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Infant Sensitivity to Age-Based Social Categories in Full-Body Displays

Running head: Sensitivity to age in full bodies

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Highlights

- 3.5- and 6-month-old infants display a visual preference for larger bodies.
- Infants prefer to look at peers for same-size infant and adult bodies.
- Infants have age-based expectations about face-body congruency.
- Face and body typologies and body size contribute to infant preference for individuals.

Abstract

This study examined 3.5- and 6-month-old infants' visual preferences for individuals from different age-groups: adults or infants. Unlike previous studies that only studied faces, here we included bodies, which are as frequent as faces in our environment, and highly salient, and in consequence, may play a role in identifying social categories and driving social preferences. In particular, we studied three salient dimensions along which individuals of different ages differ: body length, body typology and face typology. In Experiment 1, adult and infant stimuli were presented in real proportions, differing both in body length and face typology, and infants preferred the adult stimuli. Experiment 2 demonstrated that given identical adult stimuli, which differ only in body length, infants attended more to the longer stimuli. In Experiment 3, infant and adult stimuli were matched on body length with the infant stimuli having larger heads, and infants preferred the infant stimuli. Experiment 4 measured infant visual preference for infant or adult bodies in the absence of face information, and found that 4-month-olds attended more to the infant bodies. Experiment 5 measured infants' sensitivity to matching or mismatching faces and bodies based on age, and infants demonstrated a preference for the incongruent stimuli (i.e., adult head with an infant body). Altogether these studies show that while face typology and body size are main drivers of infant visual preference for adults, when body typology information is provided for bodies matched in size, infant preference shifts towards their peers. Thus, our results suggest that infants have early developing age-based body representations, and that body information shifts their pattern of visual behavior from a visual preference for adult faces, to a visual preference for full-body peers.

Keywords: visual preference; infant; adult; familiarity; body knowledge

Infant Sensitivity to Age-Based Social Categories in Full-Body Displays

Social categories are central to how human culture is organized. The ability to recognize and discriminate between different social categories emerges early in life, and is largely driven by the statistics of early visual experience. From about 3 months of age, infants begin to respond differentially to the perceptual categories of gender, race, and age, and display a visual preference for the more frequent social categories in their environment. When raised by female caregivers, 3-month-olds look longer at female than male faces, but this preference is reversed for infants with male primary caregivers (Quinn et al., 2002). Similarly, if raised in a Caucasian environment, 3-month-olds prefer Caucasian faces (Kelly et al., 2005). In addition, infants as young as 3.5 months of age display a preference for adult over infant faces when those faces are of the same race as the infants (Heron-Delaney et al., 2017). Aside from experience, a second social dimension strongly modulates social preferences in children and adults: similarity to self (Meltzoff, 2007). Multiple studies on older children using implicit or explicit measures have found that they prefer own-race and own-gender individuals (Aboud, 1988; Baron & Banaji, 2006; Dunham et al., 2008). So far it is unclear how early this preference for similar others develops, and what physical aspects guide these similarity judgments: face or body information.

Much of the previous research on the development of social categories in human infants has used faces as stimuli. In real life, however, faces do not appear in isolation; they are attached to bodies. Differences in age, race, or gender are not only visible in one's face configuration, but also in their body size and configuration. For instance, bodies could be a particularly rich source of social information, especially when individuals are at a distance and visual access to their face typology is limited (Bhatt et al., 2016). Here we begin to study the contribution of the human body in the representation and visual preference of one major social category. We will focus our study on the social dimension of age, primarily because differences in body shape, proportions, and size between infants and adults are easily noticeable and particularly salient.

Previous research has demonstrated that infants between 4 and 6 months of age can already discriminate infant faces from adult faces (Fagan & Singer, 1979; McCall & Kennedy, 1980). However, research investigating early preferences for individuals belonging to different age groups (adults vs. infants) had divergent findings. One set of studies that used a sequential presentation procedure found no preference for infants or adults. For instance, when using color photos of male and female faces, 10- and 18-month-old infants showed no preference for infant or adult faces (Lewis & Brooks, 1975). Similarly, 7- and 8-month-olds did not show age-based preferences when watching silent movies of full-bodied males and females (Sanefuji et al., 2005). Importantly, the absence of preference does not likely reflect difficulty in discriminating between different age groups, given evidence that infants between 4 and 6 months of age can distinguish infant faces from adult faces (Fagan & Singer, 1979; McCall & Kennedy, 1980). Yet, in the same studies, infants showed no spontaneous preference for infant or adult faces: they looked equally long at the infant and adult stimuli on first viewing, and took equally long to reach the habituation criterion for the infant and adult faces (McCall & Kennedy, 1980). However, as noted, another study reported an infant preference for same-race adult faces when they were compared against same-race infant faces (Heron-Delaney et al., 2017). This latter study used a paired-comparison procedure, which the authors suggested is more sensitive than the sequential presentation task, a point of difference that could explain why the individual presentation of different age groups did not capture a visual preference. By forcing infants to divide their attention between stimuli, the paired-comparison task may be optimally suited for detecting preference, and is thus the procedure we adopted for the current studies.

