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Driven from distraction: How infants respond to parents' attempts to elicit and re-direct their attention

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Abstract

This experiment examined how parents' verbal and non-verbal behavioral cues cause infants to shift and share attention within environments where many objects compete for infants' attention. Fifteen- and 21-month-old infants played with toys while their parent periodically shifted attention to a distal object within a larger array. Parents' attention-shifts were indicated by a change in direction of gaze, a pointing gesture, and/or verbalizations. Verbalizations were either attention-eliciting or attention-directing. In some trials parents covered their eyes to occlude line-of-gaze. Both ages seldom followed simple gaze shifts, but frequently followed gaze with-points or gaze-with-directing verbalizations. Attention-eliciting verbalizations increased infants' looks to the parent. Gaze occlusion reduced infants' responses to directing verbalizations. Responses to eliciting verbalizations increased with age. Infant receptive vocabulary did not predict attention-sharing, even when parents named objects (i.e., directing verbalizations). Implications for development of attention-sharing, language and understanding of visual attention are discussed.

Keywords: Attention-shifts; Infant social development; Infant vision; Language development; Non-verbal communication; Pointing; Pragmatic development; Visual search; Gaze perception; Shared attention

1. Introduction

By their first birthday most infants can monitor and follow an adult's attention to share an experience. Before their second birthday toddlers can shift their attention to follow adults' line-of-gaze or pointing gestures, or in response to adults' verbal directives. These abilities exemplify the emerging facility for *attention-sharing*. Episodes of attention-sharing are critical for communication, social learning, and inferring others' interests and intentions. For example, deficits of attention-sharing are predictive of deficits in language ability (Dawson, Toth, Abbott, & Osterling, 2004; Mundy, Sigman, & Kassari, 1990). Yet little is known about which actions and combinations of actions compel infants to share a caregiver's focus of attention. Specific caregiver behaviors might offer infants critical spatial information (e.g., pointing towards an object), symbolic information (e.g., saying "Look at the balloon!"), or both.

To consider how caregivers' non-verbal/spatial and verbal/symbolic behaviors promote infants' attention-following, we conceptualize the process as typically two-phased: infant attention is first elicited to focus on the adult, and

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then re-directed toward a specific target or region specified by the adult's actions. By differentiating *eliciting* and *directing* effects we might better understand how adults' non-verbal and verbal behaviors promote attention-sharing.

The current investigation tested infants' attention-following in a controlled environment that contained many potentially distracting stimuli, akin to infants' everyday environments. This is different than most experiments which use impoverished test settings (Moore & Dunham, 1995). Within this test environment infants' responses to a variety of caregiver cues were tested. The overarching purpose was to investigate how infants follow typical combinations of caregiver attention-cue within a realistically distracting environment.

1.1. Eliciting and directing infant attention

Experimental studies of gaze- or point-following usually assume that infants are attending to the adult. Typically the adult calls the infant, then looks or points towards a target, and repeats this sequence for several trials. From this method we have learned, for example, that 12-month-old infants can follow gaze or a pointing hand to targets in front of or behind them (Deák, Flom, & Pick, 2000). Yet parents trying to direct their infants' attention do not typically call them and then silently turn or point towards a target (Deák, Krasno, Jasso, & Triesch, 2006). Rather, parents produce complex combinations of non-verbal and verbal cues, partly contingent upon the infant's ongoing actions. Also, infants 4 months or older do not constantly attend to caregivers (Bakeman & Adamson, 1984; Deák et al., 2006), so infants might not notice adults' attention cues (e.g., gaze shifts). Thus, to understand infants' attention-sharing we distinguish between caregiver behaviors that *elicit* and *direct* their attention.

An adult trying to re-direct infants' attention might first *elicit* their attention by verbalizing or making other sounds (e.g., clapping; saying "Wow!": Butler, Caron, & Brooks, 2000; Gewirtz & Pelaez-Nogueras, 1992). *Eliciting* cues are actions that tend to disengage the infant's current focus of attention (Hood & Atkinson, 1993) and re-direct it to the actor, thus potentiating subsequent social responses. A common and effective eliciting cue might be the sound of the infant's own name. Four-month-olds' attention is captured for longer by the sound of their name than another name (Mandel, Jusczyk, & Pisoni, 1995), and older toddlers seem to know that their name refers to them (Stipek, Gralinski, & Kopp, 1990). Yet it is not known when infants process the sound of their name not merely as a familiar word, but as a cue to subsequent social exchange. Thus, though *any* utterance might draw infants' attention, especially if said by a caregiver in infant-directed prosody (Fernald, 1985), attention-following requires orienting to the caregiver *and* preparation for a subsequent attention-shifting response. Infants who do not yet understand the illocutionary force of someone calling their name might orient to the sound, but then remain focused on the caller. We therefore tested 1-year-olds' tendency to orient to a caregiver calling their name, but remain responsive to subsequent cues instead of just focusing on the caregiver.

Besides the sound of their own name, non-verbal behaviors might also elicit infants' attention. Because peripheral retinal fields are relatively sensitive to motion, larger motions such as pointing gestures might effectively elicit infants' attention to the caregiver (especially if parents make wider-ranging manual actions when interacting with infants: Brand, Baldwin, & Ashburn, 2002). Thus, we compared the eliciting effects of a caregiver saying the infant's name versus making pointing gesture, in terms of the infants' looks to the caregiver and subsequent attention-following.

We also considered attention-directing functions of caregiver behaviors. Once an infant has oriented to an adult she or he might re-direct attention in response to non-verbal behaviors such as the direction of adult's gaze or point, or to verbal cues like an imperative utterance (e.g., "Hey, look at that!"). By 12 months, infants in experimental settings sometimes follow caregivers' gaze shifts, even towards targets behind them and out of sight (Deák et al., 2000). By 9–12 months infants reliably follow adults' points (Butterworth & Itakura, 2000; Butterworth & Jarrett, 1991; Deák et al., 2000; Flom, Deák, Phill, & Pick, 2003; Morissette, Ricard, & Gouin Décarie, 1995). The pointing advantage is found in experimental tests where infants start out attending to the adult. This suggests a robust attention-directing effect independent of any eliciting effects of pointing. Thus, we predicted that 1-year-old infants would follow caregivers' points more than gaze shifts. Also, although there is no evidence that points are more effective than gaze shifts at both eliciting *and* re-directing infants' attention, we speculated that in an environment with many distractions, the wide-ranging motion of pointing gestures might elicit infants' attention more effectively than head turns, and thus facilitate subsequent attention-following.

Adults also verbalize to direct infants' attention. Some verbalizations have *deictic* functions (Wales, 1979) analogous to pointing. However, the effects of such verbalizations are unclear. Namy and Waxman (2000) found 17-month-old infants associate a referent with a word following “Look at the . . .” better than the word in isolation. By contrast, Flom and Pick (2003) found no effect of parents’ verbalizations on infants’ attention-following. It is unknown whether the phrase “Look at the [OBJECT LABEL]!” can direct 1-year-olds’ attention. If not, it is still possible that the phrase (or any verbalization) will *elicit* infants’ attention without facilitating subsequent re-direction. A complication is that effects of directing verbalizations might depend on infants’ language comprehension. Perhaps infants only follow attention to a given target if they understand its label. A positive correlation has been reported between infants’ vocabulary and prevalence of attention-sharing (Mundy & Gomes, 1998; Tomasello & Todd, 1983), but the nature of the association is ambiguous; although it is usually assumed that attention-sharing promotes vocabulary growth, it is equally plausible that greater vocabulary (or comprehension) facilitates attention-sharing. Thus we predict a positive relation between infant’s comprehension of target labels (or vocabulary) and response to directing verbalizations. However, because Flom and Pick (2003) found an effect inconsistent with this prediction, and because 1-year-olds might simply use adults’ gaze as a directing cue, the results are uncertain.

