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Changes in infant visual attention when observing repeated actions[☆]

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ABSTRACT

Infants' early visual preferences for faces, and their observational learning abilities, are well-established in the literature. The current study examines how infants' attention changes as they become increasingly familiar with a person and the actions that person is demonstrating. The looking patterns of 12- (n = 61) and 16-month-old infants (n = 29) were tracked while they watched videos of an adult presenting novel actions with four different objects three times. A face-to-action ratio in visual attention was calculated for each repetition and summarized as a mean across all videos. The face-to-action ratio increased with each action repetition, indicating that there was an increase in attention to the face relative to the action each additional time the action was demonstrated. Infant's prior familiarity with the object used was related to face-to-action ratio in 12-month-olds and initial looking behavior was related to face-to-action ratio in the whole sample. Prior familiarity with the presenter, and infant gender and age, were not related to face-to-action ratio. This study has theoretical implications for face preference and action observations in dynamic contexts.

1. Introduction

One of the primary learning mechanisms for infants is observing what others are doing (Bandura, 1971; Meltzoff, Kuhl, Movellan, & Sejnowski, 2009). Naturalistic studies have shown that between the ages of 12- to 18-months, infants learn 1–2 new behaviors a day simply through observing the people around them (Barr & Hayne, 2003). In these complex learning situations, multiple sources of social and behavioral information are available to help the infant interpret and benefit from the events they observe, especially if they see the same event demonstrated multiple times. We examine here the factors that influence how infants distribute their attention to elements of a dynamic learning situation (a person's face and the actions that the person is producing) across time. Identifying how attention changes as events are repeated, and are becoming increasingly familiar, will provide a better understanding of the learning mechanisms that guide infant cognitive development.

Visual preference procedures which use static images have consistently found that infants attend longer to faces compared to other stimuli (e.g., pictures of faces compared to pictures of toys). Several studies have demonstrated that this effect is in place from birth for face-like stimuli (Fantz, 1963; Johnson, Dziurawiec, Ellis, & Morton, 1991). From 4- to 5-months of age, infants attend for

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longer to pictures of faces than distractor stimuli (Di Giorgio, Turati, Altoè, & Simion, 2012; DeNicola, Holt, Lambert & Cashon, 2013; Gliga, Elsabbagh, Andravizou, & Johnson, 2009; Gluckman & Johnson, 2013; Libertus & Needham, 2011), and attentional bias towards faces becomes a robust effect thereafter (e.g. Amso, Haas, & Markant, 2014; Kwon, Setoodehnia, Baek, Luck, & Oakes, 2014; Leppänen, 2016). Following from Cohen (1972) this is often referred to as the attention holding effect of faces (e.g. DeNicola et al.).

When presented with a dynamic context, attention to faces has also been shown to increase during the first year of life (Frank, Amso, & Johnson, 2014; Frank, Vul, & Johnson, 2009) and then remains present throughout life (Stoesz & Jakobson, 2014). Furthermore, Frank et al. (2014) reported that infants' attentional abilities in general are related to how much they attend to faces. Infants who were quicker and more accurate to identify targets in visual search tasks also looked longer at faces when viewing dynamic scenes. Although faces are of prime interest to infants aged 3–30 months when viewing dynamic stimuli, with age infants increase their attention to what a person is doing, with older infants attending relatively more to the person's hands than younger infants do (Frank, Vul, & Saxe, 2012).

