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What is This?
Face preference in infancy and its relation to motor activity

Klaus Libertus1 and Amy Needham2

Abstract
Infants’ preference for faces was investigated in a cross-sectional sample of 75 children, aged 3 to 11 months, and 23 adults. A visual preference paradigm was used where pairs of faces and toys were presented side-by-side while eye gaze was recorded. In addition, motor activity was assessed via parent report and the relation between motor activity and face preference was examined. Face preference scores followed an inverted U-shaped developmental trajectory with no face preference in 3-month-olds, a strong face preference in 5- and 9-month-olds, and a weaker face preference in 11-month-olds. Adults showed no reliable face preference. Motor activity was a significant predictor of face preference in 3-month-old infants, supporting the presence of motor-social connections in early infancy.

Keywords
Eye tracking, face processing, infancy, motor development

Faces provide important information about another persons’ identity, interests, mood, and possibly also intentions. Learning to use the information provided in a face is important for social development and attending to faces early in life is thought to play an important role in social learning and in shaping the brain circuits involved in the “social brain” (Johnson, 2005). Therefore, establishing when infants show a reliable preference for faces, and what factors influence their attention towards faces, can inform our understanding of infants’ social-cognitive development.

Face preference at birth

Using simple visual-orienting paradigms, a preference for faces has been observed already in newborns (Goren, Sarty, & Wu, 1975; Johnson, Dziurawiec, Ellis, & Morton, 1991; Kleiner, 1987; Valenza, Simion, Cassia, & Umilta, 1996). A neonatal face preference is not limited to humans and can also be found in chicks and infant monkeys—even those reared without exposure to faces for 6 months or more (Rosa-Salva, Farroni, Regolin, Vallortigara, & Johnson, 2011; Rosa-Salva, Regolin, & Vallortigara, 2010; Sugita, 2008). These findings suggest that newborns’ face preference is independent of experiences with faces and may be explained by a face-specific representational bias or by general constrains of the visual system (e.g., de Schonen & Mathivet, 1989; Johnson & Morton, 1991; Simion, Leo, Turati, Valenza, & Barba, 2007). For example, it has been suggested that perceptual features, such as up-down asymmetry (i.e., more elements in the upper part of display), may account for newborns’ preference for faces (Macchi Cassia, Turati, & Simion, 2004; Simion, Valenza, Macchi Cassia, Turati, & Umilta, 2002; Turati, Simion, Milani, & Umilta, 2002). However, experiences quickly begin to shape face preferences and after only 4 days, newborns begin to show a preference for their mother’s face over a stranger’s face, and this preference varies as a function of infants’ exposure to their mother (I. W. R. Bushnell, 2001; I. W. R. Bushnell, Sai, & Mullin, 1989; Field, Cohen, Garcia, & Greenberg, 1984; Pascalis, de Schonen, Morton, Deruelle, & Fabre-Grenet, 1995).

Face preference following the newborn period

While infants seem more interested in faces than in other visual stimuli, a preference for faces over other salient visual stimuli has not been reported consistently in the 2 months following the newborn period. On the one hand, there is evidence for a face preference in 3-month-old infants when comparing photographic images of faces to scrambled faces, or in the presence of face-like movements (Ichikawa, Tsuruhara, Kanazawa, & Yamaguchi, 2013; Macchi Cassia, Kuefner, Westerlund, & Nelson, 2006; Simion et al., 2007; Turati, Valenza, Leo, & Simion, 2005). On the other hand, Johnson, Ellis, and Morton (1991) reported a decline in preferential face tracking in 2-month-old infants, and a number of other studies observed no clear preference for face over competing images in 1–3-month-olds (e.g., Chien, 2011; Dannemiller & Stephens, 1988; Keller & Boiggs, 1991; Maurer & Barrera, 1981; Wilcox, 1969).

An extensive review of some early studies on infants’ face preference suggests that no face preference is evident in infants younger than 4 months of age when static faces alongside competing visual stimuli are presented side-by-side for less than 30 seconds (Maurer, 1985). It is possible that 3-month-old infants require more time to process faces and therefore do not show a spontaneous face preference when images are presented for less than 30 seconds. Supporting this view, faces have been shown to automatically capture attention in 6-month-old but not 3-month-old infants (Di Giorgio, Turati, Alhoe, & Simion, 2012; Gliga, Elsabbagh, Andrivizou, & Johnson, 2009). Further, it has been shown that 3–4-month-old infants require

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90 seconds of familiarization to successfully recognize a previously encountered face (Otsuka et al., 2009).

