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Visual search and attention to faces during early infancy

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ABSTRACT

Newborn babies look preferentially at faces and face-like displays, yet over the course of their first year much changes about both the way infants process visual stimuli and how they allocate their attention to the social world. Despite this initial preference for faces in restricted contexts, the amount that infants look at faces increases considerably during the first year. Is this development related to changes in attentional orienting abilities? We explored this possibility by showing 3-, 6-, and 9-month-olds engaging animated and live-action videos of social stimuli and also measuring their visual search performance with both moving and static search displays. Replicating previous findings, looking at faces increased with age; in addition, the amount of looking at faces was strongly related to the youngest infants' performance in visual search. These results suggest that infants' attentional abilities may be an important factor in facilitating their social attention early in development.

Introduction

How do infants and young children see the social world? From immediately after their birth, infants attend preferentially to faces and face-like configurations (Farroni et al., 2005; Johnson, Dziurawiec, Ellis, & Morton, 1991). Over the course of their first year, their representations of faces become specific to their particular environment (Kelly et al., 2007; Pascalis et al., 2005), and they begin to be able to make inferences about other agents' internal states such as their goals (Gergely

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& Csibra, 2003) and their focus of attention (Scaife & Bruner, 1975). Infants recognize other social actors by a wide variety of signals, including the presence of facial features such as eyes, their ability to respond contingently, and even their causal abilities (Johnson, Slaughter, & Carey, 1998; Saxe, Tenenbaum, & Carey, 2005). These results and others suggest a picture of infants as both deeply involved in and increasingly knowledgeable about the social world around them.

Less is known about how these abilities are manifest in the complex task of perceiving and processing the world in real time. Most experimental paradigms addressing infants' social abilities use simple schematic stimuli presented repeatedly in isolation—often in infant-controlled paradigms where individual infants get as much time as they need to process a stimulus. These methods produce reliable results and allow for the measurement of subtle contrasts between conditions, but they do not tell us how effective infants are at using their knowledge in real-time perception (Aslin, 2009; Richards, 2010).

Our previous work used eye-tracking data from infants' viewing of videos to begin to address this question. Frank, Vul, and Johnson (2009) showed 3-, 6-, and 9-month-old infants a set of 4-s clips from an animated stimulus (the *Charlie Brown Christmas* movie) and measured the amount of time they spent looking at the faces of the characters. This study found significant increases in fixation time to the faces of the characters between 3 and 9 months of age. This increase was accompanied by increases in the overall similarity of older infants' fixations to one another and decreases in the amount by which their fixations were predicted by the low-level salience of the movies they saw.

Although this study provided evidence for developmental changes in infants' looking at faces in complex scenes, it gave limited insight into the causes of this developmental change. The middle of the first postnatal year is a time of many changes, and changes in social attention could be driven by a wide variety of factors. For example, changes in social preference could emerge as the result of social learning mechanisms. Children might be learning about the information that can be gleaned from the faces of others (e.g., Scaife & Bruner, 1975; Triesch, Teuscher, Deák, & Carlson, 2006; Walden & Ogan, 1988), and this might drive them to sharpen their preference to look to others. In addition, during this period infants are undergoing substantial motoric development; they are learning to reach for objects and sit unattended, and they are even beginning to crawl. There is growing evidence that these motoric changes may be related to infants' visual preferences (Cashon, Ha, Allen, & Barna, 2013; Libertus & Needham, 2011). Finally, there are many substantial changes in children's visual attention over the period from 3 to 9 months of age (Amso & Johnson, 2008; Colombo, 2001; Dannemiller, 2005; Richards, 2010).

Although it is likely that all of these changes have an impact on children's social attention, in our current work we focused on changes in visual attention. In the Frank et al. (2009) study described above, overall visual salience appeared to pull the youngest infants' attention away from social targets and toward other parts of the stimulus background. We were interested in whether this impression was correct. If developmental change in looking at faces is related to infants' changing attentional abilities, then measures of attentional ability should be expected to correlate with face looking. We employed this logic in our study, although we note that the presence of a correlation between these two measures does not imply a causal relationship. Such a correlation might be driven by independent development because both face looking and visual search are known to undergo developmental changes during the first year of life or might be the product of a third causal factor. We begin to address this issue by controlling for chronological age in our analyses, but we return to the problem of causal inference in the Discussion section.

Visual attention involves a variety of distinct abilities. Following the conceptual framework in Colombo (2001), we can separate baseline alertness, spatial orienting, feature-based attention, and endogenous (sustained) attention to a target. Alertness refers to the simple fact of being awake and able to process stimuli; spatial orienting and feature-based attention deal with finding and recognizing visual stimuli, respectively; and endogenous or sustained attention refers to the ability to maintain focus on a target stimulus. Although understanding how infants identify faces is an important challenge (Johnson et al., 1991; Pascalis et al., 2005; Turati, Valenza, Leo, & Simion, 2005), to answer our questions about social attention, we were primarily interested in how infants orient to and sustain attention to faces in complex scenes.