Changes in volitional control of attention (Colombo, 2001; Courage & Setliff, 2010) may play a role in age-related changes in infant attention to, and memory for, aspects of dynamic scenes. Bahrick and Newell (2008) presented infants with videos of adults demonstrating everyday activities (hair brushing, teeth brushing, blowing bubbles, or applying make-up) and tested memory for the faces and actions using a novelty preference test. While 5.5-month-old infants showed memory for the action being performed, by 7 months of age infants showed memory for both the performers' faces and their actions. The authors argued that actions are more salient than the presenters' faces and 5-month-olds do not have the attentional resources to register both the action and the face. From the age of 7 months, infants have the resources to register both elements (Bahrick, Gogate, & Ruiz, 2002). Using eye-tracker methodology, Taylor and Herbert (2013, 2014) found that infants from 6 to 12 months of age attend less to the background and focused both on the presenter and the action she was performing, but did not find differences in attention for the presenter and the action. There is also evidence that 12-month-old infants (Kolling, Óturai, & Knopf, 2014) and 18-month-old infants (Óturai, Kolling, & Knopf, 2013) attend more to actions than to the presenter's face, independent of whether the action with the object was functional or arbitrary. These eye-tracker studies analyzed infants' attention to the video during different periods but did not compare between repetitions of actions. Thus they did not consider how attention might change across the learning situation. Changes in infants' focus of attention over time when they are viewing novel actions could be important for understanding observational learning processes.

The current study aims to identify the relative distribution of infants' attention to a presenter's face and the repeatedly demonstrated actions. We consider two alternative predictions for how infants might distribute their visual attention over time. One alternative, in line with infants' primary interest in faces, is that infants will first attend to the presenter's face until they have sufficiently processed the social information, before then directing their attention to what that person is doing. This prediction would suggest that the relative distribution of visual attention to the face would decline over time, and visual attention to the action area would increase over time. An alternative suggestion comes from the research reviewed above on infants' action observation, and predicts that infants would first be interested in the action itself and only later shift their attention to the person performing the action. According to this account the relative distribution of visual attention to the face would increase as actions are repeated.

The reviewed literature shows infants' primary interest in faces, on the one hand, and their strong interest for action observation, on the other hand. None of the reviewed studies were designed to answer a direct question of whether infants prefer to look at faces or at actions. Such a comparison would depend very much on the context, and in particular the social context, of the action presentation. We focus here on the dynamics of where infants distribute their attention during the demonstration phase of the imitation paradigm, while the infant is observing an adult demonstrate an action or sequence of actions with a novel object. Infants' imitation performance increases as a function of age (for review see Hayne, 2004), and additional demonstrations of target actions improves learning from a 2D televised presentation at all ages tested between 12- and 21-months (Barr, Muentener, Garcia, Chavez, & Fujimoto, 2007). Attentional mechanisms that may lie behind the effect have not been investigated. By comparing across two ages (12- and 16-months) we examine whether age might influence the observed distribution of visual attention across the repetitions, in line with increasing endogenous control of attention (Colombo, 2001).

The decline or increase in attention to the face relative to attention to the action may also be influenced by early gender differences in attending social stimuli. With 6-month old infants, Gluckman and Johnson (2013) have shown that social stimuli (faces, body parts, and animals) attract attention in a stimulus array compared to common objects. However, for girls especially, faces were the strongest attention holder. Furthermore, Mundy et al. (2007) reported that girls, slightly more than boys, used gaze and gestures to elicit aid from a social partner in a live interaction. Although the use of a pre-recorded video presentation would reduce the strength of social cues, the research mentioned above suggests that girls might attend more than boys to a presenter's face rather than her actions, either throughout or at some parts of the presentation. A third factor that may influence the distribution of visual attention is familiarity with the person or the object involved. Well-established findings of visual preference (for review see Rose, Feldman, & Jankowski, 2004) suggest that familiarity of a person or an object may influence how infants distribute their attention towards that person or object. Familiarity is usually shown by more attention to novel objects compared to familiar ones. Familiarity, in the current study, is established for some infants in real life before they are shown pre-recorded videos that show the presenter or object they have been familiarized with. Due to the visual preference effect, infants might spend more time visually exploring the novel aspects (novel face or novel object) during observational learning, which would be indicated by a lower face-to-action ratio for infants who are familiar with the presenter compared to infants who are unfamiliar with the presenter, and a higher face-to-action ratio for infants who are familiar with the object compared to infants who are unfamiliar with the object. Finally, we examine the influence of differences in the microstructure of visual behavior. Jankowski, Rose, and Feldman (2001) studied 5-month-old infants' visual behavior with the visual paired comparison paradigm and found that infants with fewer shifts and longer looks at encoding did not show novelty preference whereas infants with more shifts and shorter looks during encoding did show novelty preference. These

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