Starting at around 4–5 months of age, infants again start to show a preference for faces over other, highly salient, images such as toys or cars (Durand, Baudouin, Lewkowicz, Goubet, & Schaal, 2013; Libertus & Needham, 2011). A face preference has also been confirmed in 6- and 9-month-old infants using animated video clips (Frank, Vul, & Johnson, 2009). In particular, this study reported an increase in face preference from 3 to 9 months of age, with the strongest face preference being evident in adults. Such changes in face preference over the first year are likely influenced by infants’ own experiences. For example, infants’ face discrimination skills have been shown to become increasingly specialized to human faces over the first 9 months in a process called “perceptual narrowing” that is dependent on the kinds of faces infants are exposed to (Pascalis, de Haan, & Nelson, 2002; Pascalis et al., 2005).

Learning through motor experiences

Experiences such as exposure to different types of visual stimuli play a critical role throughout development and can strongly impact infants’ face processing skills. However, the infant is not a passive observer, but actively moving around while exploring the world. Consequently, the kinds of experiences infants are able to provide for themselves are limited by their own motor abilities. For this reason, motor skills have been called a “rate limiting” factor in infant development (E. W. Bushnell & Boudreau, 1993).

It has long been recognized that motor experiences offer a foundation for learning (Piaget, 1952) and several studies have investigated how motor skills affect development across domains. To describe how infants’ own motor abilities influence their perception of the potential for actions offered by objects, Gibson (1988) introduced the concept of “affordance.” Infants’ object exploration skills have also been shown to affect their perception of 3D objects (Soska, Adolph, & Johnson, 2010). Similarly, a growing literature has found associations between infants’ crawling skills and their spatial abilities such as mental rotation or spatial search (Bai & Bertenthal, 1992; Campos et al., 2000; Clearfield, 2004; Schwarzer, Freitag, Buckel, & Lofrute, 2012). Together, these findings highlight the important role played by motor skills for infants’ cognitive and perceptual development.

Motor skills and social development

Going beyond cognitive and perceptual domains, a number of recent studies have identified connections between infants’ motor skills and their social development. For example, studies of infants at high familial risk for Autism Spectrum Disorders (ASD) have found associations between fine and gross motor skills during the first year of life and subsequent social and language development (Bhat, Galloway, & Landa, 2012; Bhat, Landa, & Galloway, 2011; LeBarton & Iverson, 2013). Flanagan, Landa, Bhat, and Bauman (2012) have even reported that head lag during a pull-to-sit task administered at 6 months of age is predictive of ASD outcomes at 3 years of age.

In typically developing infants, motor experiences have been shown to affect elementary aspects of infants’ social development. For example, facilitating independent reaching in 3-month-old infants (via “sticky mittens”) has been found to encourage a preference for face (Libertus & Needham, 2011), and facilitate infants’ perception and understanding of observed actions (Gerson & Woodward, 2013; Skerry, Carey, & Spelke, 2013; Sommerville, Woodward, & Needham, 2005). In slightly older infants, the transition from crawling to walking has been found to alter infants’ social exchanges with their mothers (Karasik, Tamis-LeMonda, & Adolph, 2011, 2014). These findings suggest that new motor skills providing infants with different ways to interact with others (such as grasping and walking) alter their attention to and engagement with social interaction partners. One could argue that experiencing a new motor skill changes the “affordances for interaction” that infants perceive in others.

The relation between infants’ grasping experiences and their preference for faces is of particular interest, as grasping is an early emerging motor milestone and early attention to faces is, as reviewed above, critical for the development of the “social brain” (Johnson, 2005). Two previous studies have reported a relation between grasping experiences and face preference, but only in the context of training paradigms where infants’ motor experiences were actively manipulated (Libertus & Needham, 2011, 2014). It remains unclear, whether a similar relation exists in naïve, untrained infants.

The current study

The first goal of this research was to investigate the developmental trajectory of face preference across infancy and in adults. Libertus and Needham (2011, 2014) reported no face preference in three separate groups of 3-month-old infants, a result that contrasts with other studies reporting a face preference at this age (Ichikawa et al., 2013; Maacci Cassia et al., 2006; Turati et al., 2005). Therefore, it seemed important to re-investigate face preference in 3-month-olds using the same stimuli as Libertus and Needham (2011). We hypothesized that 3-month-olds would not show a face preference using static face-toy pairs (Maurer, 1985), that a face preference would be evident by age 5 months, and that this preference would strengthen into adulthood (Frank et al., 2009).

