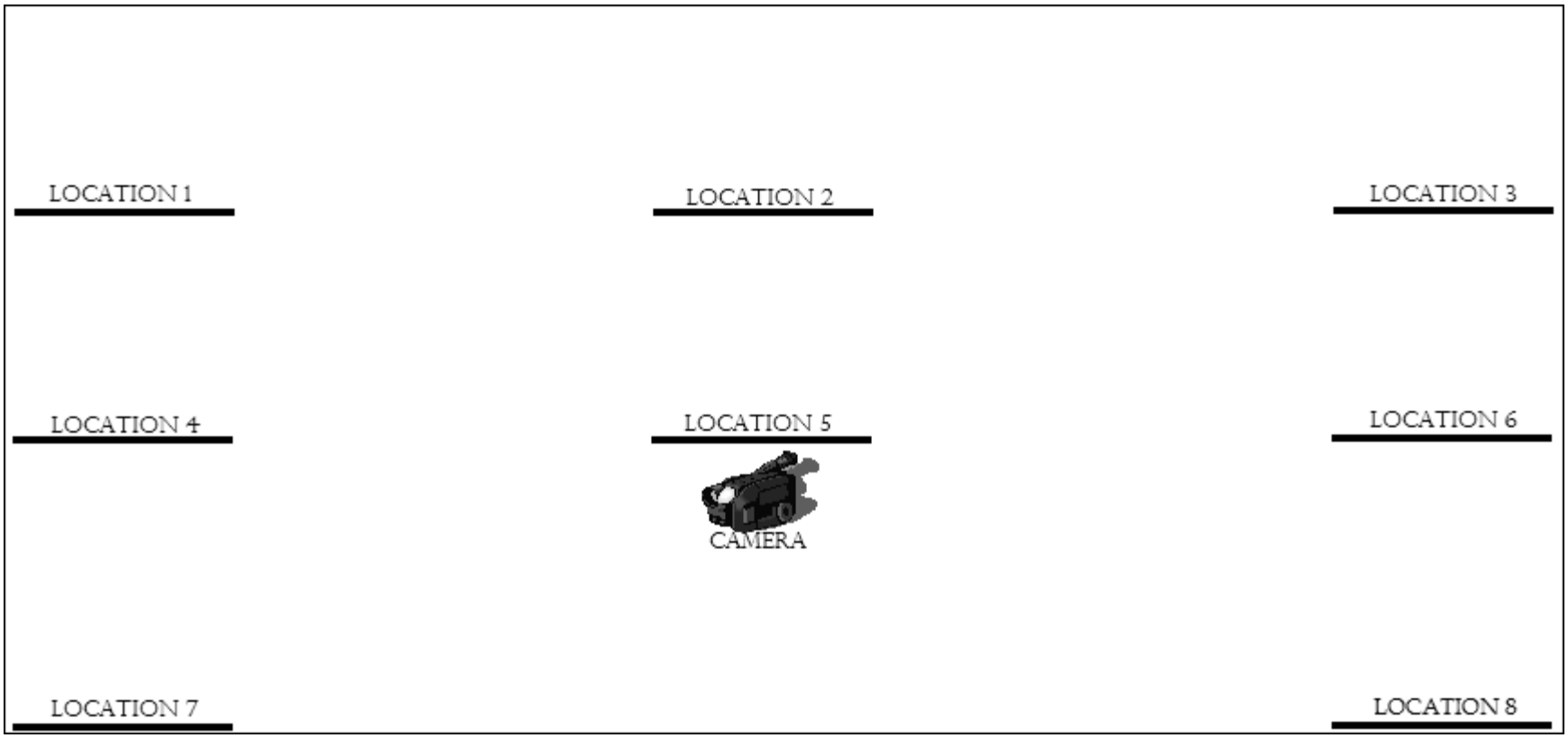
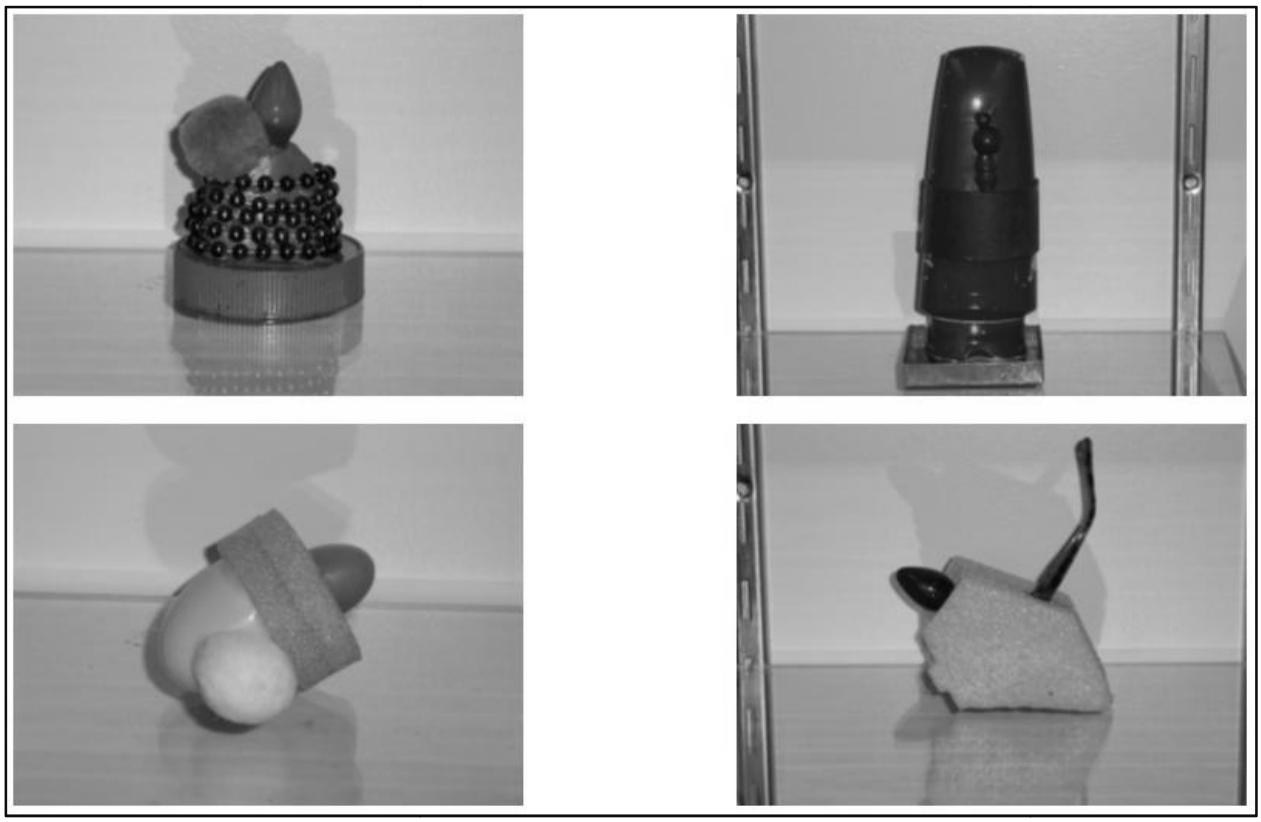