Although the early perception of social categories has primarily been studied in relation to faces, human bodies are as frequent as human faces in our environment, and the two generally co-occur. These observations raise the possibility that faces and bodies are processed together throughout development, and that they both contribute to our representation of social categories. The two may also have a combined role in the formation of our social preferences, as suggested by previous studies with adults (Aviezer et al., 2012). As human bodies are proportionally larger than human heads, they may play an important role in identifying members of different social categories, particularly at a distance, or early in development when the visual system is not yet mature. However, since the primary function of the body is locomotion, human bodies have often been studied in relation to motion (Astafiev et al., 2004). For example, it has been shown that body movement conveys important information about the gender and age of an individual for adult perceivers (Cutting & Kozlowski, 1977; Vaina et al., 2001). With regard to infants, when presented with point-light displays, 4-month-olds were found to discriminate between human motion and unfamiliar patterns (Bertenthal et al., 1987), suggesting an early representation of basic features of human body movement.

However, evidence about early knowledge of body configurations from static displays is sparser and sometimes inconsistent. One study with 12-, 15-, and 18-month-olds compared looking times to images of static normal bodies versus scrambled bodies, in which the legs were attached to the shoulders instead of the arms, but maintained the canonical head position and symmetry along a vertical axis (Slaughter et al., 2002). It was reported that only the 18-month-olds displayed a preference between normal and scrambled bodies, while the 12- and 15-month-olds showed no sensitivity to differences in body configurations, suggesting that before age 18 months, limb size and structure are not crucial dimensions of the human body representation. Nonetheless, in the same study, all age groups preferred normal versus scrambled human faces, highlighting a developmentally earlier sensitivity to face-like configurations. In a follow-up study using real people, mannequins, dolls, and large human body photographs, Heron and Slaughter (2010) found that even 9-month-old infants could discriminate between normal and scrambled human bodies, but only for three-dimensional bodies of real people or mannequins. The authors concluded that infant responding was highly dependent on the realism of the stimuli, and although some body knowledge is available to infants by their first birthday, a more robust representation only becomes available during their second year of life (Slaughter et al., 2012).

Although the development of a fine-grained representation of the human body seems to be slower in comparison to the representation of the human face, several other studies suggest that some basic knowledge about body structure is present very early in life. For instance, one study reported that from 3 months of age, just as for faces, infants are sensitive to normal human body configurations, when two essential features of body organization are present: body symmetry and head position (Gliga & Dehaene-Lambertz, 2005). One way to interpret these findings is that though not fully defined, the first representations of human bodies start with a coarse depiction of a head on top of a body-like structure, expected to be symmetrical. Another study presenting normal and scrambled bodies side by side found that 3.5-month-olds were sensitive to body structure, and preferred the rearranged configurations, but only when the stimuli were presented upright - no preference was found for inverted bodies (Zieber et al., 2015). This selective preference in the upright conditions indicates that infant attention was modulated by the familiarity of the body configurations and not by low-level features. These findings are consistent with those of Gliga and Dehaene-Lambertz (2005) that infants have an early sensitivity to human bodies in canonical orientation, with the heads at the top.

Both the Gliga and Dehaene-Lambertz (2005) and Zieber et al. (2015) findings are at odds with the data of Heron and Slaughter (2010) indicating that body-structure sensitivity only becomes available towards the end of the first year of life. A fundamental difference between these studies, that may have led to their divergent findings, lies in their procedures. Zieber and collaborators (2015) used a paired-comparison procedure with two stimuli presented side by side on each trial, while Slaughter and colleagues used a successive procedure with stimuli presented one at a time. These procedural variations have also been studied by Fagan (1978), who showed that visual paired-comparison tasks are indeed more sensitive than successive presentations.

Research on the holistic processing of bodies also suggests expert body processing abilities in very young infants. Several studies have documented that from 3 month of age, infants show holistic processing of humans based on whole image information, i.e., head + body (Hock et al., 2016; Quinn, 2004; Quinn et al., 2007). In addition, other studies have shown that infants have a basic, but rather specific, representation of humans that includes both head *and* body information, and that differs from that of closely-related species. When presented simultaneously with human and non-human (monkey or gorilla) heads, bodies, or heads and bodies, human infants consistently preferred to look at the human stimuli, indicating a precise representation of conspecific faces and bodies (Heron-Delaney et al., 2011). At the same time, infants may utilize their representation of humans (i.e., a head attached to a body with skeletal appendages) to respond to non-human animals as being human-like, a process that may allow infants to develop a representational structure for animals in general (Quinn, 2004).

Building on previous research showing an early differential responding to infant and adult faces, and a basic representation of human body structure by 3 months of age, the current study investigated visual preferences and early representations of full-body individuals belonging to different social groups defined by age. Adults sometimes prioritize information coming from the body to information coming from the face (Aviezer et al., 2012) when evaluating socially relevant characteristics of other individuals. To date, it is unclear if young infants can extract social category information about others, such as their age, from full-body displays. From 3-4 months of age infants can extract a multitude of socially-relevant cues from faces (Lee et al., 2011; Quinn et al., 2020). In particular, prior research has shown that infants are sensitive to age-related cues from faces by 3.5 months, and that infants prefer adult over infant faces (Heron-Delaney et al., 2017). Here, we aim to study if infants can extract social category information from full-body displays and if the same preferences for adults over infants will be maintained.

The current research specifically aims to evaluate the visual preferences of infants for conspecifics that differed in age. To understand the perceptual information that may drive their social categorization, we systematically manipulated three dimensions that we considered diagnostic of the age-based category distinctions between adults and infants: *body length* (infant length vs. adult length), *body typology* (infant body vs. adult body), and *face typology* (infant face vs. adult face). We examined the visual preferences of infants for full-body adults (a highly-familiar age group) compared to peers ("like me", Meltzoff, 2007, but a less familiar age group) at 3.5 and 6 months of age.

