What aspects of others' behaviors do infants attend to in live situations?

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A B S T R A C T

A head-mounted camera was used for studying infant focus of attention. In two situations, 10- and 14-month-old infants observed two adults interacting. In one situation, the adults had a conversation and in the other situation, they were playing with blocks. The results indicate a preference for observing manual actions and a different pattern in looking at conversations than has been shown in eye-tracking studies. The head-mounted camera is a promising method for examining the infant's focus of attention.

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1. Introduction

Through participating in social interactions infants learn to predict the behaviors of others (Mumme & Fernald, 2003), and by observing movements and gestures of a social partner, infants acquire skills and competences (Ray & Heyes, 2011). However, infants are also exposed to other people's interactions when the infant is not participating. For example, when mum and dad are engaged in a conversation, or when an older sister and her best friend are playing games. Although the infant is not involved, other people's interactions provide an important source of social information. But what aspects of the behaviors of others do infants attend to?

During the last decade, much research has investigated infants' perception of people (e.g., Frank, Vul, & Johnson, 2009), objects (e.g., Shinskey & Munakata, 2005), and actions (e.g., Brandon & Wellman, 2009). Young infants prefer to attend to face-like stimuli (Macchi Cassia, Turati, & Simion, 2004; Simion, Macchi Cassia, Turati, & Valenza, 2001) and, at around 4 month of age, infants begin to show recognition of faces (Farroni, Massaccesi, Menon, & Johnson, 2007). A few months later, infants can selectively encode the goal of a reach (Woodward, 1998). During the second half of their first year, infants can analyze the goals of actions even when the actions are uncompleted (Brandon & Wellman, 2009; Hamlin, Hallinan, & Woodward, 2008). Thus, even before their first birthday, infants show a growing understanding of other people and their actions.

Although many researchers have examined infants' perception and selective looking, most studies have used photographs or short video clips of faces (e.g., Gredebäck, Eriksson, Schmitow, Laeng, & Stenberg, 2012) and objects (Reynolds, Zhang, & Guy, 2012). Infants' everyday social environments, however, are dynamic and complex, composed of the interplay between persons, actions, and objects. Therefore, such research does not inform us about what infants prefer to attend to in more unconstrained social contexts and under more natural conditions. Some researchers, however, have examined infants' focus

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of attention during more complex scenes. Frank et al. (2009) used a corneal-reflection eye-tracker to examine 9-month-old infants' looking behavior when the infants were presented with videos of animated cartoon characters (Charlie Brown Christmas). The infants looked most at the faces of the characters. Also Frank, Vul, and Saxe's (2012) used a corneal-reflection eye-tracker to study infants' looking pattern. When the infants were shown live-action videos with real people, the infants (from 11.5 months) also looked at the hands of the persons, especially if the hands were engaged in some action. Thus, videos with animated cartoon characters and videos with real persons may extract different looking patterns in infants. In the present study we examined what infants focus on when they are watching live interactions (two adults who are interacting). To capture the infant's focus of attention, a head-mounted camera was used.

A conversation between two persons is surely a common scene in the everyday environment. Only a few studies have explored how infants look at conversations between other persons. One such study found a preference in 12-month-old infants to look at the speaker (von Hofsten, Uhlig, Adell, & Kochukhova, 2009). Also, Augusti, Melinder, and Gredebäck (2010) found a preference to attend to the speaker in infants as young as 6 months of age, which has been interpreted as an early understanding of cues of social cognition. To get a high degree of precision in measuring infants' attention, previous work has generally made use of eye-tracking technology, most often remote eye tracking (e.g., von Hofsten et al., 2009; Augusti et al., 2010). The infant sits in front of a video screen and looks at video clips while her or his eye movements are measured. However, it is not clear if these looking patterns will be the same in real life situations. On the screen the actors are only a few visual degrees from each other. Thus, such a scene does not mirror social interaction in real life. Furthermore, the presence of the infant in the setting and spatial location (see also Yoshida & Burling, 2011) can make a difference in how infants look at social situations. Thus, the infant's looking pattern could be expected to differ depending on which methodology used (naturalistic situations or video recordings).