Figure 3

Examples of novel target objects



Two miniature cameras with zoom lenses were mounted on either end of the stimulus wall 100 cm above the floor, approximately level with the middle row of shelves in order to record infants' head and upper body movements. A third camera was positioned in the center column directly beneath the second row shelf (approximately 90 cm above the floor) to record the infants' faces at eye-level. The three videos were routed through quad-screen and time-stamp generators and recorded on a Panasonic VHS VCR, allowing coders to view images from the three cameras at once.

General Procedure

When families arrived, the procedures were explained to parents while an experimenter played with the child in the experimental room. After a brief warm-up period with the experimenter, the child was seated at the table facing the stimulus wall. Several age-appropriate toys were placed on the table in front of the child (e.g., wooden alphabet blocks, large Legos, a string of plastic "pop" beads, etc.); toys were replaced by the experimenter during the procedure, as needed, to maintain infants' interest. The experimenter sat next to the child on a short stool. Parent(s) watched from an adjacent observation room. If the infant was unable to separate from his/her parents, one parent was asked to remain present during the procedure; the infant was seated on the parent's lap at the same position and height as those without a parent present. If present, parents were asked to close their eyes and remain silent to ensure that their child's responses were not influenced by verbal or non-verbal cues from the parent.

Testing sessions included two blocks of eight different cue combinations. Within each block, each cue combination was repeated on either side of the infant (left and right) for a total of 16 trials per block. Each trial began when the infant was seated and initially visually engaged with the toys at the table. Trials lasted 10 s after the onset of the non-verbal/verbal cues; the experimenter held the physical position and facial expression constant for the duration of each trial. After the first block (8 types of cues/cue combinations; 16 trials), target objects on the stimulus wall were switched while the experimenter and infant participated in several other activities in a different room before the second block was resumed. Each child received all 16 types of cues/cue combinations; cue order was randomized and counterbalanced across participants. Objects were randomly assigned to locations and trials.

Types of Cue Combinations

Twelve of the 16 cue combinations were chosen to address the research questions in this study. Each cue combination consisted of non-verbal and verbal cues. Three non-verbal attention-directing cues were used: (1) gaze toward the target (*gaze-only*), (2) gaze plus point toward the target (*gaze-at-target + point;* see Fig. 4), and (3) gaze down at lap plus point toward the target (*gaze-at-lap + point*; see Fig. 4) (see Table 2 for descriptions).

Each type of non-verbal cue was presented silently and paired with three different verbal cues: *name*, *label*, and *name + label* (see Table 2). Thus, the 12 cue combinations were composed by pairing the three types of non-verbal cues with the four types of verbal cues. The timing of the non-verbal cues was dependent on the type of verbal cue (see Table 3). Each cue combination was repeated twice. During each trial, the experimenter directed infants' attention toward one of the eight objects arranged on shelves across the stimulus wall facing the infant and the experimenter. Each child received all attention-following trials.

Table 2

Descriptions of specific non-verbal and verbal cues

Type of cue		Description
Non-verbal		
	Gaze-only	Experimenter turns her head and gazes toward the target object for the 10s trial
	Gaze-at-target + point	Experimenter turns her head and gazes toward the target object while simultaneously raising her arm with index finger extended to point toward the target; continues to gaze and point toward the target for the 10s trial
	Gaze-at-lap + point	Experimenter turns her head down and gazes toward her lap while simultaneously raising her arm with index finger extended to point toward the target; continues to gaze at her lap and point toward the target for the 10s trial
Verbal		
	Name	Experimenter looks at the infant and calls the infant's name twice ("Ben, Ben!") before indicating the target
	Label	Experimenter says "Look at the [unfamiliar label]!" as she indicates the target
	Name + Label	Experimenter looks at the infant and calls the infant's name twice ("Ben, Ben!") then says "Look at the [unfamiliar label]!" as she indicates the target

