Infant Behavior & Development 36 (2013) 513–516

Contents lists available at ScienceDirect

Infant Behavior and Development

Brief report

Infants' scanning of dynamic faces during the first year

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ARTICLE INFO

Article history:
Received 30 August 2012
Received in revised form 3 March 2013
Accepted 2 May 2013
Available online 31 May 2013

Keywords:
Face scanning
Infants
Dynamic faces

ABSTRACT

This research investigated infants' scanning of a talking, socially engaging face. Three- to four-month-olds looked equally at the mouth and eyes whereas 9-month-olds attended more to the eyes than mouth. These findings shed light on information infants' seek from dynamic face stimuli.

From the first moments of life we have extensive and repeated exposure to faces. Recognition and identification of faces forms the basis for human interaction and facial features convey a host of socially relevant information. There are some aspects of face processing about which a great deal is known. For example, we know that newborn infants orient to and prefer face-like over other patterned stimuli (Fantz, 1963; Farroni, Johnson, Menon, Zulian, & Faraguna, 2005; Goren, Sarty, & Wu, 1975). Young infants prefer pictures of upright to inverted or scrambled faces (Chien, 2011; Mondloch et al., 1999; Turati, Valenza, Leo, & Simion, 2005) and fixate more on the human face than other visual stimuli (Gliga, Elsabbagh, Andravizou, & Johnson, 2009). Newborns are sensitive to differences between individual human faces, quickly learn to identify their own mother from non-familiar females (Barrera & Maurer, 1981; Bartrip, Morton, & de Schonen, 2001; Bushnell, Sai, & Mullin, 1989), and with time and experience better discriminate between individuals within their own than a different race (Kelly et al., 2007; Sangrigoli & de Schonen, 2004).

In contrast, there are other aspects of face processing that are underspecified. For example, we have more limited information about how infants scan individual components of a face. There is evidence that 1-month-olds fixate primarily on the outer contour of the face but by 2 months focus on internal elements, mostly the eyes and mouth (Hainline, 1978; Maurer & Salapatek, 1976). When scanning of the internal features relative to each other is assessed, young infants spend more time attending to the eyes than the mouth (Haith, Bergman, & Moore, 1977; Hunnius, de Wit, Vrins, von Hofsten, 2011). Most faces infants see, however, are not static but dynamic and viewed within a social context. Studies investigating infants' visual scanning of dynamic face displays are few and the results mixed. One group of researchers (Lewkowicz & Hansen-Tift, 2012; see also Haith et al., 1977) showed infants a video in which a female produced a monolog while looking at the infant. Infants aged 4 months attended more to the eyes than the mouth, whereas 8- and 10-month-olds attended more to the mouth than the eyes. In contrast, other researchers (Hunnius & Geuze, 2004; see also Merin, Young, Ozonoff, & Rogers, 2007) presented infants with a video of a female smiling and attempting to engage their attention. Infants aged 1.5–6.5 months looked about equally at the eyes and mouth. Although infants older than 6.5 months were not tested in this study, there

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0163-6383/$ – see front matter
http://dx.doi.org/10.1016/j.infbeh.2013.05.001

is some evidence to suggest that between 6 and 10 months infants shift attention away from the mouth and to the eyes of dynamic face displays (Wheeler et al., 2011).

On the basis of current findings it is difficult to draw firm conclusions about the nature and development of dynamic face scanning during the first year. The dynamic displays used in the studies reported above differed in two important ways. First, the dynamic displays used by Lewkowicz and Hansen-Tift (2012) contained an auditory component, whereas the dynamic displays used by Hunnius and Geuze (2004) were silent. Second, in Hunnius and Geuze the speaker's primarily intent was to engage the infants' attention, a social act, and in Lewkowicz and Hansen-Tift the speaker produced a scripted monolog. The current research explored 3- to 4-month-olds' and 9-month-olds' scanning of dynamic faces in which the speaker attempted to engage the infants' attention by smiling and uttering simple vocalizations. Hence, the displays were socially engaging and included an auditory component.

1. Method

Participants were twenty 3- to 4-month-olds (10 F; *M* age = 4 months, 2 days; range = 3 months, 1 day to 4 months, 26 days) and eighteen 9-month-olds (7 F; *M* age = 9 months, 14 days; range = 9 months, 1 day to 9 months, 31 days). Six additional infants were tested but failed to contribute eye-tracking data. Parents reported their infant's race/ethnicity as Caucasian (N = 27), Hispanic (N = 3), Asian (N = 2), Black (N = 2), or mixed race (N = 4). Parents were recruited from commercially produced lists and were offered $5 or a lab T-shirt for participation. The experimental procedure was explained to the parents and informed consent was obtained prior to testing.

Infants were positioned in an infant seat 56 cm from a 20 in computer monitor. An infrared eye-tracker with remote optics (Model R6, Applied Science Laboratories) measured eye movements during test trials. The camera was placed directly below the computer monitor (and 56 cm from infants' eyes) and was not visible to infants. A magnetic head tracker (Flock of Birds®, Ascension Technology Corporation) was worn by infants to limit disruption in eye tracking as a function of head movement. Eye movement data were calibrated prior to testing using three gaze positions covering over 80% of the viewing area.