In five experiments using a visual paired-comparison procedure, we presented pairs of full-body infant and adult photographs side by side. Experiment 1 investigated visual preference for full-body infants and adults when head size was kept constant across the different age groups, and the body length and body typology were adjusted to match real-life proportions. Face and body typology were matched in age, and head to body proportions were kept realistic for each age group; thus, body length varied between age groups, just as in real-life. Experiment 2 examined the preferences of infants for smaller or larger individuals, by presenting pairs of identical adult bodies of different sizes. To understand if body length is the primary cue driving visual preferences, Experiments 3 and 4 evaluated visual preference for full-bodies or headless bodies belonging to different age groups, when length was equated across age groups and full-body or headless body proportions were kept realistic.

In light of the findings from Experiments 1 through 4, Experiment 5 investigated if representation of age-based social categories by infants includes a face-body expectation. Two groups of infants were tested in one of two conditions: (i) infant and adult faces with identical infant bodies, or (ii) infant and adult faces with identical adult bodies. The prediction was that if infants detect the mismatch between the face and body typology based on the social category of age, they will look longer at the incongruent/novel images. Finally, together, these studies provide a comprehensive assessment of how face typology, body typology, and body length contribute to infant visual preferences for own-race conspecifics varying in age.

Experiment 1

This study investigated the visual preferences of infants for full-body infants or adults, where the infant and adult heads were matched in size, while each body's proportion and their relative size were kept realistic. Longer looking times to the infant images, although smaller in size, would indicate a peer preference. Alternatively, a preference for the adult images may reflect a preference for adults or indicate a preference for larger stimuli.

Method

Participants. Participants were recruited from XXX. In total, 15 full-term 3.5-month-olds (8 females; age range 104-114 days) and 18 6-month-olds (9 females; age range 183-195 days) were included in the final sample. Three 3.5-month-olds and one 6-month-old were excluded due to side bias. Side bias was defined as looking at one image in the pair for 95% or more of the total looking time.

Stimuli. The stimuli were four color photographs of adults (age = 30 years) and infants (age = 9 months) wearing black briefs/shorts. There were two adult-infant pairings with the adult and infant presented standing in one pair and sitting crossed-legged in the other pair (see Figure 1a for the crossed-legged pairing). Photographs were presented against a white background. The adult male was cleanly shaven in terms of facial hair, and the hair on his head was closely shaved. Male adults were chosen as stimuli rather than females, since they provided a closer match to the infant stimuli in terms of hair on the head and overall body shape, which allowed us to more closely focus our investigation on the two dimensions of interest (body length and face typology). Additionally, there was concern that female adults could produce an adult preference that was simply based on the stimuli being female, since infants have previously demonstrated a preference for female over male adults (Quinn et al., 2002). The head size of the infant and adult images was equated. The proportion of head to body for each individual was matched with real body proportions for their age groups, such that for the standing images, the adult full-body size was 21.5 cm and the infant was 12.0 cm. For the sitting stimuli, the adult was 19.5 cm and the infant was 12.5 cm. Thus, just as in real life, the infant image was considerably smaller than the adult image.

Procedure. Infants were tested in an anechoic chamber at the University of XXX. Infants sat on their mother’s lap approximately 60 cm away from a screen, which displayed the images. The experimenter was out of sight during testing, and both the mother and the experimenter remained quiet. Each pair of photographs was presented for a total duration of 10 s. Each infant was presented with two trials (two pairs of images). The adult and the infant images were presented standing in one pair and sitting crossed-legged in the other pair. Left-right positioning of the adult versus infant was counterbalanced across infants on the first trial, and reversed on the second trial. Half of the infants started with the standing stimuli, and the other half started with the crossed-legged stimuli. We recorded infant fixations to the stimuli, and the videos were subsequently analyzed frame by frame on a computer using specialized software. An independent observer recoded 33% of the data for reliability. Both observers were blind to condition. The average level of inter-observer agreement was high (Pearson $r = .99$).

Results and Discussion

A one-sample two-tailed t-test conducted on the percentage of time spent looking at the adult versus a 50% chance level of looking revealed that 3.5-month-old infants attended reliably to the adult (64.29%, $SD = 14.49$), $t(14) = 3.82$, $p = .002$, Cohen's $d = .99$. Similarly, 6-month-old infants attended significantly to the adult (57.05%, $SD = 9.27$), $t(17) = 3.23$, $p = .005$, Cohen's $d = .76$. Additionally, we conducted an ANOVA on the proportion of time looking at the adult body with age (2: 3.5 months or 6 months) and position (2: sitting or standing) as factors. This analysis revealed no main effect of age ($F[1] = 1.78$, $p = .19$), or position ($F[1] = .31$, $p = .58$), and no significant interaction ($F[1] = .32$, $p = .58$).

Experiment 1 showed a similar pattern of response for the 3.5- and 6-month-old infants. Both groups preferred to attend to adults rather than infants when presented with full-body images of conspecifics whose head to body proportions and relative size closely depicted a 9-month-old infant and a 30-year-old male, respectively. The findings extend a previous report that comparably aged infants prefer adult to infant faces (Heron-Delaney et al., 2017), indicating that their age-based preferences are maintained for full-body displays. However, one alternative explanation of our findings is that rather than showing a general preference for adults, they might simply reflect a preference for larger stimuli.

Experiment 2

To determine if 3.5- and 6-month-olds generally prefer to attend to larger individuals, Experiment 2 introduced stimuli that were identical in every respect, except for their size. Infants saw two images of the same adult: one image was the same size as the adult image in Experiment 1, while the second one was the height of the infant image in the previous study. If an individual's size alone modulates visual preference, infants will look longer at the larger than at the smaller image. This outcome would suggest that the preferences for adults in Experiment 1 may have simply been driven by size, rather than other features of the stimuli, such as their age.