Figure 4

Photographs of gaze-at-target plus point and gaze-at-lap plus point cues

Table 3

Descriptions of twelve cue combinations used to re-direct infants' attention

Non-verbal cue	Verbal cue	Description of cue combination
Gaze-only		
	Silent	Experimenter turned to gaze toward the target
	Name	Experimenter looked at the infant and called the infant's name twice, then turned to gaze toward the target
	Label	Experimenter said "Look at the [unfamiliar label]!" and turned to gaze toward the target
	Name + Label	Experimenter looked at the infant and called the infant's name twice, then said "Look at the [unfamiliar label]!" and turned to gaze toward the target
Gaze-at-target + point		
	Silent	Experimenter simultaneously turned to gaze and point toward the target
	Name	Experimenter looked at the infant and called the infant's name twice, then simultaneously turned to gaze and point toward the target
	Label	Experimenter said "Look at the [unfamiliar label]!" and simultaneously turned to gaze and point toward the target
	Name + Label	Experimenter looked at the infant and called the infant's name twice, then said "Look at the [unfamiliar label]!" and simultaneously turned to gaze and point toward the target
Gaze-at-lap + point		
	Silent	Experimenter silently turned her head to gaze down towards her lap while simultaneously pointing toward the target
	Name	Experimenter looked at the infant and called the infant's name twice, then turned her head to gaze down towards her lap while simultaneously pointing toward the target
	Label	Experimenter said "Look at the [unfamiliar label]!" and turned her head to gaze down towards her lap while simultaneously pointing toward the target

Name + Label	Experimenter looked at the infant and called the infant's name twice, then said "Look at the [unfamiliar label]!" and turned her head to gaze down towards her lap while simultaneously pointing toward the target

Coding & Reliability

To ensure that coders remained unaware of the cues, coding occurred without sound and cameras were positioned such that the experimenter's extended pointing arm was not visible (although her face was partially visible). Session videotapes were converted to digital format and coding was completed using ProcoderDV software (Tapp & Walden, 1993), allowing the onset and offset of each attention-following trial to be recorded with single-frame accuracy.

Attention-following

Attention-following was coded by trained observers with a partial interval coding system. Coders judged the primary focus of infants' attention for each trial. The focus could be any of the eight target locations or an alternate focus: non-target toys, visual scanning of the stimulus wall, or other foci (such as other areas of the room or the experimenter). If the child looked to a target location on the wall, the code was determined by the child's initial visual fixation unless the child clearly referred back to the experimenter and then visually re-oriented to a different target location during the 10 s trial interval.

Two dependent variables were derived from the attention-following data: looks to correct targets and looks away from non-target toys. The accuracy with which children located the target (looks to correct targets) was evaluated by comparing codes to the actual target location using the following criteria. If the code matched the target location, a score of 1 was given. If the coded location was vertically adjacent to the target location, a score of 0.5 was given (e.g., child

looked at the top row position of the left column but the target location was the middle row position of the same column; see Fig. 2). This procedure compensated for the fairly small visual angle between vertically adjacent target locations, which made it difficult for coders to distinguish them. If the coded location did not match or was not vertically adjacent to the target, a score of 0 was given. Possible scores were 0, 0.5, and 1 for each trial, with higher scores reflecting increased accuracy.

Coders were trained to an established standard ($\kappa > .60$). Eight infants' tapes (20%) were randomly selected to be coded by a second observer. Agreement was estimated using weighted kappas calculated at the participant level (with disagreements between vertically adjacent locations coded as 0.5). Average agreement between coders was .90 (*SD* = .06). Intraclass correlation coefficients (ICCs) for each of the twelve cue combinations were greater than .70 for looks to correct targets and looks away from non-target toys (see Appendix); ICCs of 0.6 and above are considered acceptable (Mitchell, 1979).

Infants' looks

Infants' looks were coded using a timed event coding system in which the direction of the child's gaze was coded continuously during the 10 s interval following the onset of each cue combination. Six mutually exclusive codes were used to describe infants' looks during each trial: (1) looks to the stimulus wall, (2) looks to the experimenter's face, (3) looks to the experimenter's lap, (4) looks to the experimenter's shoulders/chest, (5) other looks (e.g., looks to self, to the ceiling, or parent if present), and (6) looks down at the table. Note that in contrast to the attention-following codes, a look to the stimulus wall was coded if the infant looked toward the wall but not necessarily to a specific object/target location (i.e., the infant could have looked at a space between columns or between rows on the wall; see Fig. 2). Dependent variables

derived from these codes were defined as the mean proportion of incorrect trials (i.e., trials in which infants did not follow attention) in which each type of look occurred.

Coders were trained to an established standard ($\kappa > .60$). Eight infants' tapes (20%) were randomly selected to be coded by a second observer. Reliability was estimated by intraclass correlation coefficients. ICCs for each of the twelve cue combinations were greater than .60 for all six variables; ICCs for dependent variables included in analyses are shown in the Appendix.

CHAPTER III

RESULTS

Overview

Infants' attention-following scores (looks to correct targets) were examined to address the questions of whether the addition of points to gaze shifts increased attention-following (Research Question 1) and whether infants were more likely to follow points toward targets when the adult also gazed at the target than when she gazed down at her lap (Research Question 2). In addition, the effects of each of the three different types of verbal cues were examined within each non-verbal cue type to determine whether each verbal cue facilitated attention-following relative to silent trials (Research Questions 3 through 5) and whether verbal cues with labels were more effective than those without labels (Research Question 6). Finally, infants' looks during incorrect trials were analyzed to address the final questions of where infants looked when they did not follow attention (Research Questions 7 & 8).

Data from three infants were excluded from the following analyses because both trials for a given cue combination were coded as invalid due to experimenter error. Three additional infants were missing data from one of the two trials for a cue combination; these infants were retained in the following analyses and variables are reported as proportions. Measures of effect size are reported as partial eta-squared (η_P^2); common guidelines characterize values between .02 and .12 as small, between .13 and .25 as medium, and .26 and over as large (Bakeman, 2005). Gender differences on all dependent variables were compared by *t*-tests; no significant differences were found so girls and boys were combined in all analyses.