A comparison of gaze direction, pointing and verbalizations is theoretically interesting because all can “refer” to an entity, scene, or event. However, gaze and pointing are spatially informative (pointing more than gaze perhaps) whereas directing utterances are symbolically informative. Comparing infants’ responses to pointing and directing verbalizations is ecologically relevant because parents in everyday interactions use gaze, pointing, *and* denotative imperative verbalizations to indicate a referent of interest (Deák et al., 2006; Ninio, 1980). However, it is hard to tell how each cue or cue combination affects infants’ attention. Deák et al. (2000) and Flom et al. (2003) compared effects of gaze plus-pointing combinations with and without added verbalizations on 9-, 12- and 18-month-olds’ attention-following. Verbalizations had no added effect in a stripped-down test setting, perhaps because they added no informative to points. However, a subtler added effect of verbalizations was found by Flom and Pick (2003). Also, as the next section explains, infants in more naturally distracting settings might respond differently to various combinations of verbal and non-verbal cues.

1.2. Attention-sharing in settings with many distractions

Little is known about how different environments affect infants’ attention-following. Controlled studies have been restricted to artificially impoverished settings (e.g., Butterworth & Jarrett, 1991; Deák et al., 2000; Moore, Angelopoulos, & Bennett, 1997; Morissette et al., 1995), but infants socialize in dynamic, cluttered settings with many interesting sights, sounds, and agents that vie for attention. This competition for attention could be an important factor in social development. Adults in Western cultures, for example, try to make infants’ environments “stimulating” by providing artifacts and events to engage infants’ attention. It is not known how atypically bare experimental settings influence infants’ attention-sharing responses. For example, adults’ behavioral cues might be harder for infants to detect, or easier to ignore, in busy settings. Moreover, attention-eliciting cues might be especially important within busy environments. Finally, busy environments might favor redundant (i.e., more elaborate) cue combinations.

Experimental studies also call for the adult confederate to present repetitive, simple behaviors over multiple trials. Yet caregivers in natural interactions produce a wide range of behaviors at a fairly fast rate (Deák et al., 2006). Thus, infants in experimental studies might learn that the adult’s cues are invalid, or habituate to them across trials (Deák et al., 2000), and thus respond less. It remains to be seen how infants respond over multiple trials to an adult producing a variety of realistically complex behaviors.

To address these questions we tested the effects of caregivers’ (or CG’s) eliciting and directing cues on infants’ attention in a controlled setting that was distracting enough to simulate natural competition for attention. Although many factors could make an environment more distracting, we operationalized it as an abundance of visual targets, both distal and proximal. Proximal targets were age-appropriate toys within the infant’s reach. Distal targets were eight objects spaced along a far wall. The CG was seated just beyond the toys so all her behaviors were visible to the infant even when attending to the toys. CGs interacted naturally with their infants, but, when specific timing and situational contingencies were met the caregiver was told to produce one of seven cue combinations to indicate a distal target. Each combination included one or more cues. The basic cue was a *gaze shift* to the target, which also serves as a within-subjects baseline to compare other cues and combinations. Other cues were: eliciting verbalizations, directing verbalizations, pointing gestures, and a gesture to block the CG’s own gaze. These are described in Table 1 (panel “A”). The cue combinations (see Section 2 for details) are described in Table 1, panel B. These were chosen to address how

Table 1
(A) Description of specific verbal and non-verbal cues, as operationalized and (B) description of seven cue combination types produced by caregivers in test trials

A. Cues	Abbreviation	Description
Gaze shift	G	CG makes smooth head turn (from starting pose of head at midline with eyes down) to directly face a target, with eyes centered
Eliciting verbalization	EV	CG calls infant's name ("Max, Max!") said just before shifting gaze to a target
Directing verbalization	DV	CG utters imperative with conventional target label ("Look at the balloon!") during gaze shift to target
Point	P	CG extends hand and arm) resulting in a line to the target, while shifting gaze to that target
Blocked gaze	BG	CG raises open hand right in front of eyes, leaves it upraised while shifting gaze to, and looking at, target

B. Cue combinations	Abbreviation	Description
Gaze only	G	CG looks down for 2–3 s, then looks up at infant for 1–2 s, then shifts gaze (head and eyes together), smoothly and at normal speed, to a target. CG looks directly at target for 10 s
Gaze + eliciting verbalization	G + EV	CG calls infant's name twice ("Max, Max!") in natural "calling" prosody (i.e., slightly excited), before turning to look at target
Gaze + directing verbalization	G + DV	CG produces imperative "Look at the [object label]!" using natural prosody when first looking at target. Conventional object label is used
Gaze + directing & eliciting verbalizations	G + EV + DV	CG produces eliciting verbalization just before shifting gaze to target, and immediately follows with directing verbalization
Gaze + point	G + P	CG extends one arm and hand with a finger pointing toward target. Point is produced in rough synchrony with gaze shift and help for 10 s
Blocked gaze	BG	CG raises open hand in front of eyes before turning to target, and leaves hand to occlude gaze for entire 10 s trial
Blocked gaze + directing verbalization	BG + DV	CG blocks gaze, and produces directing verbalization when first looking at target

specific verbal and non-verbal cues, produced in conjunction with gaze shifts, elicit or direct infants' attention. This design also addresses questions about social development in the second year.

1.3. Developmental changes in attention-sharing

Developmental changes in attention-following occur in the second year. From 9 to 18 months infants become more responsive to adults' attention cues in laboratory settings, follow caregivers' gaze shifts and pointing gestures more reliably, and start responding to smaller gaze shifts (Butterworth & Jarrett, 1991; Deák et al., 2000; Morissette et al., 1995). We do not know, though, how these skills change in a range of environments with various degrees of clutter and distraction. Perhaps in more natural environments younger infants require more explicit eliciting cues than older infants, for example. To address such questions we compared younger 1-year-olds of about 15 months to older 1-year-olds of around 22 months.

Major advances in language abilities mark the second year of life, and these might change infants' responses to verbal cues. With respect to directing verbalizations, for example, vocabulary increases greatly in the second year (productive vocabulary median = 40 words at 16 months versus 280 words at 21 months; Fenson et al., 1994). Older infants, who know more words, might be able to use the object label to pick out the appropriate target. By this logic, infants' vocabulary size should be correlated with ability to follow directing verbalizations.

Pragmatic skill also develops extensively in the second year: A large-scale study by O'Neill (2007) documents changes from 18 to 24 months in infants' uses of receptive language in shared attention. This and related age differences (Ninio & Snow, 1996) suggest 21-month-olds might be better at inferring the purpose of caregivers' attention-sharing bids. Development of the ability to associate others' actions with underlying intentional states seems to emerge around 14–15 months (Baldwin & Moses, 2001) but is more robust by 18–22 months (Bretherton, McNew, & Beeghly-Smith, 1981; Melzoff, 1995; Moses, Baldwin, Rosicky, & Tidball, 2001; Tomasello, 1999). Thus, 21-month-olds might grasp the intended meaning of eliciting verbalizations (i.e., look at me, then follow my lead to look at something else), but 15-month-olds might not.