Method

Participants. Participants were recruited as in Experiment 1. In total, 12 full-term 3.5-month-olds (5 females; age range 95-109 days) and 15 6-month-olds (6 females; age range 180-192 days) were included in the final sample. Nine 3.5-month-olds were excluded due to side bias.

Stimuli. We used the same adult images as those used in Experiment 1. One image in a pair was presented in an identical size as in the previous study (length standing = 21.5 cm, and length sitting = 19.5 cm), while the second image was matched in size to the infant image in Study 1 (length standing = 12.0 cm, length sitting = 12.5 cm).

Procedure. We used the same procedure as in Experiment 1. The average level of inter-observer agreement was high (Pearson $r = .98$).

Results and Discussion

A one-sample two-tailed *t*-test conducted on the percentage of time spent looking at the larger stimulus versus a 50% chance level of looking revealed that the 3.5-month-olds attended reliably more to the larger stimulus (61.57%, $SD = 8.59$), $t(11) = 4.66$, $p = .001$, Cohen's $d = 1.35$. The 6-month-olds followed the same pattern: they attended significantly to the larger image (60.63%, $SD = 11.38$), $t(14) = 3.61$, $p = .003$, Cohen's $d = .93$. An ANOVA on the percentage of time spent looking at the larger stimuli with age (2: 3.5 months or 6 months) and position (2: sitting or standing) as factors revealed no main effects of age (F[1] = .02, $p = .89$) or position (F[1] = 2.84, $p = .09$), and no significant interaction (F[1] = .17, $p = .68$).

Thus, when infants are presented with two identical images that only differ in size, they display a visual preference for the larger stimulus. This result suggests that the preference for the adult over the infant stimuli in Experiment 1 may have simply captured a preference for larger stimuli, rather than a preference for a social category based on age.

Experiment 3

In Experiment 3, to understand whether the preference for adult bodies that infants displayed in Experiment 1 was based on stimulus size, as Experiment 2 indicates, or on the social category displayed, groups of 3.5- and 6-month-olds were exposed to infant and adult stimuli equated in length.

Method

Participants. Participants were recruited as in Experiment 1. In total, 16 full-term 3.5-month-olds (5 females; age range 100-114 days), and 18 6-month-olds (9 females; age range 180-190 days) were included in the final sample. Five 3.5-month-olds were excluded due to side bias ($n = 3$) or fussiness ($n = 2$), and one 6-month-old was excluded due to fussiness.

Stimuli. The adult and infant stimuli were matched in height (21.5 cm standing, 19.5 cm sitting). The head to body proportions for each individual were kept realistic, which resulted in infants having a larger head than adults.

Procedure. We used the same procedure as in Experiment 1. The average level of inter-observer agreement was high (Pearson $r = .99$).

Results and Discussion

A one-sample two-tailed t-test conducted on the percentage of time spent looking at the infant stimuli versus a 50% chance level of looking revealed that the 3.5-month-olds attended more to the infant (58.47%, $SD = 13.58$), $t(15) = 2.49$, $p = .025$, Cohen's $d = .62$. The 6-month-olds behaved in a similar way: they too attended more to the infant (59.36%, $SD = 11.12$), $t(17) = 3.57$, p

= .002, Cohen's $d = .84$. An ANOVA on the percentage of time spent looking at the infant stimuli with age (2: 3.5 months or 6 months) and position (2: sitting or standing) as factors revealed no main effects of age ($F[1] = .039$, $p = .84$) or position ($F[1] = .058$, $p = .81$), and no significant interaction ($F[1] = 1.23$, $p = .27$).

When presented with full-body images of an adult and an infant (equated for length), 3.5- and 6-month-old infants showed a visual preference for peers compared to adults. By matching the total size of the infant and adult stimuli, we reversed the findings from Experiment 1, where infants showed a preference for adults (with adult stimuli that were larger in overall size than the infant stimuli). The results of Experiment 3 suggest a peer preference ("like me") when full-body images of infants are presented alongside adults. The findings stand in contrast to previous findings by Heron-Delaney and collaborators (2017), who found that infants preferred adult to infant faces of their own race. One possible interpretation of the different outcomes when studying faces versus full-bodies, is that infants have a holistic representation of their conspecifics that includes the head and the body, and that the presentation of full-body individuals supports the recognition and preference for their peers. An alternative interpretation is that visual preference was mainly driven by the size of the head, rather than the social category of the stimuli. When matching the infant and adult bodies in length, the difference in body proportions (i.e., the head-body ratio) between these two age groups resulted in a larger head for the infant than for the adult. However, the current findings leave open the possibility that visual preference for the infant may not be based on the social category presented and body information may not have had any contribution at all. To understand the contribution of the body typology in the visual preference of infants for peers versus adults, our next experiment introduced the same bodies matched in length, while the head information was removed.

Experiment 4

Here we used the stimuli in Experiment 3, except that the head and face information was removed from the images and bodies were matched in length. If infants display a preference for peer bodies, when individuals are matched in size, we predicted that infants will look longer at the infant body. Alternatively, if infants display a preference for adult bodies, they will look longer at the adult bodies. Finally, if infants have no age-based body knowledge, we would not expect them to show differential responsiveness to the two body types. Since in Experiments 1 to 3 we found no difference in performance between the 3.5- and 6-month-olds, in this experiment we tested one group of infants ranging from 3 to 6 months of age.