Attention-following

Looks to correct targets was defined as the proportion of trials in which infants looked at the target object indicated by the adult's attention-directing cues. These responses were aggregated across performance on two trials (range = 0 to 2) for each cue combination. For gaze-only trials, looks to correct targets reflected the accuracy with which infants located the target indicated by the adult's gaze. For gaze-at-target plus point trials, looks to correct targets reflected the accuracy with which infants located the target indicated by the adult's gaze and point cues. For gaze-at-lap plus point trials, looks to correct targets reflected the accuracy with which infants located the target indicated by the adult's point.

The number of infants who looked at the correct target object on zero, one, or both trials for each cue combination is shown in Table 4. Overall, silent cue combinations were the most difficult to follow. This was true even in response to silent points: 63% of infants (22 out of 35) never looked at the correct target during gaze-at-target plus point or gaze-at-lap plus point trials. Note that none of the infants looked at the target on both silent gaze-only trials. By contrast, over half of infants looked at correct targets on one or both trials when gaze-only cues were combined with multiple verbal cues (e.g., name + label). Similar patterns were observed when name plus label verbalizations were added to gaze-at-target plus point and gaze-at-lap plus point cues. However, the majority of infants still had difficulty following attention; at most, only 25% of infants looked at the correct target on both trials of any cue combination.

Table 4

Numbers of infants who looked at the correct target on 0, 1, or 2 trials of each cue combination

	Type of non-verbal cue								
	Gaze-only			Gaze-at-target + point			Gaze-at-lap + point		
Verbal cue	0	1	2	0	1	2	0	1	2
Silent	28	7	0	22	11	2	22	11	2
Name	21	10	3	15	14	6	18	14	3
Label	18	13	4	10	16	9	17	15	2
Name + Label	9	17	9	10	18	7	13	19	3

Note. On each trial, infants received a score of 0, 0.5, or 1. Infants who received a score of 0 on both trials are in the leftmost columns, infants who received a score of 0.5 or 1 on one trial are in the middle columns, and infants who received a score of 0.5 or 1 on both trials are in the far right columns. $N = 35$ except for three cue combinations (gaze-only name trials, gaze-at-target plus point silent trials, gaze-at-lap plus point and name) where $N = 34$ because one infant was missing one of the two trials (see text); these infants were excluded from this summary.

Mean looks to correct targets for each of the twelve cue combinations are shown in Table 5. Responses exceeded zero ($ps < .05$) for all cue combinations except when the adult silently gazed toward the target. This exception is not surprising given that gaze shifts without added verbal cues have been shown to be particularly difficult for one-year-old infants to follow (Deák et al., 2008). However, for all other cue combinations, infants looked toward the correct target object in response to the adult's non-verbal and verbal cues.

Table 5

Means (and SEs) of looks to correct targets for each cue combination

	Type of non-verbal cue		
Verbal cue	Gaze-only	Gaze-at-target + point	Gaze-at-lap + point
Silent	.07 (.03)	.18 (.04)	.17 (.04)
Name	.20 (.05)	.31 (.05)	.26 (.05)
Label	.22 (.05)	.39 (.05)	.24 (.04)
Name + Label	.34 (.05)	.41 (.05)	.28 (.04)

Note. Responses significantly greater than zero (ps < .05) for all cue combinations, with the exception of silent gaze-only.

Effects of Non-Verbal Cues

To address the first research question of whether the addition of points to gaze shifts facilitates attention-following regardless of verbal cues, responses to gaze-at-target plus point and gaze-only trials were compared by 2 x 4 mixed model analysis. Type of non-verbal cue (gaze-only, gaze-at-target plus point, gaze-at-lap plus point) and type of verbal cue (silent, name, label, name + label) were the within-subjects factors. There was a significant main effect of type of non-verbal cue, $F(1,34) = 12.49$, $p < .05$, $\eta_P^2 = .27$, and type of verbal cue, $F(3,102) = 10.01$, $p < .05$, $\eta_P^2 = .23$. The interaction effect was not significant, $F(3,102) = .40$, *ns*, $\eta_P^2 = 0$. Infants were significantly more likely to look at the correct target during gaze-at-target plus point ($M = .33$, $SD = .19$) compared to gaze-only trials ($M = .21$, $SD = .14$). This replicates previous work

(e.g., Deák et al., 2000; Deák et al., 2008) demonstrating that the addition of pointing gestures to shifts in gaze reliably increases attention-following for one-year-old infants.

To address the second research question of whether attention-following was greater when the adult gazed and pointed than gazed down at her lap while pointing, gaze-at-target plus point and gaze-at-lap plus point responses were compared. There was a significant main effect of type of non-verbal cue, $F(1,34) = 6.28$, $p < .05$, $\eta_P^2 = .16$, and type of verbal cue, $F(3,102) = 4.40$, $p < .05$, $\eta_P^2 = .11$. The interaction effect was not significant, $F(3,102) = .89$, *ns*, $\eta_P^2 = .03$. Infants were significantly more likely to look at the correct target object during gaze-at-target plus point trials ($M = .33$, $SD = .19$), compared to gaze-at-lap plus point ($M = .24$, $SD = .17$). This indicates that although infants successfully located the target of the adult's attention when she gazed (gaze-only) or pointed (gaze-at-lap plus point), infants were significantly more likely to do so when the adult gazed and pointed toward the target (gaze-at-target plus point).

Ruling out an alternative explanation. Infants may have failed to follow attention because they did not look away from the non-target toys on the table in front of them. Differences in looks away from the non-target toys between types of non-verbal cues were compared with two 2 x 4 mixed model analyses. The proportion of trials in which infants looked away from the toys was the dependent variable and type of non-verbal cue and type of verbal cue were the within-subjects factors.