Because ability to infer others' mental states (e.g., attention) from observable behaviors improves from 15 to 21 months, the current study can shed light on the development of understanding others' seeing and attention. How do 1-year-old infants infer others' *seeing* (a covert mental state) based on their *gaze* (an overt behavior)? Gaze-following might be learned without inferences about seeing (Corkum & Moore, 1995; Triesch, Teuscher, Deák, & Carlson, 2006); in fact, even 3-year-old children do not fully grasp the relation between "looking at" and seeing (Flavell, Green, Herrera, & Flavell, 1991). Brooks and Meltzoff (2002) found 14- and 18-month-olds, but not 12-month-olds, followed an adult's gaze less if the adult wore a blindfold than a headband (see also Caron, Butler, & Brooks, 2002). Thus, 21-month-old infants should be able to infer an adult's focus of attention based on direct line-of-gaze, but it is less clear if 15-month-old infants can do so. To provide additional data from a controlled setting with some distractions, we added trials in which the caregiver interposed a gaze barrier (her hand) between her eyes and the target. If the barrier reduces gaze-following in 21-month-olds more than in 15-month-olds, it will support the idea that 1-year-olds gradually learn the significance of line-of-gaze for visual attention. If both ages do less attention-following it will confirm reports that infants as young as 14 months have some sensitivity to line-of-gaze. If neither group alters their attention-following it might suggest that in distracting settings infants do not use line-of-gaze information.

1.4. Summary of purpose

This study assessed 1-year-old infants' responses to caregivers' attention-specifying cues in an environment with distractions. In a room with various distal objects and toys within reach, parents periodically shifted attention to targets, using various combinations of verbal and non-verbal behaviors. Every combination involved a gaze shift. Some included an eliciting or directing verbalization or pointing gesture, or the caregiver put a hand in front of her eyes while looking towards the target. Also, infants' vocabulary and knowledge of target labels were tested to determine their relation to attention-following.

2. Method

2.1. Participants

Infants of normal birth weight with no known birth complications were recruited from birth records in Davidson County, TN. Eighty-one parent-infant dyads participated. Six 15-month-old (one girl, five boys) and four 21-month-old infants (three girls, one boy) were excluded due to parental ($n = 9$) or experimenter ($n = 1$) error. The other 71 infants were 33 15-month-olds (17 girls, 16 boys; mean age = 15.0 months; range 13.8–16.2) and 38 21-month-old infants (18 girls, 20 boys; mean age = 20.9; range 19.4–21.8). Parent participants were all mothers except for three fathers. Infants were African–American ($n = 1$), Caucasian ($n = 69$), and Hispanic ($n = 1$). Family incomes were lower-middle class ($20–50 k/year.; $n = 30$), middle- ($50–100k/year.; $n = 36$) and upper-middle class (≥$100k/year.; $n = 11$). Each child received a small gift for participating.

2.2. Materials

Eighteen target objects were chosen based on words understood by at least 50% of 14-month-olds, according to Bates-Macarthur CDI data (Fenson et al., 1994). Objects were age- and size-appropriate tokens of *apple*, *ball*, *balloon*, *banana*, *bear*, *bottle*, *brush*, *bunny*, *car*, *cup*, *dog*, *doll*, *duck*, *flower*, *hat*, *keys*, *phone*, and *spoon*. Only 16 objects were used: each parent initially identified two of the 18 objects that were most preferred by their infant, and these were excluded. This was meant to minimize false positives from spurious fixations on favorite objects.

Children were tested in a 3.8 m × 5.3 m room (see Fig. 1). A child-sized table (61 cm^2) was in the center, with a child-sized chair on one side and a floor pillow on another. Several age-appropriate toys were placed on the table; these were switched between trial blocks.

Along one wall of the room clear shelves were placed 0, 90, and 180 cm high in each of three columns 1.4 m apart, with the center column aligned with the table. Eight shelves held targets; the lowest shelf of the furthest column was occluded by the table and therefore left empty. Two video cameras with zoom lenses were placed between the columns

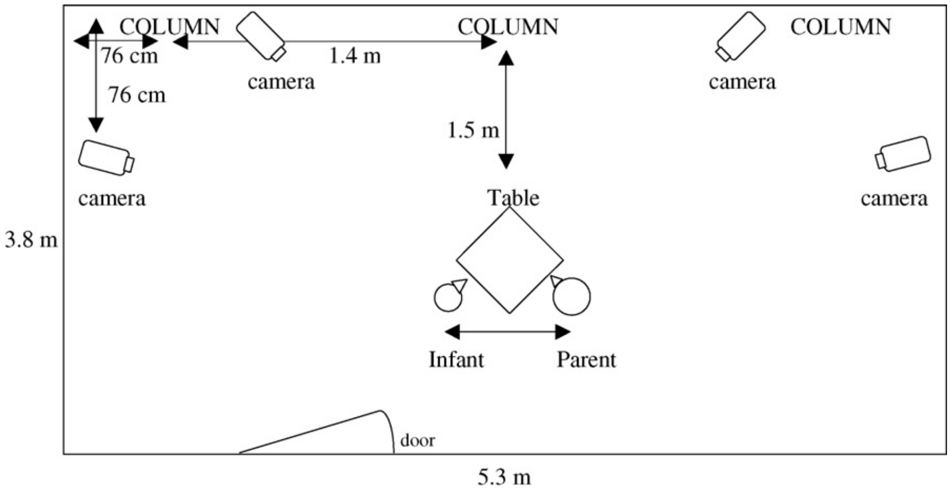

Fig. 1. Configuration of the testing room. See text for description of cameras, table/participants, and columns with stimulus shelves.

and focused on infants' heads. Two cameras with wide-angle lenses were on each side of the room to provide a more contextualized view of the dyad. The four videos were routed through quad-screen and time-stamp generators and recorded on a Panasonic VHS VCR.

2.3. General procedure

When dyads arrived at the lab an experimenter explained the procedure and parents filled out consent and demographic forms. The infant and parent were seated in a chair and on a pillow, respectively, at the testing room table. Age-appropriate toys were placed on the table to interest the infant. The parent's head was near the center of the infant's visual field and slightly above the table and about 80 cm away. This ensured the parent's head, and any gaze shift, were visible to the infant, and that we could code when infants looked at the parent's face rather than toys.

The parent was fitted with an earphone to receive instructions from experimenters in another room. A microphone in the testing room recorded the interaction. A cue card with descriptions of the cue type and a chart of the eight target locations was placed in front of the parent. This allowed the parent to locate targets without visually searching.

Testing sessions included two blocks of seven trials. Each trial began when the infant was seated and attending to toys, but oriented so the parent's head was in her/his visual field, as determined by an experimenter watching a monitor from an adjacent room. The experimenter then prompted the parent to produce the next cue combination (see below) on the instruction sheet. Parents were instructed not to interrupt an ongoing interaction but wait for the soonest opportunity to produce the cue naturally. The experimenter gave prompts to ensure a fairly consistent trial pace both within and between infants. Parents first completed two practice trials (with different objects) and received feedback.

After one block of trials an experimenter replaced target objects, toys, and cue and object sheets. During this time infants were distracted with a toy while a barrier prevented them from watching the new targets being placed. The procedure was then repeated for seven more trials. Cue order was randomized in each block, and each cue combination (or trial) type occurred once per block. Objects were randomly assigned to locations and trials.

2.4. Cues and cue combination types

Because pilot testing showed infants could complete about 14 trials before tiring, seven trial types (based on seven cue combinations) were chosen to address the theoretical questions outlined above. Given the novelty of the paradigm, this exploratory design was chosen over a more thorough but narrower comparison of fewer cues or simpler (but less interesting) combinations.

Baseline attention-following was assessed in two *gaze only* (*G*) trials (see Table 1 for description). The same action was produced in all other trial types.

Three other trial types used this procedure and added verbal cues: *gaze + eliciting verbalization* (*G + EV*), *gaze + directing verbalization* (*G + DV*), and *gaze + eliciting + directing verbalizations* (*G + EV + DV*). A fifth trial type added a second non-verbal cue: *gaze + point* (*G + P*). The last two trial types *blocked gaze* (*BG*) and *blocked gaze + directing verbalization* (*BG + DV*), were modified from previously described (G and G + DV). Note that adults would interpret the blocked gaze as a person deliberately trying not to look at something.