Method

Participants. Participants were recruited and tested at the XXX. In total, 21 full-term 3- to 6-month-olds (10 females; age range 96 to 195 days) were included in the final sample. Three infants were excluded due to side bias and one due to fussiness.

Stimuli. Stimuli included the adult and infant bodies from the pictures used in Experiment 3, from which their heads were removed. Infants viewed two pairs of photographs in this study: (i) the regular infant body (standing) paired with an adult body standing (length = 19.5 cm), and (ii) the infant body sitting cross-legged paired with an adult body sitting (length = 21.5 cm). Image presentation was counterbalanced for side and order. Height was equal for the two bodies (one adult and one infant body) in each trial.

Procedure. The procedure was identical to Experiment 1. The average level of inter-observer agreement was high (Pearson $r = .97$).

Results and Discussion

A one-sample two-tailed t-test conducted on the percentage of time spent looking at the adult body versus a 50% chance level revealed that the 4-month-olds attended significantly less to the adult body than to the infant body (44.04%, $SD = 10.72\%$, $t[20] = -2.54$, $p = .02$, Cohen's $d = .56$). A paired-sample t-test comparing the percentage of time spent looking at the standing versus sitting adult bodies revealed no significant difference ($t[20] = 0.69$, $p = .49$).

The pattern of infant looking behavior in Experiment 4 revealed that 4-month-old infants preferred to look at the infant over the adult headless bodies when they were equal in length. These findings are in line with those of Experiment 3 where the same bodies were displayed with heads, and where we found that infants looked longer at the infant compared to the adult photos. One interpretation of these findings is that 4-month-old infants display a preference for the body typology most similar to their own. This pattern of infant preference is different from that previously found for faces (Heron-Delaney et al., 2017), where infants preferred own-race adult faces more than infant faces. One possible interpretation for infants' differential pattern of attention to faces and bodies is that infants see their own bodies much more than they see their own faces, which may enable them to develop an understanding and preference for their own body before an understanding of their own face. Although this interpretation is purely speculative, future research should address the potential dissociation between face and body processing in infancy.

Importantly, this interpretation of the preference for peer bodies by infants rests on the assumption that they can discriminate between infant and adult bodies. To further understand if infants are indeed sensitive to body typology and to full-body body age-based categories, our next experiment tested whether infant expect faces and bodies to be matched in age. Thus, in Experiment 5, we presented infants with same length stimuli where the face typology and body typology were either congruent (e.g., adult face with an adult body) or incongruent (e.g., adult face with an infant body).

Experiment 5

Previous research has consistently shown that infants can discriminate faces based on their age, and that they prefer to attend to own-race adult faces as opposed to own-race infant faces (Fagan & Singer, 1979; McCall & Kennedy, 1980; Heron-Delauney et al., 2017). The preference of infants for infant bodies in Experiment 4 suggests that by 4 months of age infants can also discriminate bodies based on their age, and that they display a preference for peer bodies. To further understand how others are represented based on their age, Experiment 5 tested the sensitivity of infants to the coherence between age-based face typology (infant or adult) and body typology (infant or adult). We used the faces and bodies of infants and adults from the previous experiments, and we matched the head and body size in each pair to create a set of same-size congruent photos (i.e., adult head with adult body or infant head with infant body), and a set of incongruent photos (i.e., adult head with infant body or infant head with adult body). On each trial, infants saw one congruent and one incongruent photo where bodies were the same, but the heads differed. Our prediction was that if infants expect faces and bodies to be matched in age, they will be surprised by a mismatch between the face and body typologies and they will spend more time looking towards the incongruent photos. Alternatively, if infants cannot detect the mismatch between face and body typology, their preference will be driven by the face information since the body information is always the same in each trial. Should that be the case, given the previous findings by Heron-Delaney et al. (2017), we expected infants to prefer adult faces over infant faces.

Method

Participants. Participants were recruited in an identical manner to Experiment 1 to 4. In total, 35 full-term 3.5-month-olds (15 females; age range 104-114 days), and 35 6-month-olds (20 females; age range 182-194 days) were included in the final sample. Eight 3.5-month-olds were excluded due to side bias and one 6-month-old was excluded due to fussiness.

Stimuli. Stimuli included the adult and infant pictures used in the previous studies, as well as variations of these pictures created by editing the photographs. Infants were assigned to one of two conditions: (i) infant body, or (ii) adult body. In the infant body condition, infants saw one congruent full-body photo (*i.e.*, infant head with the infant body) paired with one incongruent full-body photo *(i.e.*, adult head with the infant body). Similarly, in the adult body condition, we presented a congruent photo (*i.e.*, adult head with the adult body) and one incongruent photo (*i.e.*, infant head with the adult body). Each infant viewed two pairs of photographs belonging to the same condition, one standing and one sitting pair. The side of the congruent photo was counterbalanced across trials, and the order of the sitting and standing trials was counterbalanced between participants. Head size and body length were equal for the congruent and incongruent photos in each trial.

Procedure. The procedure was identical to Experiment 1. The average level of inter-observer agreement was high (Pearson $r = .97$).