When gaze-only and gaze-at-target plus point trials were compared, the main effect of type of non-verbal cue was not significant, $F(1,34) = .09$, *ns*, $\eta_P^2 = 0$. The main effect of type of verbal cue was significant, $F(3,102) = 9.36$, $p < .05$, $\eta_P^2 = .22$. The interaction effect was not significant, $F(3,102) = .02$, *ns*, $\eta_P^2 = 0$. Infants looked away from the non-target toys similarly during gaze-only ($M = .69$, $SD = .20$) and gaze-at-target plus point ($M = .68$, $SD = .24$) trials.

Thus, reduced attention-following in response to gaze-only cues cannot be attributed to failure to disengage from the toys on the table in front of them.

When gaze-at-target plus point and gaze-at-lap plus point trials were compared, the main effect of type of non-verbal cue was not significant, $F(1,34) = 1.53$, *ns*, $\eta_P^2 = .04$. The main effect of type of verbal cue was significant, $F(3,102) = 7.80$, $p < .05$, $\eta_P^2 = .19$. The interaction effect was not significant, $F(3,102) = .28$, *ns*, $\eta_P^2 = .01$. Infants looked away from the non-target toys similarly during gaze-at-target plus point ($M = .68$, $SD = .24$) and gaze-at-lap plus point trials ($M = .72$, $SD = .20$). Thus, infants were equally likely to look away from the non-target toys during all of the non-verbal cues; on average, infants looked away during approximately 2/3 (5 out of 8) of trials for each type of non-verbal cue (across types of verbal cues).

Effects of Verbal Cues

To examine the effects of verbal cues, mixed model analyses were conducted within each non-verbal cue with type of verbal cue as the within-subjects factor. These analyses were performed first with looks to correct targets as the dependent variable and second with looks away from non-target toys. Planned contrasts were conducted to determine whether infants were more likely to respond when the adult provided three different types of verbal cues (name, label, name + label) compared to silent trials and whether verbal cues including labels (label, name + label) were more effective than those without labels (name). Results of these comparisons are summarized in Table 6, using critical $\alpha = .01$ (one-tailed).

Gaze-only. The analysis of looks to correct targets during gaze-only trials revealed a significant main effect of verbal cue, $F(3,102) = 7.06$, $p < .05$, $\eta_P^2 = .17$. Verbal cues with labels (label, name + label) led to increases in looks to correct targets relative to when the adult was

silent. However, verbal cues with labels were not significantly more effective than calling infants by name before shifting gaze toward the target.

Similar results were found when looks away from non-target toys were analyzed. There was a significant main effect of verbal cue, $F(3,102) = 4.62$, $p < .05$, $\eta_P^2 = .12$; infants were more likely to look away from the toys in response to verbal cues with labels (label, name + label) compared to silent trials.

Gaze-at-target plus point. The analysis of looks to correct targets during gaze-at-target plus point trials revealed a significant main effect of verbal cue, $F(3,102) = 4.04$, $p < .05$, $\eta_P^2 = .11$. Both verbal cues with labels (label, name + label) led to increases in looks to correct targets compared to when the adult was silent, however there was no significant difference between verbal cues with labels and calling infants by name.

When looks away from non-target toys were analyzed, there was a significant main effect of verbal cue, $F(3,102) = 4.76$, $p < .05$, $\eta_P^2 = .12$. Both verbal cues with labels (label, name + label) increased looks away from toys compared to when the adult was silent.

Gaze-at-lap plus point. When looks to correct targets during gaze-at-lap plus point trials were analyzed, the main effect of verbal cue was not significant, $F(3,102) = 0.97$, *ns*, $\eta_P^2 = .03$. None of the contrasts between types of verbal cues were significant.

However, the analysis of looks away from non-target toys revealed a significant main effect of verbal cue, $F(3,102) = 3.26$, $p < .05$, $\eta_P^2 = .09$. Two of the three types of verbal cues (name, name + label) significantly increased looks away from toys relative to silent trials.

Table 6

Within-subjects planned comparisons of types of verbal cues with respect to two variables: looks to correct targets and looks away from non-target toys

		Looks to correct targets		Looks away from non-target toys	
Non-verbal cue	Contrast	*t* value (d.f. = 102)	η_P^2	*t* value (d.f. = 102)	η_P^2
Gaze-only					
	Silent vs. Name	2.27	.05	1.98	.04
	Silent vs. Label	2.60**	.06	2.78**	.07
	Silent vs. Name + Label	4.58**	.17	3.53**	.11
	Name vs. Label	0.32	0	0.80	.01
	Name vs. Name + Label	2.30	.05	1.54	.02
Gaze-at-target + point					
	Silent vs. Name	1.83	.03	2.29	.05
	Silent vs. Label	2.91**	.08	2.84**	.07
	Silent vs. Name + Label	3.10**	.09	3.58**	.11
	Name vs. Label	1.08	.01	0.55	0
	Name vs. Name + Label	1.28	.02	1.29	.02
Gaze-at-lap + point					
	Silent vs. Name	1.29	.02	2.48**	.06
	Silent vs. Label	1.02	.01	2.04	.04
	Silent vs. Name + Label	1.61	.02	2.87**	.07
	Name vs. Label	0.27	0	0.43	0
	Name vs. Name + Label	0.32	0	0.38	0

**$p < .01$, one-tailed.

Analysis of Trials in which Infants did not Follow Attention

To address the final research question of where infants looked when they did not follow attention, infants' looks during incorrect trials were examined. On average, infants did not follow attention during 71% (*SD* = .17) of gaze-only, 62% (*SD* = .21) of gaze-at-target plus point, and 71% (*SD* = .18) of gaze-at-lap plus point trials. During these incorrect trials, six types of looks were examined: (1) looks to the stimulus wall, (2) looks to the experimenter's face, (3) looks to the experimenter's lap, (4) looks to the experimenter's shoulders/chest, (5) other looks, and (6) looks down at the table. The proportion of incorrect trials in which each type of look occurred was analyzed to determine whether the non-verbal and verbal cues influenced infants' looking behaviors. Looks down at the table occurred during every incorrect trial (*M* = 1.0, *SD* = 0) and were not analyzed. Looks the experimenter's shoulders/chest and other looks were rare; each type of look occurred in less than 1% of incorrect trials and were also not analyzed.