After testing parents completed a checklist of their infant's comprehension of words for the target object as well as 12 filler words. Parents also received the MacArthur-Bates CDI (Communication Development Inventory; Fenson et al., 1994). This checklist estimates receptive and expressive vocabulary. Parents were to complete, within 2 weeks, the Infant form (comprehension and production) or Toddler form (production only), depending on infant age.

2.5. Coding

Behaviors were coded from videotape with the PROCODER computer-assisted observational coding system (Tapp & Walden, 1993). Target behaviors are entered into a computer that controls an S-VHS VCR with single frame accuracy and automatic VITC time code stamping.

Infants' looks to the parent in each trial also were coded to assess attention-eliciting effects. These were defined as fixating on the parent's head/face or pointing arm/finger (in G + P trials) while the parent produced the cue(s). Between-coder agreement Kappa = 0.91.

Joint attention scores were the number of trials where the infant followed the parent's cue. Coders blind to the cue on each trial and partly blind to infant age (they could, however, see infants on video) judged the primary focus or foci of infants' attention in each trial. The focus could be any of the target locations or an alternate focus: proximal toys, floor, table, non-target wall, or the infant's own body. Coders could also code a *scan* trial if the infant looked at various locations on the target wall without fixating a particular object. If the infant looked at the target location a score of 1 was given. If the infant looked at the object just above or below the target location they received 0.5: given the fairly small visual angle between vertically adjacent locations, a look towards one of these would likely reflect an attempt to follow the adult's attention. If the infant looked at non-adjacent object location or an alternate focus, or scanned, they received a score of 0. Accuracy scores were summed for each cue combination type for each infant (range = 0–2). Fifteen infants' videotapes (21%) were re-coded by a second observer. Between-coder agreement was computed as a weighted Kappa (with disagreements between two vertically adjacent positions coded as 0.5). The mean weighted Kappa = 0.73, which exceeds acceptable levels (Cohen, 1968).

3. Results

Because a few trials were coded as invalid (usually due to parent error) we examined whether it was justified to retain for analysis infants who had all but one valid trial ($n = 14$; another five infants had all but two valid trials). We compared $n = 52$ infants who completed all trials (mean age = 18.4 months) to $n = 19$ who completed all but one or two trials (mean = 18.0 months) on 17 dependent measures (details available from author) by t-tests (d.f. = 69). No group difference was significant and only one was marginal ($p < .10$), so infants who completed all but one trial were retained. Most variables (see below) were analyzed and reported as proportions; thus infants with only one trial of a given type received an extrapolated score based on the one trial.

Gender differences on all dependent measures were compared by t-tests. No significant or marginal differences were found, so girls and boys were combined in all analyses.

3.1. Looking at the caregiver

The mean proportions (with S.E.s) of trials of each combination during which infants looked at the parent are shown in Fig. 2. It seems infants of both age groups looked at the parent in most trials. To examine in detail how different cue combinations compelled infants to look at parent, means were compared by repeated-measures ANOVA with seven cue combinations within-subjects and age between-subjects. The main age effect was not significant, $F(1, 64) < 1$. Thus, if 21-month-olds follow parents' attention to targets more than 15-month-old, it is not because they look at parents more to encode cues such as gaze direction. The within-subjects cue combination effect was significant, $F(6, 384) = 9.0$, $p < .001$ ($\eta^2 = .12$). There was no interaction of age and cue type, $F(6, 384) < 1$.

Both G + EV and G + DV trials elicited more looks to parents (means = 82 and 77%, S.D.s = 31, 33%) than trials with gaze alone (58%, S.D. = 35%). Thus, either type of verbalization had an additive eliciting effect. This effect was

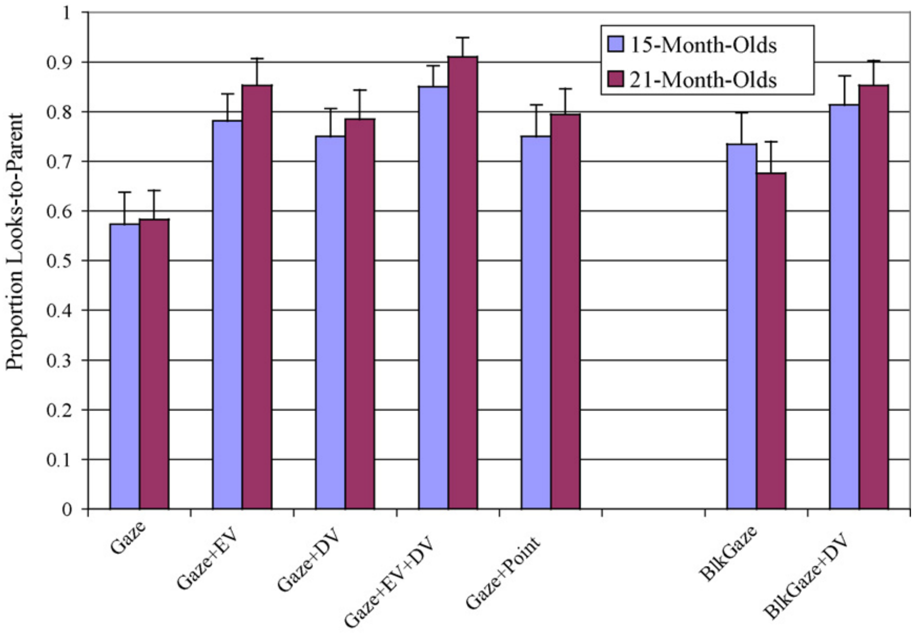

Fig. 2. Mean proportion of trials (with S.E. bars) in which infants of each age group looked at parent, for each of seven cue combinations (gaze, gaze + EV, gaze + DV, gaze + EV + DV, gaze + point, and blocked gaze and blocked + DV).

not limited to simple gaze shifts: when parents raised their hand to block gaze (mean = 70%, S.D. = 36%), added DVs (i.e., BG + DV) also significantly increased looks to parents (to 83%; S.D. = 31%). Thus, when parents verbally exhort their infants in some way, infants tend to look at them, whatever the parents are looking at.

Evidence that EVs were especially effective was equivocal: adding eliciting to directing cues (G + EV + DV versus G + DV) increased looks to parent (88% versus 77%; S.D.s = 23, 33%). However, G + EV and G + DV trials did not differ, and a silent pointing gesture caused a similar increase in looks to the parent (mean = 77%, S.D. = 33%). On the other hand, a combination of verbal cues (G + EV + DV) elicited the most looks to parents. Also, other non-verbal actions, specifically raising a hand to block gaze, also increased looks compared to gaze shifts (G versus BG).

To assess infants' consistency, individual infants' responses to both trials of each type were examined. The percent of infants (both ages) who responded to 0, 1, or 2 trials is shown in Table 2 (left side). In all cue types except gaze only and blocked gaze, most infants of both ages looked at the parent on both trials. This means, importantly, that on most trials infants could encode parents' gaze direction.

3.2. Following to the target

The main question was whether infants followed CG cues to focus on a specified target. First, to test for fatigue, block (split-half) differences were tested by within-subjects *t*-test. First and second blocks did not differ in percent of trials with correct following (means 30% versus 33%, S.D.s = 17%), $t(65) = 1.3$, $p = .21$.