Results and Discussion

A one-sample two-tailed *t*-test conducted on the percentage of time spent looking at the incongruent body versus a 50% chance level of looking revealed that the 3.5-month-olds attended longer to the body where the face and the body were incongruent (54.44%, $SD = 10.44$), $t(34) = 2.03$, $p = .049$, Cohen's $d = .43$). Similarly, the 6-month-olds attended longer to the incongruent face-body pairs (55.03%, $SD = 13.32$), $t(34) = 2.23$, $p = .032$, Cohen's $d = .38$). An ANOVA on the percentage of time spent looking at the regular infant stimuli with age (2: 3.5 months or 6 months), position (2: sitting or standing) and body type (2: adult or infant) as factors revealed no main effects of age ($F[1] = .025$, $p = .88$), position ($F[1] = .83$, $p = .36$), or body type ($F[1] = .48$, $p = .49$) and no significant interactions.

In Experiment 5, 3.5- and 6-month-old infants looked longer at incongruent bodies, where the face typology (infant or adult) was mismatched with the body typology (infant or adult). This outcome suggests that infants associate faces typical of an age group with the body typology specific for that age group and are surprised when presented with incongruence . To our knowledge, these are the first findings to show that from 3.5 months of age infants are sensitive to the face-body congruence.

Age is a major social category and infant sensitivity to the correspondence between faces and bodies of the same age confirms their ability to extract age-based social information from inputs other than faces. Our findings are particularly surprising in light of previous research suggesting that face and body knowledge are not linked during the first months of life. For instance, Slaughter and colleagues (2012) claimed that body knowledge only develops during the second year of life. However, more recent studies suggest that 3-month-old infants are already sensitive to the normal configuration of bodies (Gliga & Dehaene-Lambertz, 2005; Zieber et al., 2015), and our results are consistent with that view.

General Discussion

In a set of five experiments, we investigated the visual preferences of 3.5- and 6-month-old infants for adults or infants, when full-body photos of these two age groups were presented to participants. Previous studies documented the visual preference of infants for own-race adult faces compared to infant faces, but no age-based preference was observed for adult or infant faces that belonged to a different race (Heron-Delaney et al., 2017). Here we investigated infant visual attention to adults and infants in more naturalistic scenarios, where full bodies were presented. To understand infant sensitivity to age-based body typologies and the factors that may be driving their preferences when presented with full-body displays, we systematically varied the three most salient dimensions that differentiate adults from infants: body length, body typology, and face typology. Our results suggest that face typology is not the sole driver of early social preferences, and that infants are already sensitive to body length, and to the body typology corresponding to different age groups, which are major factors driving their social attention.

Experiment 1 paired infant and adult photos, where real-life differences between the social categories in body length and face and body typology were preserved. This manipulation led to an early preference for full-body adults. Experiment 2 examined whether size alone could have driven the results in Experiment 1 by studying the preference of infants for a shorter or taller version of the same adult. The infants preferred to attend to the larger individual. Experiment 3 equated individuals in full body length (head + body) while maintaining realistic proportions between the head and the rest of the body for the infant and adult. This procedure yielded a looking preference towards peers, leading to two potential interpretations. The first is that when full-body size is controlled for, infants prefer to attend to individuals that are like them. Alternatively, our findings might have been driven by the size of the head — the infant head was larger than the adult head in this manipulation to keep body shape and proportions realistic. Experiment 4 tested the preference for a headless infant or an adult body matched in length. We found a preference for the infant body, which mirrors the results of Experiment 3. These findings corroborate those of Experiment 3 and suggest that when individuals are matched in size, infants prefer to attend to infant bodies. However, this interpretation lies on the assumption that infants are sensitive to differences in body typology between infants and adults. Experiment 5 tested infant sensitivity to age-based body typology by presenting them with individuals whose face types (infant or adult) either age-matched or age-mismatched their body types (infant or adult). This manipulation resulted in a visual preference for the incongruent full-bodies, which suggests that infants can discriminate between matching and mismatching faces and bodies based on their age category.

Interestingly, across five experiments we found no differences in looking behavior between the sitting and the standing positions. The null effect of body position can have two possible explanations. A first explanation for the similar response of infants to the sitting and standing bodies is that early body representation is flexible and incorporates multiple postures and positions, aside from the canonical one. This interpretation is consistent with the observation that infants are exposed to a variety of body positions that are not limited to the standing posture with arms spread along the torso. Future research should address infant sensitivity to different body postures that provide varying perceptual access to the different body parts, structure, and proportions. Second, this result may indicate that face information is the primary driver of our effects. Since faces were identical for the sitting and standing positions, body position did not play a contributing role to the effects we observed. This interpretation is supported by research showing that faces have a high social value and are prioritised by our visual system, due to the richness and importance of the information they can convey. Adults are more efficient at detecting faces that non-face objects, even when some features are removed, such as the mooney-faces or blurred faces (Kanwisher et al., 1998; Yin, 1969; Lewis & Edmonds, 2003). Infants also display a strong bias and visual preference for faces and face-like configurations from birth (Johnson et al., 1991; Turati et al., 2002), which may indicate they use faces as a primary source of social information. Nevertheless, our findings from Experiments 4 and 5 speak against this interpretation. In Experiment 4 infants displayed a visual preference for the infant body, even in the absence of face information. In Experiment 5, infant visual attention was driven by the congruency of the stimuli, and not by the face typology. This latter result shows that early looking behavior is modulated by integrated information from the face and body, and not merely from one of these sources.