Our second goal was to examine the relation between face preference and motor development. Libertus and Needham (2011) reported that scaffolded reaching experiences (“sticky mittens”) increased infants’ face preference. In a more recent study, the same authors report that experiences of actively moving an object attached to the infant’s hand also encouraged their preference for faces (Libertus & Needham, 2014). However, it is possible that the interactive exchanges during these training procedures, rather than the motor experiences themselves, encouraged a preference for faces in their study. The current study addresses this issue by examining the relation between face preference and a parent-report measure of motor activity in naïve, untrained infants. Activity level is inversely related to infants’ ability to control and focus their own limb movements, which in turn predicts the onset of successful grasping (Thelen et al., 1993). If face preference were indeed related to aspects of infants’ grasping skills (as suggested by the findings of Libertus & Needham, 2011), one would expect to observe a similar relation between infants’ motor activity level and their preference for faces. Such a motor-social relation could be driven by changes in what opportunities for social interactions infants perceive in others depending on their own ability to control their limb movements. For example, once infants engage in independent grasping, opportunities for sharing games and triadic exchanges with others open up (Striano & Reid, 2006).
Methods

Participants

A total of 75 full-term infants and 23 adults participated in this experiment. Infants were divided into five groups based on their age: 20 children aged 3 months, 19 children aged 5 months, 18 children aged 9 months, and 18 children aged 11 months. All participants came from a middle- to upper-class background, full participant details can be found in Table 1. Eleven additional participants were recruited (2 adults, 9 infants) but excluded from the final sample due to technical difficulties (1 adult), calibration failure resulting in inaccurate tracking and data loss (1 adult, 7 infants), and due to prematurity (2 infants).

Infant participants were recruited from public birth records. Parents received $5 travel reimbursement and an infant-sized t-shirt as gift for their participation. Adult participants were undergraduate students at a major research university and received course credit for their participation. The university Institutional Review Board approved the research protocol and informed consent was obtained (from a parent or legal guardian for infants) prior to testing. Although all infants were born after 37 weeks of gestation, age was recorded as post-menstrual age (PMA) based on parent report (van der Fits, Klip, van Eykern, & Hadders-Algra, 1999).

Procedure

Testing was completed in a small, dimly lit room. Adults were seated in a stable chair; infants were seated in a reclined bouncy chair, a stable high chair, or on a caregiver’s lap at a distance of about 60 cm from a Tobii 1750 remote cornea-reflection eye-tracker with a 50 Hz sampling rate. At the beginning of the experiment, a 9-point calibration procedure was performed. Tracking quality and drift was monitored throughout the experiment using a recurring central fixation stimulus.

Stimuli

All stimuli were presented sequentially on a 17” screen (33.4 × 25.4 degrees of visual angle) at a resolution of 1024 × 768 pixels. Sample stimuli are shown in Figure 1. To facilitate comparisons of our results with previous studies that only used the Face-Preference Task (Libertus & Needham, 2011), infants first completed the Face-Preference Task and then the Visual Acuity Task.

Face-preference task. Stimuli used in the face-preference task consisted of colored photographs of faces and infant toys displayed side-by-side for a fixed trial-duration of 10 seconds on a white background (Figure 1) followed by a 1-second central fixation stimulus. Two male and two female faces showing neutral expressions were selected from the NimStim database (Tottenham et al., 2009) and were each paired with a different toy to create four unique face-toy pairs. The same stimuli were used by Libertus and Needham (2011, 2014) and by DeNicola, Holt, Lambert, and Cashon (2013). Side of face presentation was counterbalanced. Faces or toys were not equated for visual saliency but were of similar luminance (DeNicola et al., 2013).

Visual acuity. Maturity of the visual system, in particular the ability to perceive high-spatial frequency content, is likely to influence infants’ face preferences. To account for differences in visual acuity across the large age-range tested here, a High-Spatial Frequency (HSF) preference task was included. This task estimates preferences for high- vs. low-spatial frequency information in faces using a preferential looking paradigm identical to the face-preference task. Gray scale photographs of one male and one female face selected from the NimStim database (Tottenham et al., 2009) were modified using low-pass, and high-pass filters in Adobe Photoshop®. For each face, the Low-Spatial Frequency (LSF) and the High-Spatial Frequency (HSF) version were then presented side-by-side for fixed trial-duration of 10 seconds on a white background (Figure 1) followed by a 1-second central fixation stimulus. Each face identity was presented twice, counterbalancing for the side of the HSF image (total of 4 presentations).