The mean proportion of correct following responses for each cue combination in each age group is shown in Fig. 3 (with S.E.s). Data were analyzed by a repeated-measures ANOVA with age between-subjects and cue combination within. The age difference was significant, $F(1, 64) = 10.3$, $p = .002$, $\eta^2 = .14$. The within-subjects factor also was significant, $F(6, 384) = 42.2$, $p < .001$, $\eta^2 = .40$. The mixed-measures interaction was marginally significant, $F(6, 384) = 2.3$, $p = .051$ (with Greenhouse-Geisser adjustment). Note that if combinations with blocked gaze are eliminated from the ANOVA, leaving five within-subjects levels, the main effects remain but the age-by-cue interaction becomes non-significant ($F(4, 256) = 2.0$, $p = .11$).

Differences between cue combinations were examined by within-subjects *t*-test contrasts. We examined a subset of theoretically motivated contrasts, again with critical $\alpha = .01$: G versus G + EV; G versus G + DV; G + EV versus G + DV; G + DV versus G + EV + DV; G versus G + P; G + P versus G + EV + DV; G versus BG; BG versus BG + DV. These are also shown in Table 3 in the "Follows to target" rows.

Table 2
Percentages [and numbers] of infants (15-month and 21-month-old groups in separate rows) that responded to 0, 1, or 2 trials of each combination

Cue type	Age (m)	Looks at parent			Looks at parent + follows to target		
		0	1	2	0	1	2
Gaze	15	21.9 [7]	43.8 [14]	34.4 [11]	93.8 [30]	6.3 [2]	0 [0]
	21	17.6 [6]	50.0 [17]	32.4 [11]	94.1 [32]	5.9 [2]	0 [0]
Gaze + EV	15	6.3 [2]	31.3 [10]	62.5 [20]	90.6 [29]	0 [0]	9.4 [3]
	21	8.8 [3]	11.8 [4]	79.4 [27]	52.9 [18]	44.1 [15]	2.9 [1]
Gaze + DV	15	9.4 [3]	31.3 [10]	59.4 [19]	62.5 [20]	28.1 [9]	9.4 [3]
	21	11.8 [4]	17.6 [6]	70.6 [24]	44.1 [15]	11.8 [4]	44.1 [15]
Gaze + EV + DV	15	3.1 [1]	25.0 [8]	71.9 [23]	37.5 [12]	37.5 [12]	25.0 [8]
	21	2.9 [1]	11.8 [4]	85.3 [29]	29.4 [10]	23.5 [8]	44.1 [15]
Gaze + point	15	12.5 [4]	25.0 [8]	62.5 [20]	37.5 [12]	28.1 [9]	34.4 [11]
	21	5.9 [2]	29.4 [10]	64.7 [22]	26.5 [9]	29.4 [10]	44.1 [15]
Blocked gaze	15	12.5 [4]	28.1 [9]	59.4 [19]	84.4 [27]	15.6 [5]	0 [0]
	21	14.7 [5]	35.3 [12]	50.0 [17]	91.2 [31]	5.9 [2]	2.9 [1]
Blocked G + DV	15	9.4 [3]	18.8 [6]	71.9 [23]	78.1 [25]	15.6 [5]	6.3 [2]
	21	5.9 [2]	17.6 [6]	76.5 [26]	55.9 [19]	32.4 [11]	11.8 [4]

Note: Responses listed are (left columns) looking to parent; and (right columns) looking-to-parent *and* following to the correct target. For $n = 14$ infants missing one trial (see text), number of responses for the incomplete trial type is imputed from the remaining trial (i.e., 0 or 2 correct). Sample size: 15-month-olds: $n = 32$; 21-month-olds: $n = 34$.

Correct following was increased (compared to simple CG gaze shifts: mean = 7.7%, S.D. = 14.4%) by eliciting verbalizations (21.6, 25.9%), by directing verbalizations (48.0, 33.8%), and by pointing (54.9, 34.0%). Thus, a range of verbal or non-verbal cues added to a parent's gaze shift can effectively increase infants' following to a specific distal target.

Yet not all verbal cues are created equal. DVs were more effective than EVs (means = 48% versus 22%). Also, producing both verbalizations compelled more following (mean = 53.0%, S.D. = 31.1%) than just EVs (i.e., G + EV + DV versus G + EV). (Conversely, G + EV + DV did not differ from G + DV, $t(65) = 1.1$, $p = .29$, suggesting EVs did not have

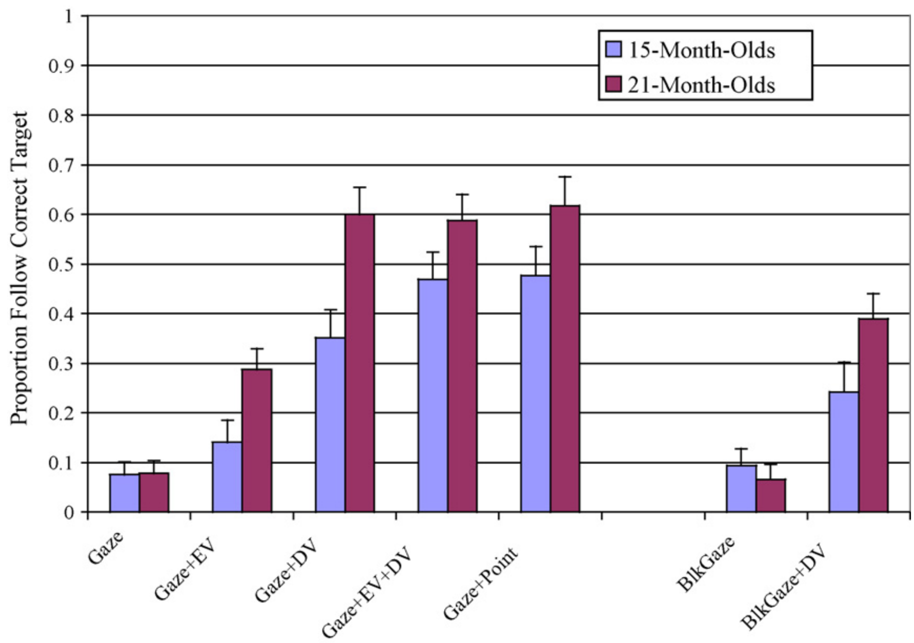

Fig. 3. Mean proportion of trials (with S.E. bars) in which infant fixated on correct target location, by each age group for each of seven cue combinations.

Table 3
Within-subjects planned comparisons of specific cue combinations, with respect to two variables: looks to CGs, and following to the target

Contrast	Variable	Theoretical question	*t* value (d.f. = 65)	*p*-value
G vs. G + EV	Looks to CG	Do EVs draw infants' (Inf.) attention to CG's face/head (more than a non-verbal gaze shift)?	4.3	<.001
	Follows to target	Do EVs predispose or "set the stage" for Inf. to follow CG's head/face to CG's visual target?	4.4	<.001
G vs. G + DV	Looks to parent	Do DVs draw Inf. attention to CG's face/head?	3.5	.001
	Follows to target	Do DVs encourage Inf. to shift attention to the named target?	9.4	<.001
G + EV vs. G + DV	Looks to parent	Do EVs draw Inf. attention to CG more than other verbalizations (e.g., DVs)?	1.1	*ns*
	Follows to target	Do DVs encourage Inf. to shift attention to a specific target more than other verbal imperatives (EVs)?	5.6	<.001
G + DV vs. G + EV + DV	Looks to parent	Do EVs have an attention-eliciting effect greater than other verbal (DV) and non-verbal (G) cues?	3.1	.003
	Follows to target	Do DVs increase Inf. attention-shifting to a specific target above another verbal imperative (EV)?	7.7	<.001
G vs. G + P	Looks to parent	Do P gestures away from CG draw Inf. attention to CG's face/head, more than gaze shift alone?	3.6	.001
	Follows to target	Do P gestures away from CG encourage Inf. To shift attention to the specified target?	11.9	<.001
G + P vs. G + EV + DV	Looks to parent	Do EV, DV sequences draw Inf. attention to CG's face/head more than P gestures away from CG?	2.4	.018
	Follows to target	Do P gestures encourage Inf. as much as EV, DV sequences to shift attention to a specified target?	<1.0	*ns*
G vs. BG	Looks to parent	Do Inf. look at CG's face/head more when CG shifts gaze, if CG raises hand in front of face?	2.6	.010
	Follows to target	Do Inf. follow CG's gaze more to a specific target if the CG has a direct line of sight to the target?	<1.0	*ns*
BG vs. BG + DV	Looks to parent	Do Inf. look at CG's face/head less if a DV follows CG's gaze shift with raised hand?	3.5	<.001
	Follows to target	Do DVs increase Inf. attention-shifting to a specific target more, when CGs hand is in front of eyes?	5.7	<.001