Infants' looks were analyzed by mixed model with type of look (stimulus wall, experimenter's face, experimenter's lap) as the within-subjects factor. The main effect of type of look was significant, $F(2, 66) = 87.28$, $p < .05$, $\eta_P^2 = .73$. Follow-up comparisons revealed that across the twelve cue combinations, there was not a significant difference between looks to the stimulus wall (*M* = .39, *SD* = .21) and looks to the experimenter's face (*M* = .37, *SD* = .26), $t(66) = .35$, *ns*, $\eta_P^2 = .01$. However, infants were significantly more likely to look at the stimulus wall than at the experimenter's lap, $t(66) = 11.61$, $p < .05$, $\eta_P^2 = .15$. Looks to the experimenter's face were also significantly different from looks to the experimenter's lap (*M* = .08, *SD* = .09), $t(66) = 11.26$, $p < .05$, $\eta_P^2 = .15$.

Because of the unusual nature of the gaze-at-lap plus point cues, infants' looks to the experimenter's lap during these trials were compared to looks during gaze-only and gaze-at-

target plus point trials to determine whether infants attempted to follow the experimenter's gaze down towards her lap when they did not look at the target object on the stimulus wall. Mean proportion of incorrect trials in which infants looked at the experimenter's lap for each cue combination is shown in Table 7. A mixed model analyses was conducted with type of non-verbal cue and type of verbal cue as within-subjects factors. The main effect of non-verbal cue was significant, $F(2,66) = 8.86$, $p < .05$, $\eta_P^2 = .21$. The effect of verbal cue was not significant, $F(3,98) = 1.23$, *ns*, $\eta_P^2 = .04$. The interaction effect was significant, $F(6,150) = 2.47$, $p < .05$, $\eta_P^2 = .09$.

Infants were more likely to look at the experimenter's lap during gaze-at-lap plus point than gaze-only, $t(66) = 3.74$, $p < .05$, $\eta_P^2 = .17$, and gaze-at-target plus point trials, $t(66) = 3.48$, $p < .05$, $\eta_P^2 = .16$. The difference between gaze-only and gaze-at-target plus point trials was not significant, $t(66) = 0.17$, *ns*, $\eta_P^2 = 0$.

Table 7

Mean proportion of incorrect trials (and SEs) in which infants looked at the experimenter's lap for each cue combination

	Type of non-verbal cue		
Verbal cue	Gaze-only	Gaze-at-target + point	Gaze-at-lap + point
Silent	.06 (.04)	.08 (.05)	.03 (.02)
Name	.02 (.02)	.09 (.04)	.23 (.07)
Label	.07 (.04)	.04 (.04)	.15 (.05)
Name + Label	.02 (.02)	0 (0)	.23 (.07)

Follow-up comparisons were conducted to investigate the interaction effect. These analyses revealed that when infants did not follow attention, they were more likely to look at the experimenter's lap during trials in which gaze-at-lap plus point cues were combined with verbal cues (name, label, name + label) than during silent trials (see Table 8).

Table 8

Within-subjects comparisons of verbal cues with respect to looks to the experimenter's lap during incorrect trials

Contrast	*t* value (d.f. = 150)	η_P^2
Silent vs. Name	3.13*	.06
Silent vs. Label	2.12*	.03
Silent vs. Name + Label	3.05*	.06
Name vs. Label	0.93	.01
Name vs. Name + Label	0.01	0
Label vs. Name + Label	0.92	.01

*$p < .05$, two-tailed.

CHAPTER IV

DISCUSSION

In the commotion of everyday life, infants are often surrounded by things to look at and toys to play with amidst a flurry of people talking, heads turning, hands waving, and fingers pointing. To follow others' attention in these dynamic environments, infants must monitor and respond to referential cues that are intended to re-direct their attention. This study reveals several new findings about how one-year-old infants follow attention in a distracting experimental setting and how they interpret others' referential cues.

In the current study, the "busy" experimental setting consisted of multiple targets (distal) and distracting toys (proximal). This presented several challenges for infants to engage in attention-following. Because the adult provided attention-directing cues only when infants were initially visually engaged with the non-target toys on the table in front of them, infants had to look away from the toys and follow the adult's non-verbal cue(s) in order to locate the target object. In addition, because the target stimuli were unfamiliar objects and verbal cues, even those including labels (e.g., "Look at the modi!"), did not specify the referent, infants had to use the adult's non-verbal cues to identify the target object.

A notable finding is that infants seldom followed an adult's silent gaze shifts. This seems inconsistent with previous research demonstrating robust gaze-following abilities in one-year-old infants (Butterworth & Itakura, 2000; Deák et al., 2000; Morissette et al., 1995). There are several possible interpretations for this finding. One is that infants simply did not notice the adult's head/gaze shift toward the target. However, this is unlikely given that the majority of

infants looked away from the non-target toys on the table in front of them during half of the silent gaze-only trials. In fact, 77% of infants (27 of 35) looked away from the toys whereas only 20% (7) subsequently followed the adult's gaze toward the intended target during either trial.