The test stimuli (Fig. 1) were two videos of a smiling Caucasian female adult who waved with one hand and said "Hi Baby" or clapped her hands together below her mouth and said, "Hey Baby". The videos filled the computer screen. The hands served as a control for motion-directed attention. Each video was approximately 4 s and shown twice for a total of

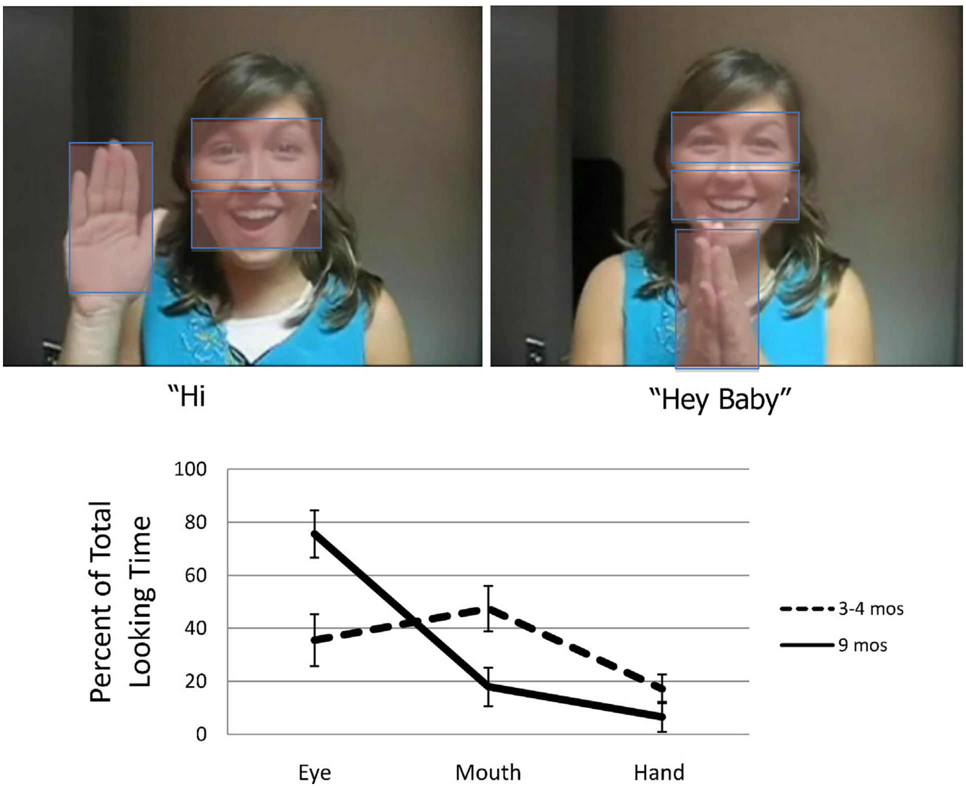

Fig. 1. (Top) Screen shot from each of the two dynamic face videos used in the present experiment with the three AOIs (eyes, mouth, hands) drawn to scale. The eyes, mouth, and hands AOIs covered approximately the same percentage of the face area in both videos, respectively. (Bottom) Mean (SE) proportion of looking to each of the three AOIs for the younger and older infants.

Table 1
Mean (SD) duration of looking (in sec) by younger and older infants to the AOIs of the dynamic face displays.

	Eyes	Mouth	Hand	Off
Dynamic display				
3–4 months	.29 (.41)	.63 (.70)	.18 (.28)	.55 (.46)
9 months	.76 (.68)	.12 (.20)	.03 (.10)	.37 (.39)
Total	.51 (.60)	.39 (.58)	.11 (.23)	.46 (.44)

four test trials. The actress' eyes, mouth, and hands were each defined as an area of interest (AOIs); all other areas of the display were considered off AOI. Number of fixations and total duration of looking (i.e., cumulative looking) to each of the three AOIs were calculated. However, these two variables yielded the same results so only the duration of looking data are reported. There were 152 possible trials (38 infants × 4 trials each); 53 of these trials were missing data because the infant failed to look at any of the three AOIs. Test trials were presented as part of a larger testing protocol involving non-face objects.

2. Results

Preliminary analyses of the data revealed no main effects or interactions involving video type ('Hi Baby' or 'Hey Baby'), trial number (1 or 2) within each video type, or sex of the infant on looking behavior. Hence the data were collapsed across these factors in subsequent analyses. Duration of looking (cumulative looking) data is presented in Table 1.

Percent-of-total-looking time (PTLT) scores were computed for each AOI by dividing the time directed at each AOI, respectively, by total looking time to the display. PTLT off AOI scores were also created by dividing the time spent directed off the three AOIs by total time to the display.

Analyses of mean PTLT off AOI revealed that the younger (M = 23.0, SD = 14.0) and older (M = 18.4, SD = 16.4) infants did not differ significantly in the proportion of time they spent looking off, as compared to on, the dynamic talking face display, $t(36) < 1$. Hence, any differences between groups in subsequent analyses cannot be attributed to greater attention to dynamic faces in one age group over another.