Note: The combination that elicited more responses is underlined in the left column. BG: blocked gaze; CG: caregiver; DV: directing verbalization; EV: eliciting verbalization; G: gaze direction; P: point. See Table 1 and text for explanation.

much added directing influence). Also, pointing gestures were as effective as both verbalizations together (means = 55% versus 53%).

Blocked gaze shifts elicited no less following (mean = 7.9%, S.D. = 18.1%) than normal gaze shifts. However, adding a DV to blocked gaze increased following (mean = 31.8%, S.D. = 32.4%) above a silent blocked gaze. As a follow-up we compared G + DV to BG + DV (means = 48% versus 32%; not shown in Table 3) to assess whether DV effects are independent of CG's non-verbal cues. In fact the effects are not independent ($t(65) = 2.9$, $p = .005$): infants follow DVs more when CG is looking directly at the target.

Age differences were tested for each cue combination, using critical $\alpha = .01$. Twenty-one-month-old infants on average followed more G + DV combinations, $t(64) = 3.2$, $p = .002$. They followed marginally more G + EV combinations, $t(64) = 2.4$, $p = .02$, G + P combinations, $t(64) = 1.7$, $p = .09$, and BG + DV combinations, $t(64) = 1.9$, $p = .06$. The age difference in following G + EV + DV combinations was in the expected direction but not reliable ($t(64) = 1.6$, $p = .12$). Thus, infants over 1.5 years get better at following simple verbal imperatives to share a speaker's attention.

3.3. Complex responses: looking at parent and following to target

A more stringent attention-sharing criterion, looking at CG *and* following to the CG's target (Tomasello, 1995), was also examined. The percent of trials in which infants made this complex response was analyzed by repeated-measures ANOVA, with age (15 months versus 21 months) between-subjects and seven cue combinations within-subjects. Means (and S.E.s) are shown in Fig. 4.

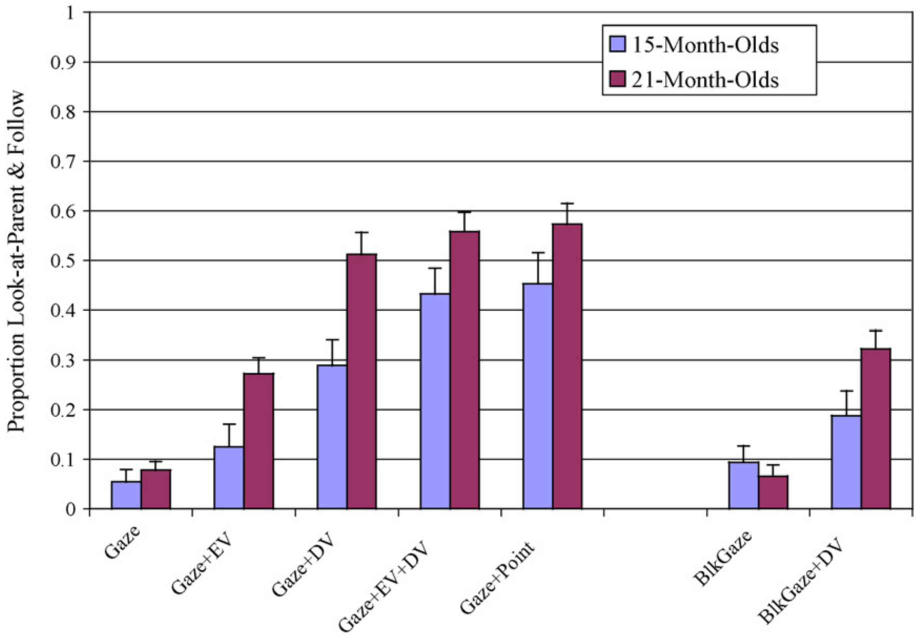

Fig. 4. Mean proportion of trials (with S.E. bars) in which infant looked at the parent and fixated on correct target location, by each age group for each of seven cue combinations.

The age effect was significant, $F(1, 64) = 8.2$, $p = .006$: 21-month-olds made complex responses more often than 15-month-olds. Across all seven cue combinations 15-month-old infants averaged 23% complex responses (S.D. = 15%) and 21-month-olds averaged 34% (S.D. = 15%). Averaging across the five combinations without blocked gaze, 15-month-olds averaged 27% complex responses (S.D. = 18%) and 21-month-olds averaged 40% (S.D. = 17%).

The within-subjects factor was also significant, $F(6, 384) = 37.0$, $p < .001$. Follow-up *t*-tests compared eight combinations, similar to those carried out for each dependent variable (above, and Table 3): G versus G + EV; G versus G + DV; G versus G + P; G + EV versus G + DV; G + EV versus G + EV + DV; G + DV versus G + EV + DV; G versus BG; BG versus BG + DV. Results showed that all these contrasts were significant and in the same direction as indicated in Table 3, at $p < .001$, with two exceptions: G versus BG was not significant ($t(65) < 1$), and G + DV versus G + EV + DV was marginal ($t(65) = 2.0$, $p = .055$). Overall, then, infants tended to look at CG and then follow if CG either verbalized or pointed to the target; however, directing verbalizations were more effective than eliciting, and blocked gaze suppressed the DV effect (as with simple following responses, above).

The mixed-measures interaction of age and cue combination was not significant, $F(6, 384) = 1.8$, $p = .11$ (Greenhouse-Geisser correction).

Age differences were tested for each cue combination, using critical $\alpha = .01$. Twenty-one-month-old infants looked at CG and then followed more than 15-month-olds on G + DV trials ($t(64) = 2.6$, $p = .01$), and marginally more on G + EV trials ($t(64) = 2.4$, $p = .02$) and BG + DV trials ($t(64) = 1.9$, $p = .06$). Thus, as in simple following responses, age differences were driven by combinations that included an imperative to the infant to shift attention.

Individual differences in complex responses are summarized on the right side of Table 1, in terms of the numbers of infants producing 0, 1, or 2 complex responses to each combination. Note that either directing verbalizations or pointing gestures compel almost half of 21-month-olds to produce the complex response on both trials. By contrast, a minority of 15-month-olds show similar consistency in the G + EV + DV or G + P trials (i.e., the most effective combinations). No other combination elicited consistently complex responses from 10% or more of 15-month-old infants. Also note that most infants *never* produced a complex response in G or BG trials.