Another possibility is that infants did not interpret the social partner's silent gaze shift as an intentional request to direct attention (Deák et al., 2000). In typical interactions, adults frequently shift their gaze toward objects in the environment without intending to direct infants' attention toward those objects (Behne et al., 2005). It may be adaptive for infants to rarely follow silent gaze shifts; after all, even adults do not follow others' attention in response to every shift in gaze (Deák et al., 2008). Infants may require additional verbal cues to grasp the intentions behind another person's head/gaze shift (Sabbagh, Henderson, & Baldwin, 2006). This argument is consistent with the finding that adding verbal cues (e.g., label, name + label) to gaze shifts significantly increased attention-following, perhaps because the verbal cues made it easier for infants to recognize the adult's head/gaze shift as an intentional attention-directing behavior.

The addition of pointing gestures to gaze shifts also facilitated attention-following. Even when the adult silently gazed and pointed toward the target, 37% of infants (13 of 35) followed attention during one or both trials. When the adult gazed, pointed, and verbalized, the majority of infants successfully followed attention. Regardless of verbal cues, infants were significantly more likely to follow attention when the adult gazed and pointed rather than only gazed toward the target. Moreover, on average, infants looked away from the non-target toys during 2/3 of the trials for each type of non-verbal cue, indicating that reduced attention-following during gaze-only trials cannot be attributed to failure to disengage from the toys. This replicates previous work demonstrating that adding points to shifts in gaze reliably increases attention-following in one-year-old infants (e.g., Deák et al., 2000; Deák et al., 2008).

The addition of verbal cues with labels (label, name + label) to congruent gaze and point cues further increased attention-following. However, previous studies have found that general verbalizations (Deák et al.; 2000; Flom & Pick, 2003) as well as those including unfamiliar labels (Baldwin & Markman, 1989) do not increase attention-following above and beyond the effects of pointing. It is likely that methodological differences account for these discrepant findings. For example, the previous studies were conducted in relatively sparse experimental settings and involved procedures in which an adult elicited infants' attention before pointing. Both of these factors may have masked the effects of verbal cues by making the adult's non-verbal cues more salient. This claim is consistent with the current finding that infants were also more likely to look away from the toys when they heard a labeling verbalization, indicating that although points were noticeable, hearing a directive "Look" followed by an unfamiliar label was more effective in encouraging infants to look away from the toys and follow the adult's gaze and point. Although no direct comparisons of experimental settings have been made, the results of the current study indicate that the effects of verbal cues are more apparent in busier environments. However, it should be noted that the effects of verbal cues during gaze-at-target plus point trials were small (Bakeman, 2005). As infants' attention-following and language abilities develop and improve, the facilitative effects of these types of verbal cues may become more pronounced.

Responses to gaze-at-lap plus point trials revealed that infants did follow the adult's point when she gazed down at her lap. This was no small feat for one-year-old infants to accomplish. When the adult gazed down at her lap and pointed to an object, infants were faced with conflicting directional cues. To locate the intended target, infants had to overcome this conflict and follow the adult's point in spite of her downward-oriented gaze, perhaps because pointing

was regarded as a more reliably intentional referential cue than gaze. Thus, infants did not simply fail to respond to the adult's pointing gesture when she gazed down at her lap, indicating that congruent gaze cues are not a necessary condition for infants to engage in attention-following. Even without the benefits of verbal cues, it was possible to direct infants' attention toward an object by pointing while looking down, whereas gaze alone was not a sufficient cue. This suggests that, similar to the toddlers in Povinelli et al.'s (1997) study, one-year-old infants considered pointing to be an intentional attention-directing action even when head and gaze cues conflicted.

Verbal cues did not increase attention-following when the adult gazed down at her lap while pointing. That is, infants successfully followed points (with gaze down) regardless of whether or not verbal cues were provided, but infants did not benefit from the addition of verbal cues. This is in contrast to the facilitative effects of some verbal cues observed for both gaze-only and gaze-at-target plus point cues. One possible interpretation is that during gaze-at-lap plus point trials, infants failed to integrate the adult's non-verbal and verbal cues. In order to follow attention when gaze and point cues conflicted, infants may have dissociated the adult's point from her other non-verbal and verbal cues, whereas when there was no conflict to overcome, it may have been easier for infants to integrate the adult's non-verbal and verbal behaviors into a "cue package." Perhaps infants expect adults to talk about objects that they are visually focused on. For example, 18-month-old infants are able to learn a word for a novel object when it is produced by a person who is attending to the object, but not when the word comes from a person who is out of view (Baldwin, Markman, Bill, Desjardins, Irwin, & Tidball, 1996). Infants may expect that a person's verbal cues are relevant to what they are looking at. It is possible that different results would be found if target objects and their labels were familiar to infants.

Familiar targets and labels could fill in the blanks when non-verbal cues conflict by helping infants make the connection between the verbal label and the object they know to be the labeled referent (Flom & Pick, 2003).

The comparison of gaze-at-target plus point and gaze-at-lap plus point trials revealed that the social partner's head/gaze cues did influence infants' tendency to follow her point. Infants were significantly more likely to follow attention when the adult gazed and pointed toward the target than when she gazed down at her lap while pointing. Thus, although infants followed the adult's point when she gazed down at her lap, they were significantly more likely to do so when the adult also gazed at the target. From a theoretical standpoint, this suggests that point-following is not guided purely by a geometric mechanism. Although it was possible to direct infants' attention when only a point indicated the target, the combination of congruent cues was more effective than pointing while looking down in terms of directing infants' attention, suggesting that infants integrate and benefit from congruent gaze and point cues.