Analysis of mean PTLT on AOIs, displayed in Fig. 1, were subjected to a mixed-model analysis of variance (ANOVA) with AOI (eyes, mouth, hands) as the within-subject factor and age group (younger or older infants) as the between-subjects factor. The main effect of AOI, $F(2, 72) = 10.38$, $p < .001$, $\eta_p^2 = .22$ and the AOI × age group interaction, $F(2, 72) = 7.00$, $p = .002$, $\eta_p^2 = .16$, were significant. Planned comparisons revealed that the younger infants spent about the same proportion of time looking at the eyes (M = 35.5, SD = 43.9) and mouth (M = 47.4, SD = 38.2), $t(19) < 1$, but a greater proportion of time looking at the mouth than hands (M = 17.1, SD = 23.8), $t(19) = 2.94$, $p = .008$, Cohen's $d = .95$. These data suggest that infants' attention to the mouth, which they scanned as often as the eyes, cannot be easily explained by greater attention to moving parts. The older infants spent a greater proportion of time looking at the eyes (M = 75.6, SD = 38.2) than mouth (M = 17.9, SD = 31.4), $t(17) = 3.72$, $p = .001$, Cohen's $d = 1.65$. Finally, the younger infants spent a greater proportion of time looking at the mouth than the older infants, $t(36) = 2.58$, $p = .014$, Cohen's $d = .84$. In contrast, the older infants spent a greater proportion of time looking at the eyes than the younger infants, $t(36) = 2.99$, $p = .005$, Cohen's $d = .98$.

3. Discussion

When viewing a video of an adult female speaking and acting in a positive and engaging way, 3- to 4-month-olds looked about equally at the eyes and the mouth of the face. The eyes and the mouth convey a great deal of socially relevant information, including cues about the emotional and affective state of a social partner (eyes and mouth), where the infant should direct attention during a social interaction (eyes), and how to parse and decode the speech stream (mouth). The present results suggest that by at 3–4 months infants perceive both facial features as important sources of information and scan faces accordingly. In contrast, the 9-month-olds spent a significantly greater proportion of time looking at the eyes than the mouth of the face. This finding suggests that with time and experience infants identify that a great deal of socially relevant information can be quickly and effectively gathered from the eyes, making mouth scanning redundant and unnecessary.

These results shed light on factors that influence infants' scanning of dynamic face displays during the first year. First, they suggest that whether a dynamic face display contains an auditory component, alone, cannot explain inconsistencies in the current literature (Hunnius & Geuze, 2004; Lewkowicz & Hansen-Tift, 2012). The scanning patterns obtained here with the younger infants are similar to those obtained by Hunnius and Geuze (2004) with infants 6.5 months and younger, which were obtained with dynamic face stimuli that were silent. We are not suggesting that the auditory component is irrelevant, or that the infants in the present experiment did not attend to the female adult's vocalizations, but that in some contexts other factors are more important to face scanning. Second, these results suggest that the communicative intent of the display is important to face scanning. Other studies with young infants that have reported equal scanning of the mouth and eyes in dynamic face displays share a feature in common with the present study: the adult speaker engaged in behaviors specifically designed to garner and maintain the infant's attention, such as smiling, nodding, or calling the infant's name (Hunnius & Geuze, 2004; Merin et al., 2007). The present results build on these findings by revealing that by 9 months infants no longer depend on the mouth as a critical source of information in this context and spend more time visually exploring the eyes.

Finally, at first blush the current findings may appear at odds with those of Lewkowicz and Hansen-Tift (2012), who found that 8- to 10-month-olds looked longer at the mouth than eyes of a dynamic display. Recall, however, that the dynamic faces in their displays recited a scripted monolog. Lewkowicz and Hansen-Tift suggested that selective attention to the mouth, by infants of this age group, reflects processes by which infants learn speech sounds (i.e., infants gather information about the production of speech sounds by watching the mouth). Following this logic, the 9-month-olds in the present experiment attended only minimally to the mouth because the linguistic content of video was quite sparse ("Hi Baby" and "Hey Baby") and, hence, provided little information about the production of speech sounds. Further research is needed to directly test this hypothesis.

In summary, the present results revealed age-related changes in the way infants scan socially engaging dynamic face displays. Whereas young infants gather information from the mouth and eyes, older infants gather information mostly from the eyes. Further investigation of infants' scanning of dynamic faces, under diverse and ecologically relevant conditions, has the potential to significantly enhance our understanding of how infants go about gathering and extracting information from one of the most important and frequently viewed visual stimuli that humans encounter.

Acknowledgements

We thank Tracy Smith Brower, Kayla Boone Upshaw, Jennifer Moore Norvell, Amy Hirshkowitz, Mariam Massoud, and the staff of the Infant Cognition Lab at Texas A&M University for help with data collection and management, and the infants and parents who so graciously participated in the research. This work was supported by NICHD grant R01-HD057999 to TW and NSF grant BCS-0618411 to GMA. A fuller report will be provided upon request.

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