3.4. Receptive language and shared attention

Parents of 56 (out of 66) infants returned completed MCDI forms, which were scored for total words understood. Fifteen-month-old infants averaged 25 words (S.D. = 24, range 0–105). Twenty-one-month-old infants averaged 215 words (S.D. = 137, range 29–593). These scores are similar to norms reported by Fenson et al. (1994). Parents reported

Table 4
Partial correlations among language comprehension measures and shared-attention measures, with infant's age controlled

Partial correlation	Target labels known	Follow eliciting combinations	Follow directing combinations	Follow block-gaze combinations	Total complex following
MCDI comprehension ($n = 56$)	.23	.16	.11	.11	.04
Target labels known		.18	.34*	.17	.25‡
Following eliciting-verb. combinations			[.67**]	.23	[.60**]
Following directing-verb. combinations				[.57**]	[.74**]
Following blocked gaze combinations					[.47**]

Note: ‡$p < .07$; *$p < .01$; **$p < .001$. Directing-verbalization combination scores are not independent of eliciting-verbalization scores or blocked gaze scores. Similarly, total complex response following scores are not independent of any other shared-attention measure. Those correlations are therefore not interpretable and are bracketed.

that 15-month-old infants understood a mean of 8.6 conventional labels out of the 14 target objects (S.D. = 3.3), and 21-month-old infants understood a mean of 12.9 (S.D. = 1.4). The correlation between MCDI comprehension scores and number of target labels understood, with age partialled out, was $r = .23$ ($p = .09$).

To assess the relation between vocabulary and joint attention we analyzed the correlation, with infant's age partialled out, between MCDI comprehension scores, number of target labels understood, and several summary dependent measures of shared attention: mean following in all trials with an EV, mean following in all trials with a DV, mean following in all BG trials, and complex following (with looks to parent) in all trials. Correlations are shown in Table 4. Note that some dependent measures (in brackets) overlap so correlations among them cannot be interpreted.

As Table 4 shows, receptive vocabulary (MCDI) did not predict infants' tendency to follow parents' attention. Perhaps, however, knowledge of specific target labels did predict infants' following. This correlation was non-significant for 15-month-olds, $r = .08$, and weak and marginally significant for 21-month-olds, $r = .29$ ($p < .08$). However, parents of 21-month-olds reported that they understood a mean of 92% target labels (S.D. = 11%), so the distribution is non-normal. Also, number of understood target labels did not correlate with correct following in trials with a DV (i.e., G + DV, G + EV + DV, and BG + DV): $r = .09$ and $r = .08$ for 15- and 21-month-olds, respectively. Thus there is little evidence that infants' specific understanding of relevant target labels predicted their attention-following.

4. Discussion

Infants spend much of their waking time in dynamic social events in settings that provide competition for attention. By late in their first year infants start using verbal and non-verbal social cues from caregivers to allocate and shift attention among competing foci of attention. These social cues can draw infants' attention to the caregiver, or re-direct it to some distal focus. The current work reveals infants' patterns of responses to caregivers' different attention-specifying cues, as well as changes during the second year in infants' response to those cues.

4.1. Responses to gaze shifts

A notable finding is that infants seldom disengaged attention to follow a parent's silent gaze shift to a target. This seems inconsistent with evidence that infants from 9 to 18 months become quite good at following caregivers' gaze shifts in controlled settings (Butterworth & Jarrett, 1991; Deák et al., 2000). Although no direct comparisons of settings has been made, the finding has several possible interpretations. One is that the infants just did not see parents' head turns. We find it unlikely that this can explain the cue combination effects on following: parents' head turns were well within infants' visual fields, close to the infant, and produced when the infant was facing the parent. Also, infants responded to another event near the parent's face: specifically, raising her hand to her eyes (i.e., blocked gaze). Also, parents' head turns were fairly salient (see Deák et al., 2000), involving a large radial head turn and lateral saccade and (on most trials) a change in head inclination (to fixate on upper or lower target shelves). Thus, it seems reasonable to assume that infants could detect most or all gaze shifts. Nonetheless, because infants looked at parents somewhat less after gaze shifts than after more elaborate combinations, it is possible that infants monitored parents' head turns less reliably than other cues.

Another possible interpretation is that infants did not expect parents' gaze shifts to specify a stimulus that was any more interesting than whatever toy they were looking at. This is consistent with the finding that when parents added a verbal or non-verbal cue infants *did* shift attention; that means infants did not *typically* override parents' cues in favor of objects-at-hand. Perhaps infants learn to gauge parents' enthusiasm from the complexity or redundancy of their deictic behaviors, and a simple head turn does not usually indicate that the parent is particularly interested in the target. This idea goes beyond available evidence but warrants future study. In particular, it suggests a more general implication: infants' adapt their social responses to complex interactions of caregivers' actions with properties of the current social situation and environment. In a moderately interesting environment, sampling social information by following 5–10% of caregivers' gaze shifts might provide an adequate sampling of noteworthy objects or events. At the same time, this low rate of following will minimize disruptions of the infant's own focused attention on subjectively selected objects of attention. Thus, infants' minimal gaze-following in this paradigm suggests an adaptive balance of social information seeking and autonomous exploration. This implies that infants use complex cue-integration processes to decide *when* and *where* to shift gaze, consistent with models of "democratic integration" in visual sampling (Triesch & von der Marlsberg, 2001; see also Findlay & Walker, 1999; Triesch et al., 2006).

This interpretation contradicts a simpler model wherein adult gaze shifts are rigid behavioral cues with some (presumably high) probability of eliciting a gaze-following response from infants (Baron-Cohen, 1995). This parsimonious model would predict maladaptive behaviors in some contexts. For example, if infants followed parents' gaze regardless of setting they would sometimes end up attending to objects and events interesting to the adult but not to toddlers (e.g., newspapers; spreadsheets). In fact there is suggestive evidence that 12- and 18-month-old infants follow adults' gaze shifts less over time if the environment has boring, unchanging targets than if it has interesting and changing targets (Deák et al., 2000). In boring environments, however, adults' gaze shifts might become one of the more interesting events to watch and respond to. Consequently, in the short run infants produce robust gaze-following in controlled laboratory studies; however, this does not reflect how they respond to simple gaze cues in naturally cluttered and complex social environments.

4.2. Responses to added verbal cues

Infants followed parents' attention-shifts more often, despite being engaged with toys, if the gaze shift was accompanied by another verbal or non-verbal cue: an eliciting verbalization or, more powerfully, a directing verbalization or pointing gesture. The results speak to the effect of parents' everyday behaviors, because parents do not just shift their gaze to re-direct infants' attention. They also gesture and/or verbalize (Deák et al., 2006).

How do infants respond to verbal cues? Parents sometimes try to direct infants' attention by calling them (Deák et al., 2006). Four-month-old infants prefer hearing their name over another (same-length) name (Mandel et al., 1995), but how do older infants interpret these personalized speech acts? Eliciting verbalizations increased looks to the parent (compared to gaze shift alone) from 58% of trials (averaged over trials and infants) to 82% (+24%). They doubled the number of infants (from 34 to 71%) who looked at the parent on both trials. Although we did not compare eliciting verbalizations to a same-length non-imperative verbalization (a critical question for future research), and thus cannot specify what makes these verbalizations effective, the effect indicates that calling 1-year-old infants often gets them to look at the caller. Does this recruitment of the infant's attention facilitate subsequent re-direction of attention to a shared target? Compared to gaze shift-only trials, calling the infant increased complex responses (looking at parent and following to target) from 7 to 20% (averaged across trials and infants): a significant increase. In terms of individual differences, it increased the number of infants who made a complex response on at least one trial from 6 to 29%. This effect also varied with age: only 9% of 15-month-olds produced a complex response on at least one G + EV trial, versus 47% of 21-month-olds. Thus, during the second year some infants seem to learn that their name is not merely referential but can carry a non-literal social meaning: if someone calls you and then looks away, they want you to follow their attention.