The current findings contribute to a limited literature examining infant response to perceptual age-based social categories. Three previous studies obtained no preference for adults or infants (Lewis & Brooks, 1975; McCall & Kennedy, 1980; Sanefuji et al., 2005). These studies differed on a number of procedural aspects including the body parts presented to the infant (face or body or both), the type of stimuli (drawing, photograph, or movie), or the age of the infants tested (varying between 6 and 18 months). One crucial procedural factor may have prevented previous researchers from finding age-based preferences: the sequential presentation of items from different social categories. Only one study, using paired-presentation, found a visual preference for same-race adult faces over infant faces (Heron-Delaney et al., 2017). Interestingly, our findings using full-body stimuli suggest that infants prefer to look at full-body adults when they are larger in size, even if the infant and adult head size is kept equal (Experiment 1). These findings mirror those of Heron-Delaney and colleagues (2017). However, when the full-bodies or headless bodies of infants and adults are equal in size, infants shift their preference towards peers (Experiments 3 and 4). These findings are in contrast with those for faces, where a consistent preference for adults was found. Our results using full-body stimuli may indicate that body typology plays a crucial role in infant preference for peers-. This is consistent with the fact that infants are more exposed to infant bodies, since they can always see their own. However, they are less frequently exposed to infant faces, compared to infant bodies, as well as adult faces and bodies.

Importantly, our study demonstrates that 3.5 and 6-month-olds are sensitive to differences between the bodies of infants and adults and to age-based mismatches between faces and bodies. This result suggests that by 3.5 months infants are processing the perceptual features of some social categories around them, at least those defined by age, and expect the type of face and body of an individual to belong to the same social category. Previous research has only found evidence for this type of sensitivity in older infants. For instance, Brooks and Lewis (1976) showed that 7-month-olds responded to adults, small adults and children as if they belonged to three categories, which reveals their expectations of congruence between face typology and body length. Another study, looking at infant sensitivity to how faces and bodies match based on their gender, found that 3.5-month-olds displayed no preference for gender congruent or gender incongruent faces and bodies, but that 5-month-olds preferentially attended to faces and bodies mismatched in gender. This result suggests at 5 months infants understand the perceptual features differentiate between genders, and that infants expect an the gender of an individual's face and body to be congruent, or to belong to the same gender (Hock et al., 2015). An interesting avenue for future research is to investigate if gender-based and age-based perceptual categorization develop at the same age.

To date, there is mixed evidence about the early body representations of infants, which aspects of the body structure they are most sensitive to, and whether their sensitivity to these features is modulated by the familiarity of the body typology (i.e. female body = very familiar, male body = moderately familiar, and infant body = very familiar) in their environment. For instance, Zieber and colleagues (2015) found that 3.5-month-olds are sensitive to human body structure and prefer scrambled to intact bodies. However, when using a successive presentation, Slaughter and colleagues (2004) could not detect any sensitivity to disruptions in human body structure until the second year of life (i.e. 18 months). Other studies showed that when presented with attractive and unattractive bodies, infants showed a preference for unattractive bodies at 9 months, but they could not discriminate the two body types at 6 months (Heron-Delaney et al., 2013). Multiple other studies suggest that infants become sensitive to body proportions (Zieber et al., 2010) and to violations of body configurations (Heron & Slaughter, 2010) around 9 months of age.

We found a preference for adults in Experiment 1, where adult bodies were larger in size than infant bodies. This preference may reflect a more general perceptual bias observed in infants and adults alike driven by the visual salience of a larger individual, independent of their conceptual content or potential for action or social interaction (Newman et al., 2001; Libertus et al., 2013). A second possibility is that this may reflect a visual preference for adults. Previous studies using faces matched in size found an early preference for adult-like stimuli, explained by the greater experience infants have with adult faces, consistent with previously reported visual preferences for highly frequent social categories, such as race and gender (Kelly et al., 2005; Quinn et al., 2002). Head-mounted camera studies have documented that at 3 months of age, infants primarily see their primary or secondary caregivers (i.e., 44%, and 17%, respectively, of their total social interaction time, Sugden & Moulson, 2018). The overrepresentation of caregiver faces suggests that infants are predominantly exposed to a limited set of facial characteristics (Jayaraman, et al., 2015), and that their perceptual experience is biased towards adult own-race faces (Rennels & Davis, 2008; Sugden et al., 2014). However, in Experiments 3 and 4 where infant and adult bodies were matched in size, we found that infants preferentially attended to infant full-bodies or to infant bodies, showing a visual preference for peers. While infants are more familiar with adult faces, they are constantly exposed to their own bodies. This may be the key factor driving their visual preference towards peers in our studies and highlights the importance of using more naturalistic full-bodies in studying their visual preference for different social categories. Given that increased age likely leads to more experience with additional age groups and diversity within various social categories, future research can investigate how changes in experience impact the preferences of infants and children for individuals of different ages. Also, further work could investigate the variety of other cues and factors that may contribute to infant representation of age (e.g., movement patterns, voice). Whatever findings are revealed by these subsequent studies, the current study has provided evidence that body length, body typology, and face typology are contributors to infant preference for adults or for infants.