Activity level. Parents of all infants were asked to complete the Infant Behavior Questionnaire (IBQ, Rothbart, 1981). From the IBQ, the activity level temperament dimension was used to provide an estimate of the child’s overall motor activity level (e.g., general limb movements, locomotion) and their ability to control and focus these movements. IBQ data is missing for two 11-month-old infants.

Analyses

Due to the large age range of the participants tested here (ranging from 3 months to 21 years of age), an assumption free approach to analyze eye gaze was used. Instead of defining fixations using an arbitrary filter algorithm, raw eye-gaze was used as a time-varying signal recorded at 50 Hz. Blinks were treated as missing data. Previous findings suggest that fixation and raw gaze results yield similar results (Tichacek, 2004). To be included in the final analyses, infants had to look at the screen for at least 25% of cumulative time for each task (face preference or HSF preference). On the face-preference task, all infants met this criterion. Two infants...
were excluded from analyses for the HSF-preference task because they failed to reach this minimum criterion (one 9-month-old and one 11-month-old infant).

Face preference was assessed by calculating the proportion of looking time to the face or the toy using two rectangular Areas of Interests (AOIs) centered over the face and toy stimulus. Looks of looking time to the face or the toy using two rectangular Areas one 11-month-old infant). They failed to reach this minimum criterion (one 9-month-old and one 11-month-old infant).

Figure 1. Example of the stimuli used during the face-preference task (a) and High-Spatial Frequency (HSF) preference task (b)

Results

Face preference

Within-group analyses indicate no face preference in three-month-olds ($M = 4.20, SD = 45.30; t(19) = 4.12, p = .68, 95\% CI [-17.00, 25.40], Cohen’s $d = .19$). A stable face preference is present around age 5 months ($M = 37.76, SD = 36.87; t(18) = 4.47, p < .01, [19.99, 55.53], d = 2.05$), seems to peak around age nine months ($M = 44.07, SD = 39.30; t(17) = 4.76, p < .01, [24.52, 63.61], d = 2.24$), and weakens somewhat by age 11 months ($M = 24.66, SD = 23.61; t(17) = 4.43, p < .01, [12.91, 36.4], d = 2.09$). These results are summarized in Figure 2. In adults, no significant face preference was observed ($M = 8.90, SD = 35.36; t(22) = 1.21, p = .24, [-6.39, 24.20], d = .50$). However, visual inspection of the horizontal eye-gaze position over time (Figure 3) indicates that adults show a rapid face preference during the first 500 ms following stimulus onset.

A between-subject ANOVA revealed significant differences in face preference between the 5 age groups, $F(4, 93) = 4.37, p < .01, \eta^2_p = .16$. Post-hoc comparisons indicated a stronger face preference in 5-month-olds compared to 3-month-olds ($p = .04$, [0.66, 66.46], Cohen’s $d = .83$), in 9-month-olds compared to 3-month-olds ($p = .01$, [6.50, 73.23], $d = .96$), and in 9-month-olds compared to adults ($p = .03$, [2.85, 67.48], $d = .97$). No other comparisons were significant.

HSF preference

Within-group analyses revealed no HSF preference in 3-month-old ($M = -3.47, SD = 36.45; t(19) = -0.43, p = .68, 95\% CI [-20.53, 13.59], Cohen’s $d = -.19$), or 5-month-old infants ($M = -0.17, SD = 35.16; t(18) = -0.02, p = .98, [-17.12, 16.78], d = .01$). A significant HSF preference was observed in 9-month-olds ($M = 20.27, SD = 34.57; t(16) = 2.42, p = .03, [2.5, 38.05], d = 1.17$), 11-month-olds ($M = 21.65, SD = 24.43; t(16) = 3.65, p < .01, [9.09, 34.22], d = 1.77$), and in adults ($M = 36.49, SD = 31.37; t(22) = 5.58, p < .01, [22.91, 50.06], d = 2.33$). These results are summarized in Figure 2.