The results also show that infants' names are not uniquely attention-eliciting utterances. Directing verbalizations similarly increased looks to the parent compared to gaze shifts: from 58 to 77% (averaged across trials and infants): a 19% increase. This is quite close to the 24% increase attributed to eliciting verbalizations, a result that shows the designation of verbalizations as "eliciting" or "directing" to be an *a priori* convenience, not an empirically clean dissociation. However, complex responses (looks-at-caregiver then follows to target) do show a more specialized effect of directing verbalizations: compared to gaze shifts alone, they increased the incidence (averaged across trials and infants) from 5 to 29% in 15-month-old infants, and from 8 to 51% in 21-month-olds. Thus, not all imperatives are equally effective in drawing 1-year-old infants' attention to the speaker and then away to a distal focus of the speaker's attention: an imperative to "Look at the___" is more effective, especially for infants nearing their second birthday. The age effect is quite clear in individual infants' responses: almost half (44%) of 21-month-olds produced complex responses on both G + DV trials, compared to only 9% of 15-month-olds. These effects are significantly greater than those associated with eliciting verbalizations.

Note that directing verbalizations need not produce this complex effect; infants *could* shift gaze directly to the target, if they know the label (which, according to parents, they usually did); or just focus attention on the speaker (if any verbalization draws their attention). However, directing verbalizations had a complex effect of increasing looks at the parent and—even if adults' gaze shifts were atypical or invalid (e.g., in a mean of 26% blocked gaze + DV trials)—subsequent following to the correct target.

These results complement previous studies of how speech acts affect infants' social attention (Baldwin, 1995; Ninio, 1980). For example Deák et al. (2000) found no reliable increase in 12-and 18-month-olds' attention-following when parents added (unspecified) verbal cues to gaze and pointing. However, that study was in a stripped-down test setting, and verbalizations might have been merely redundant with points (see below). Notably, Flom and Pick (2003) found verbalizations increased 18-month-olds' *duration* of attention after following parents' gaze to a target in the same environment, so even in a simplified setting verbalizations can affect shared attention. The current results add to Baldwin's (1995) discovery that from 14 to 18 months infants improve at reconciling adults' verbal cues (e.g., object labels) with their visual attention. Those findings and the present results suggest in general that between 14-to-15 months and 18-to-21 months infants get better at interpreting specific verbal messages and speakers' non-verbal cues in a coordinated manner, to more precisely infer the speaker's intended meaning.

It remains unclear *why* infants respond differently to eliciting and directing verbalizations. That is, the verbalizations differed not only in content but also in timing, complexity, and duration. Eliciting verbalizations were slightly briefer, more repetitive and syntactically simpler, and came before the parent's gaze shifts; directing verbalizations were longer, more syntactically complex, and after the gaze shift. Currently we do not know which of these differences might have contributed to infants' partly different responses to the two verbal cues; this could be resolved by future studies. For this preliminary investigation it was more important to use ecologically valid cue forms; however, it would be possible to compare each specific cue properties.

4.2.1. Relation to developing language skills

Whatever makes directing verbalizations effective, it is probably not their semantic specificity—that is, the symbolic (referential) meaning of the target label. Individual differences in vocabulary were only weakly related to infants' tendency to locate the correct target. To be sure, there was a significant partial correlation of infants' comprehension of specific target labels and tendency to follow directing verbalizations, but this correlation was weak ($r = .34$)—though the weakness of association is unsurprising both because most labels were familiar to most infants, and because even if an infant did *not* know a label she or he could still use parents' gaze direction to identify the target. Still and all, the modest relation between attention-following and language measures (notably the MCDI) might seem surprising in light of well-known findings (e.g., Tomasello & Todd, 1983) of a correlation between joint attention and later language measures. In fact, though, the relation of joint attention to early receptive language is equivocal: Silvén (2001) found little relation between joint attention measures at 6 months and language measures at 12 months, and Delgado, Mundy et al. (2002) and Laasko, Poikkeus, Eklund, & Lyytinen (1999) found trivial correlations between joint attention and receptive language from 14 through 24 months. Thus, evidence for the relation is equivocal, and the current equivocal results further underscores the need for caution in presuming a strong relation between infant attention-sharing and emerging language.

As a point of caution, note that because there were only two trials of each type, and the particular target in each trial was assigned at random, the current data do not permit any focused analysis of how infants' comprehension of specific target labels might have facilitated their attention-following on a trial-by-trial basis.

4.3. Responses to added non-verbal cues

The present results support evidence that infants are very responsive to pointing gestures (Butterworth & Itakura, 2000; Deák et al., 2000; Morissette et al., 1995). Points drew infants' attention to the caregiver as often as directing verbalizations—reasonably so, given that both cues *are potentially* attention-getting, but do not oblige a shift to the caregiver. More critically, pointing gestures were as effective as combined eliciting and directing verbalizations at getting complex responses (looks at parent and follows to target). By this measure pointing was more effective than directing verbalizations for 15-month-old infants. This can explain Deák et al.'s (2000) finding that verbalizations did not increase infants' response over and above gaze and pointing combinations: verbalizations at this age are less effective than pointing gestures (in some settings at least). The results also suggest that even when infants are actively engaged with objects, they will disengage and re-direct attention without the benefit of a verbal cue: the right kind of gesture produced silently, within their visual field, is sufficient. This suggests one way hearing-impaired infants might develop effective attention-sharing skills.

Not all gestures are created equal. The results show that pointing is more effective than at least one other manual action: raising the hand to cover the eyes. This speaks to how infants interpret other people's gestures *and* what they understand about gaze and visual processing. Because of a floor effect in gaze only trials we cannot tell whether blocked gaze reduced infants' correct following, but it is quite clear that the gaze-blocking gesture had a different effect than pointing gestures. In addition, infants responded to blocked gaze in two distinct ways. First, they looked at parents more often compared to simple gaze shifts. This might have been because the motion of the parent's hand and arm attracted infants' attention, or because infants interpreted the gestures as a bid to play peek-a-boo or a similar game. Additional research will be necessary to resolve these alternatives. Second, blocked gaze reduced the attention-following effects of directing verbalizations in 21-month-old infants. Apparently older infants expected others' visual attention to follow an unblocked line-of-gaze, or they expect gaze to be consistent with whatever the adult is talking about. Perhaps infants noticed a discrepancy between verbal and non-verbal cues in BG + DV trials, and sought more information by watching the parents. Regardless, the results confirm evidence that 1-year-old infants expect line-of-gaze to constrain a person's visual attention (Brooks & Meltzoff, 2002; Caron et al., 2002).

5. Conclusion

Shared attention typically occurs in settings with many objects, people, and events that compete for infants' attention. Adults' bids for infants' attention are facilitated by both verbal and non-verbal cues, and to some extent the cues are functionally interchangeable. However, during the second year there is some functional differentiation of various specific verbal and non-verbal cues, in terms of how they draw infants' attention to the adult, or away from the adult to a target of shared attention. Notably, adults' simple gaze shifts seldom re-direct infants' attention, and this might allow infants to sustain attention on objects of endogenous interest.

Infants' responses to some cue combinations develop from 15 to 21 months of age. For instance, 21-month-olds follow adults' attention to a target more when the adult either calls the infant by name, or encourages them to "Look at the [target]!" in conjunction with gaze direction—or even without clear gaze cues (e.g., if the parent covers her eyes). By contrast, for example, infants by 15 months are responsive to pointing gestures.

These results begin to inform us in a systematic way how infants' attention-following functions in "busy" or distracting settings. The design, which incorporates controlled competition for infants' attention, and controlled parent-generated cue combinations to a variety of target objects, raises a number of specific questions about ecological factors in infant–parent social interactions, and questions for ethnographic studies of infant–caregiver interactions. One important issue is that although our controlled setting was modeled on everyday "busy" settings such as a home play area, we know very little about how various settings where infants spend time (e.g., day care centers; markets) differ in physical and social properties that influence infants' social interactions and shared attention. That is a pressing question for future investigation.

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