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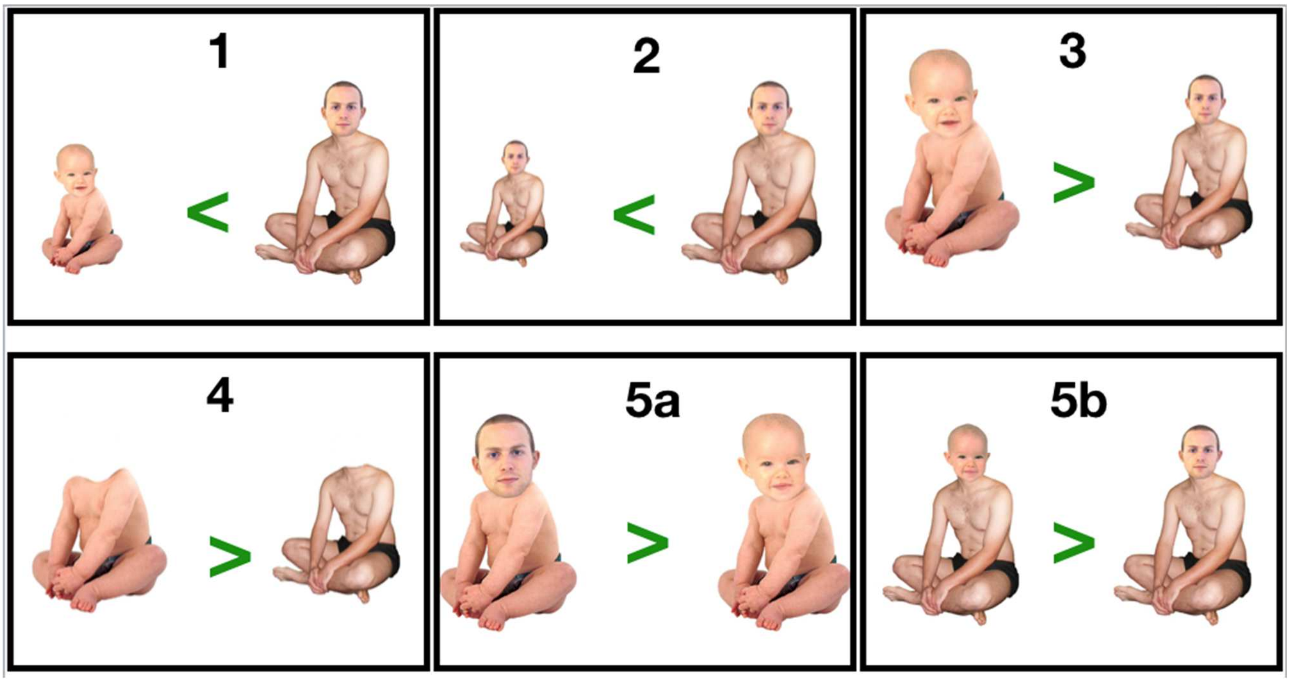
Figure 1

Infant and Adult Pairings Presented to the Infants

Note: Panels 1, 2, 3, 4 and 5 depict the stimuli for Experiments 1, 2, 3, 4, and 5 respectively.



Appendix A

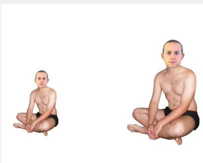
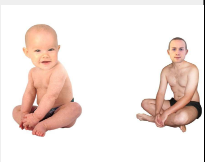
We conducted a detailed contrast analysis for each pair of stimuli, converting the images in L*a*b color space using MatLab color transform ‘srgb2lab’. We then computed the mean luminance for each of the stimuli used in our studies (see Table 1 below). The luminance contrast between pairs of stimuli, corresponding to each experiment, was calculated for each pair of images *i* using $C_i = 100*(L_{left}-L_{right})/(L_{left}+L_{right})$, a version of Michelson contrast, giving the luminance contrast between the two images. This absolute contrast value can vary from 0 to 100, where 0 is the minimum contrast and 100 is the maximum contrast achievable for any given display. Michelson contrast is a transformation that approximates the logarithmic relation displayed by photoreceptor responses which are proportional to the log of image intensity relative to background intensity (Legge & Kersten, 1983; Peeles & Teller, 1975; Teller et al., 1978; Banks & Stephens, 1982). As in adults, by 3.5 months of age, perceived contrast more closely follows the Michelson contrast than Weber contrast.

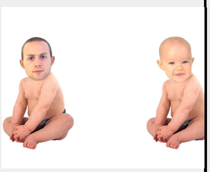
Previous research (Stephens & Banks, 1987; Brown, 1994; Brown et al., 1995; Brown & Lindsey, 2009) suggests that although the Michelson contrast in our stimuli can be easily discriminated by adults (Michelson contrast discrimination threshold ranges between 0.6 and 3), these values fall below the discrimination thresholds of infants younger than 6 months (Michelson contrast discrimination threshold ranges between 20 and 30 at this age). Brown (1994) showed that early in development infants have poor contrast sensitivity, and that at 2-3 months of age, the infant contrast detection threshold was higher than the adult detection threshold by a factor of over 50.

Previous findings on the poor contrast detection of infants in their first months make it highly unlikely that our results reflect responses to luminance differences in the stimuli, but rather that infant behavior was driven by three main dimensions of the stimuli: face typology, body typology and body length, as we argue in the main text.

Table A1

Michelson Contrast Values for Each Stimulus Pair used in Experiments 1-5

Images	**Experiment**	**Position**	**Average Luminance Left**	**Average Luminance Right**	**Michelson Contrast**
	1	Sitting	192.8957406	176.923788	4.318850506
	1	Standing	138.284558	187.2872544	-15.05127119
	2	Sitting	180.9764534	176.923788	1.132344976
	2	Standing	142.6322207	153.6619253	-3.722552318
	3	Sitting	188.8488314	177.5569759	3.081789439
	3	Standing	182.2638896	143.4096002	11.93044281
	4	Sitting	181.5766139	174.7986873	1.901906946
	4	Standing	181.0495494	141.6535136	12.20813818

	5	Sitting	177.0354057	177.4707923	-0.122814941
	5	Standing	143.2628519	145.2178311	-0.677681131
	5	Sitting	185.1846886	189.9994	-1.283293062
	5	Standing	185.2233563	186.5516021	-0.357271452

Appendix References

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