A between-subject ANOVA revealed significant main effect of Group, $F(4, 91) = 5.36, p < .01, \eta^2_p = .19$. Post-hoc comparisons indicate a stronger HSF preference in adults compared to 3-month-olds ($p < .01$, [12.06, 67.87], Cohen’s $d = .21$), and in adults compared to 5-month-olds ($p < .01$, [8.37, 64.96], $d = .13$). No other group comparisons were significant (all $ps > .14$).

Activity level

Infants’ motor activity level was assessed via parent report using the IBQ (Rothbart, 1981). A between-subject ANOVA revealed a significant main effect of Group, $F(3, 69) = 7.73, p < .01, \eta^2_p = .25$. Post-hoc comparisons indicated that 3-month-olds ($M = 3.71, SD = 0.98$) showed lower activity-level scores than both 9-month-old ($M = 4.61, SD = 0.71; p < .01, 95\% CI [-1.52, -0.27], Cohen’s $d = -1.06$) and 11-month-old infants ($M = 4.75, SD = 0.44; p < .01, [-1.69, -0.40], d = -1.36$). No other comparisons were significant.

Relation between motor activity and face preference

The relation between motor activity level and face preference was assessed separately in 3-month-old infants (as in Libertus & Needham, 2011) and in the older infants combined using a regression model with face-preference as dependent variable and activity level as predictor while simultaneously controlling for
demographic variables (age, birth weight, parent education, and gender), and HSF preference (as estimate for visual acuity).

Together, activity level, demographic factors, and HSF preference explained a significant proportion of variation in 3-month-olds’ preference for faces, $F(6, 13) = 4.25$, $p = .01$, $R^2_{\text{Adj}} = .51$. Activity level was a significant predictor for face preference above and beyond all other predictors in the model and uniquely accounted for 27% of the variance in 3-month-old infants’ face preference, $t(13) = -2.57$, $p < .01$, $\beta = -.61$, $\Delta R^2 = .27$ (Figure 4). Other significant predictors in this model were Age, $t(13) = 2.57$, $p = .02$, and HSF preference, $t(13) = -2.57$, $p = .02$. That HSF preference is a significant predictor of infants’ face preference indicates that visual acuity affects face preference in early infancy. Together, these findings confirm and extend previous results suggesting a relation between motor and social development in 3-month-old infants (Libertus & Needham, 2011).

The same regression model was used to examine the relation between face preference and activity level in the remaining infant groups combined. In these older infants, the model failed to reach significance despite the larger sample size, $F(6, 43) = 1.31$, $p = .27$, $R^2_{\text{Adj}} = .04$, and activity level was not a significant predictor of face preference $t(43) = -1.20$, $p = .24$, $\beta = -.19$.

In summary, our results suggest a relation between motor activity and face preference in 3-month-old infants. Changes in infants’ motor activation have been found to predict the onset of independent grasping skills (Thelen et al., 1993) and may therefore increase infants’ awareness of others as social interaction partners. No such relation was observed in older infants, possibly due to reduced variability in infants’ face preference scores and motor activity scores (i.e., most older infants show a strong face preference, see Figure 2).

**Discussion**

The present study reports three main findings. First, we demonstrate that 3-month-old infants do not show a reliable preference for faces when photographic images of faces and toys are presented briefly (10 seconds). This finding confirms previous studies using similar paradigms and suggests a dip in spontaneous face preference around the third month (Johnson et al., 1991; Keller & Boigs, 1991; Maurer, 1985). Second, our results show a significant preference for faces over highly salient toys by 5 months of age, with a peak around 9 months. This pattern agrees with other reports on infants’ face preference and suggests that a strong face bias exists in mid infancy (DeNicola et al., 2013; Frank et al., 2009). And third, we report a relation between 3-month-olds’ motor activity and their emerging preference for faces. The observed negative relation between motor activity and face preference seems to contradict Libertus and Needham (2011, 2014), who reported a positive relation between successful grasping and face preference. However, these findings are compatible as high levels of motor activity are likely inversely related to successful reaching, which requires slower and controlled arm movements (Thelen et al., 1993). One possible explanation for this motor-social connection is a change in infants’ perception of people as potential interaction partners following the onset of independent grasping.