It is not clear how head and gaze orientation influenced infants' attention-following. Gazing and pointing toward an object may facilitate attention-following by providing redundant directional information or perhaps because gazing and pointing is considered to be more intentional than pointing while gazing down. Alternatively, gazing down at the floor could attenuate attention-following, perhaps because the location of the intended target object is ambiguous or because gazing down while pointing is less likely to be predictive of something interesting to look at (e.g., Corkum & Moore, 1995). The influence of these factors goes beyond available data; however, infants' looking behaviors when they did not follow the adult's attention suggested that they did sometimes try to follow her gaze when she looked down at her lap while

pointing. This suggests that when infants failed to follow the point, they did attempt to follow gaze.

One limitation of this study is that attention-following measures were aggregated across two trials for each of the twelve cue combinations. However, because attention-following behaviors reflect a tendency to act that should be relatively stable across contexts and over brief periods of time, more trials may be necessary to yield stable estimates of attention-following in response to each cue combination (Crocker & Algina, 1986). In the current study, the restricted number of trials that contributed to these estimates may have led to sample-specific results; attention-following scores aggregated across more than two trials may constitute more stable estimates of the tendency to follow attention. Thus, the analyses of the effects of specific verbal cues should be interpreted cautiously as the means for each individual cue combination may not be stable estimates of attention-following.

Another reason for cautious interpretation of the comparisons between types of verbal cues is that the number of contrasts may have inflated Type I errors due to multiple significance testing (Maxwell & Delaney, 2004). Although critical alpha levels were adjusted for these one-tailed contrasts in an attempt to control the experiment-wise error rate, the results of these contrasts must be interpreted cautiously and may reflect sample-specific results, especially given the absence of a significant interaction term in the omnibus analyses.

Effect sizes for both the effects of non-verbal and verbal cues were relatively small. Small effect sizes may have been observed because overall, infants' attention-following responses were low, even in response to gaze-at-target plus point cues. This may be because of the difficult nature of the attention-following task, which required infants to look away from the distracting toys on the table in front of them and notice and follow the adult's attention-

specifying cues to locate correct targets. In addition, because of the young age range of the infants in the current study (12 to 23 months). Thus, the small effect sizes observed in the current study may reflect the fact that attention-following is a sophisticated and developing ability for one-year-old infants, particularly in busy experimental settings. It is possible that larger effect sizes would be observed if responses to the different cue combinations were compared in a less distracting measurement context, or if older infants or toddlers responses were measured.

Taken together, the results reveal that infants followed an adult's gaze (gaze-only) or point (gaze-at-lap plus point), but infants were more likely to follow attention when the adult gazed and pointed toward a target (gaze-at-target plus point). There are several possible ways to interpret this pattern of results. One is that infants followed the most intentional cue provided by the social partner. Infants followed gaze when it was the only intentional cue and they followed points even when gaze conflicted. Thus, in the context of an attention-following task, infants used the most intentional cue provided by the social partner. On the other hand, infants could have simply followed the most salient directional cue. Unfortunately, it may be impossible to disentangle these two accounts empirically because pointing is a noticeable and intentional way to direct another person's attention (Triesch et al., 2006). Even if infants relied on points because of the salience of the cue, this still indicates some understanding that pointing is a socially-motivated action that is intended to refer to something in the environment (Tomasello, Carpenter, & Liszkowski, 2007).

Much of infants' waking time is spent in busy environments with many interesting objects, events, and people that compete for infants' attention. The findings from the current study shed light on how infants' attention-following functions in busy environments. When engaged with toys, infants were more likely to follow attention when points were added to shifts

in gaze. In addition, infants followed an adult's attention even when only a pointing gesture indicated the intended target object and gaze conflicted. These results also begin to inform us about how infants interpret others' attention-directing behaviors in order to respond to conflicting referential cues. Although this experimental setting was designed to simulate natural competition for infants' attention, one important issue that remains to be addressed is how caregivers modify their attention-directing behaviors in busy contexts such as driving in the car or going to the grocery store, and how infants adapt their attention-following responses in these settings. Understanding how these types of triadic interactions unfold during everyday activities is a pressing question for future research.

APPENDIX

A. Intra-class correlation coefficients

Table A1

Intra-class correlation coefficients for each cue combination with respect to looks to correct targets and looks away from non-target toys

		Non-verbal cue type		
Dependent variable	Verbal cue	Gaze-only	Gaze-at-target + point	Gaze-at-lap + point
Looks to correct targets				
	Silent	1.00	.95	.80
	Name	.88	1.00	1.00
	Label	1.00	1.00	1.00
	Name + Label	1.00	.81	.73
Looks away from non-target toys				
	Silent	1.00	1.00	1.00
	Name	1.00	1.00	1.00
	Label	1.00	1.00	1.00
	Name + Label	1.00	1.00	1.00

Table A2

Intra-class correlation coefficients for each cue combination with respect to looks to the stimulus wall, looks to the experimenter's face, and looks to the experimenter's lap

		Non-verbal cue type		
Dependent variable	Verbal cue	Gaze-only	Gaze-at-target + point	Gaze-at-lap + point
Looks to the stimulus wall				
	Silent	1.00	1.00	1.00
	Name	1.00	1.00	.70
	Label	1.00	1.00	.94
	Name + Label	.64	1.00	1.00
Looks the experimenter's face				
	Silent	.92	1.00	1.00
	Name	1.00	1.00	1.00
	Label	1.00	1.00	1.00
	Name + Label	1.00	1.00	.77
Looks to the experimenter's lap				
	Silent	1.00	1.00	1.00
	Name	1.00	1.00	1.00
	Label	1.00	1.00	1.00
	Name + Label	1.00	1.00	1.00

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