A head-mounted eye-tracker represents a new method that avoids some of the limitations of remote eye-trackers (Corbetta, Guan, & Williams, 2012; Franchak & Adolph, 2010; Franchak, Kretch, Soska, & Adolph, 2011; Kretch & Adolph, 2014; Kretch, Franchak, & Adolph 2014; Yu & Smith, 2013). This method uses two cameras: one scene camera recording the surroundings from the infants' perspective (a "first person view"), and one eye camera recording the infant's eye movements. During the last years several interesting studies have been carried out using these types of devices. Franchak and Adolph (2010) examined spontaneous visual exploration during self-initiated locomotion when children (aged 4–8 years) and adults wore wireless head-mounted eye-trackers while walking around in a room full with different obstacles. Kretch and colleagues (2014) examined differences in visual input between 13-month-old crawlers and walkers. In the Yu and Smith (2013) study, both the parents and their 1-year-olds wore head-mounted eye-trackers during a free play situation with toys. During play the infants seldom looked to the face of the parent. Instead, they looked at objects held by the parent and by that coordinated their looking behavior with the parent. Also the 9-month-old infants as well as their mothers wore head-mounted eye-trackers in the Kretch and Adolph (2014) study. When the infants were carried around by the mothers, infants' and mothers' visual exploration was examined. When Franchak and colleagues (2011) studied infant visual exploration during natural interaction with mother they found that the 14-month-old infants seldom looked at mother following infant-directed utterances, and even more seldom fixated the mother's face. Thus, there are findings supporting the notion that infant looking patterns may be different in real life situations compared when viewing a video screen.

One obvious advantage with head-mounted eye-trackers is that the infant's looking behavior is measured while the infant is looking at natural scenes in the near surrounding. One possible disadvantage, however, is that it may be more difficult to place an eye camera on the infant compared to a single head-mounted camera. (See also Corbetta et al., 2012, for a discussion of the advantages and disadvantages of head-mounted eye-trackers.)

A single head-mounted camera (without eye-tracking) presents a less complicated method. Head-mounted cameras have been used for studying natural vision (Aslin, 2009; Noris, Keller, & Billard, 2011; Pereira, James, Jones, & Smith, 2010; Schmitow, Stenberg, Billard, & von Hofsten, 2013; Smith, Yu, & Pereira, 2011; Yoshida & Smith, 2008). Such a method also provides a "first person view" of the scene, a view from the infant's perspective. In a calibration study, Schmitow et al. (2013) assessed the correspondence between head direction and looking direction when 6- and 12-month-old infants were attending to an object presented at different vertical and horizontal positions. Although this method represents a more crude measure, the device was found to be a useful tool to give an approximation of the direction of gaze, especially when the infant is orienting to stimuli presented in the horizontal plane (for example, in situations when the infant is turning to objects in front of her or him), and when there are few fixation targets. Yoshida and Smith (2008) examined 18-month-old infants' attention with a head-mounted camera when the infants were interacting with a parent during a free-play situation. They found that the infants focused more on the hands of the parent than on the face of the parent. This finding contrasts results from studies using stationary video cameras (providing a "third person view") that report infants focus more on the faces of others. Common observational methods, such as stationary video cameras, have some inherent problems: they do not supply a view from the perspective and body scale of the infant. Further, the coder's subjective impression of where the infant is looking biases the coding. Thus, examining visual experiences from the infant's perspective ("a first person view") may provide us with new information regarding what infants' turn to in social situations.

Fiser, Aslin, Lathrop, Rothkopf, and Markant (2006) used a combination of a head-mounted camera and a head-fixed eye tracking system (see Aslin, 2009). Head-mounted videos were first gathered from an infant at the age of 15 and 38 weeks in different natural situations (e.g., feeding, playing, sitting in a stroller). Short video vignettes were then extracted from the head-mounted videos and shown on a large display screen to 4- and 8-month-old infants. Using eye-tracking technology, the infants' gaze shifts were recorded while they were watching the video vignettes. Also in this study the infants focused