**Face preference at age 3 months and beyond**

Our results show a dip in infants’ spontaneous face preference around the third month, followed by an increase in face preference.
This finding is surprising, as others reliably reported a face preference in 3-month-old infants (e.g., Chien, 2011; Ichikawa et al., 2013; Macchi Cassia et al., 2006). However, our negative findings of a preference for faces in 3-month-old infants do not undermine the fact that 3-month-old infants are able to process faces. In fact, several studies show that 3-month-old infants’ face processing skills are highly sophisticated. For example, by 3 months of age infants show evidence for holistic face processing (Turati, Di Giorgio, Bardi, & Simion, 2010), face specific representations (de Haan, Johnson, Maurer, & Perrett, 2001; Macchi Cassia et al., 2006; Turati et al., 2005), preferences for faces of their own or primarily exposed ethnic group (Kelly et al., 2007, 2005), a preference for human faces over monkey faces (Di Giorgio, Leo, Pascalis, & Simion, 2012; Heron-Delaney, Wirth, & Pascalis, 2011), and a
reported to change infants’ social interaction bids and the ability to carry and share objects during upright locomotion has been shown (Campos, & Appelbaum, 1995; Clearfield, 2011). Similarly, being interactive in social exchanges with their caregivers (Biringen, Emde, et al., 1993) infants showed more emotional expressions and engaged in more social engagement from others.

The current study suggests that infants’ motor activity predicts their preference for faces, at least in the context used here. This relation may seem surprising, but is in agreement with a number of other studies that have identified connections between motor and social development. For example, following the onset of locomotion infants showed more emotional expressions and engaged in more interactive social exchanges with their caregivers (Biringen, Emde, Campos, & Appelbaum, 1995; Clearfield, 2011). Similarly, being able to carry and share objects during upright locomotion has been reported to change infants’ social interaction bids and parents’ responses to these bids (Karasaki et al., 2011, 2013). Collectively, these findings demonstrate that dynamic social exchanges require certain motor skills and that the child’s own motor skills influence social engagement from others.

With regard to grasping experiences, training studies using “sticky mittens” have been shown to change infants’ action perception and action understanding (Gerson & Woodward, 2013; Skerry et al., 2013; Sommerville et al., 2005). More relevant to the current study, Libertus and Needham (2011, 2014) reported that 3-month-old infants showed a reliable preference for faces at the beginning of each trial. This pattern differs from the findings reported by Frank and colleagues (2009) who used animated videos as stimuli. It is possible that older infants and adults require more time to process certain faces and toys. Our results confirm this pattern in slightly older infants (mean age 100.35 days). It is possible that 3-month-old infants would require more time to process the information provided in a face to show a reliable preference (Otsuka et al., 2009).

Going beyond the third month, our results suggest an initial increase in face preference followed by a decline after 9 months of age. We did not observe evidence for an overall face preference in adults—although adults did show a strong bias to look more at faces at the beginning of each trial. This pattern differs from the findings reported by Frank and colleagues (2009) who used animated videos as stimuli. It is possible that older infants and adults require less time to process static faces and consequently disengage attention faster. Indeed, the face preference time course shown in Figure 3 reveals that adults show a reliable face preference during the first second of stimulus presentation. Faces in animated videos require more processing and therefore elicit a prolonged face preference in adults.

Connections between motor and social development

The current study suggests that infants’ motor activity predicts their preference for faces, at least in the context used here. This relation may seem surprising, but is in agreement with a number of other studies that have identified connections between motor and social development. For example, following the onset of locomotion infants showed more emotional expressions and engaged in more interactive social exchanges with their caregivers (Biringen, Emde, Campos, & Appelbaum, 1995; Clearfield, 2011). Similarly, being able to carry and share objects during upright locomotion has been reported to change infants’ social interaction bids and parents’ responses to these bids (Karasaki et al., 2011, 2013). Collectively, these findings demonstrate that dynamic social exchanges require certain motor skills and that the child’s own motor skills influence social engagement from others.

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Interaction affordances

It remains unclear why grasping experiences would affect infants’ attention towards faces as suggested by our results. As infants acquire new motor skills, their perception of the potential for actions offered by objects changes. To describe this phenomenon, Gibson (1988) introduced the concept of “affordance.” Affordances reflect the fit between a child’s abilities and the opportunities provided by the environment to utilize these skills (Gibson & Pick, 2000). For example, 4–5-month-old infants who already engage in independent reaching have been found to attempt reaching only when they perceive an object to be close enough to succeed with their reach (Rochat & Goubet, 1995; Yonas & Hartman, 1993). Similarly, it has been shown that reaching attempts in 4–6-month-old infants are guided by object size in infants with more independent reaching experiences, while less-experienced infants mainly attempt to touch the most visually salient object (Libertus et al., 2013). These two examples show that experiences with independent reaching facilitate infants’ perception of an object’s affordances for reaching (that is, distance) and grasping (that is, size).

Here, we like to make a similar argument regarding infants’ perception of the potential for interactions offered by other people: Depending on their own motor abilities, infants may perceive different “interaction affordances” in faces. In the context used here, faces and toys were both presented beyond reach on a computer screen. This may have reduced infants’ interest in the toy, as it was not perceived as reachable. At the same time, once infants engage in independent grasping, opportunities for sharing and triadic exchanges emerge (Striano & Reid, 2006). Consequently, infants may start to perceive an affordance for social interactions in faces that they have not perceived before and this may heighten their interest in faces. In fact, it is likely that parents actively encourage perceiving interaction affordances in infants who independently grasp a toy, but not in infants who are handed a toy by the parent.
For example, mothers’ who observe a child picking up a toy may respond with request statements like “What do you have there?” or “Can you show me?” whereas mothers may produce more descriptive statements when they hand a toy to the child (such as “Look, it’s a block”). Support for this notion comes from a recent study by Karasik and colleagues (2014) who showed that crawling and walking infants elicit different verbal responses from their mothers. Future research should investigate mothers’ verbal responses towards their 4–6-month-old infants as they make the transition into independent grasping.

Face preference and visual acuity

The current study introduced a novel task to estimate visual acuity development in infancy and observed a transition away from a preference for low spatial frequency to a preference for high spatial frequency information. This developmental progression is consistent with the literature on visual acuity development in infancy (Braddock & Atkinson, 2011; Catford & Oliver, 1973; Lenassi, Likar, Stirn-Kranjc, & Breecelj, 2008). However, until a direct comparison between the HSF preference task and an established acuity measure has been performed, it remains unclear whether the HSF preference task truly estimates visual acuity. Nonetheless, our results do suggest that infants’ face preference depends upon their ability to detect the detailed features present in faces. This stands in contrast to findings with newborns, who seem to rely on LSF information when learning and recognizing faces and show a LSF advantage (de Heering et al., 2008). The information provided in an LSF image provides only coarse, global information about the face, whereas a HSF image offers fine local details. With increasing visual acuity, these fine details become accessible to the infants and may attract attention because of the increased local complexity of the HSF stimulus (which may also require additional processing time).

Interestingly, both the HSF preference and the face preference task used here utilized a nearly identical preferential looking paradigm with a fixed trial duration of 10 s. However, the developmental patterns we observed in the two tasks were vastly different. This suggests that the results of the face preference task do not just reflect the development of visual orienting in a two-choice context. By controlling for HSF preference in our regression analysis, we demonstrate that the relation between face preference and motor activity is not merely an artifact of the development of visual orienting in general.

Limitations

The current study used a parent-report questionnaire to estimate infants’ motor activity level and a preferential looking paradigm to estimate infants’ preference for photographic images of faces over toys. While researchers have used both measures widely and successfully in the past, the limitations of these measures need to be considered. First of all, concerns regarding the validity of parent report measures have been raised, and it is possible that parents under- or overestimate their child’s true ability (Bartlett & Piper, 1994; Long, 1992; Seifer, 2008). A recent study compared infants’ motor performance on professionally administered standardized assessments to parent report and showed that parents provided quite reliable estimates of their child’s motor skills (Libertus & Landa, 2013). Second, looking time is an indirect measure and a variety of factors can affect infants’ visual preferences. For example, infants in our study may show a preference for the face stimulus because it shows a “face” or because it shows a “non-graspable” object. With the measures used here, we cannot discriminate between these two possibilities. Future studies should investigate this possibility more closely to determine how motor experiences shape infants visual preferences.

Conclusion

The results reported here indicate that face preference follows a non-linear, inverted U-shaped developmental pattern over the first year of life with an initial increase from 3 to 9 months of age, followed by a relative decline. Further, regression analyses suggest a relation between motor development and face preference in 3-month-old infants and add to a growing body of evidence on the importance of motor development for social-cognitive development (e.g., Bhat et al., 2012; Iverson, 2010; Libertus & Needham, 2011).

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References


from the composite face effect. *Child Development, 81*(6), 1894–1905. doi:10.1111/j.1467-8624.2010.01520.x