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Own-age biases in adults' and children's joint attention: Biased face prioritization, but not gaze following!

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ABSTRACT
Previous studies have reported own-age biases in younger and older adults in gaze following. We investigated own-age biases in social attentional processes between adults and children by focusing on two aspects of the joint attention process; the extent to which people attend towards an individual's face, and the extent to which they fixate objects that are looked at by this person (i.e., gaze following). Participants viewed images that always contained a child and an adult who either looked towards each other or each looked at objects located to their side. Observers consistently, and rapidly fixated the actor's faces, though the children were faster to fixate the child's face than the adult's faces, whilst the adults were faster to fixate on the adult's face than the child's face. The children also spent significantly more time fixating the child's face than the adult's face, and the opposite pattern of results was found for the adults. Whilst both adults and children prioritized objects when they were looked at by the actor, both groups showed equivalent levels of gaze following, and there was no own-age bias for gaze following. Our results show an own-age bias for prioritizing faces, but not gaze following.

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Eye movements; Gaze following; Joint attention; Own-age bias; Social attention

Successful human interaction relies on understanding other people's thoughts and intentions, and joint attention is thought to be one of the key components of this social cognition process (Scaife & Bruner, 1975). Joint attention refers to the process by which we identify where or what another person is looking at, and it allows us to orient our own attention to the same thing (Baron-Cohen, 1995). Joint attention not only is essential for everyday communication (Macdonald & Tatler, 2013), but also plays a critical role in developing more complex perceptual abilities such as inferring the mental states of others, language development and comprehension, and understanding emotions (Charman et al., 2000).

The first step in the joint attention process involves working out what another person is attending to, and a person's gaze direction provides valuable cues as to where this may be (Scaife & Bruner, 1975). Although looking at an object does not guarantee that we are attending to it (Mack & Rock, 1998), eye gaze provides a fairly reliable heuristic of another person's focus of attention. Given the eye's central role in joint attention, it may come as no surprise that we are particularly attuned to attend towards other people's eyes, and faces more generally.

There is much empirical research illustrating that our eyes are particularly drawn towards other people's faces. For example, some of our early pioneers in eye tracking research illustrated that when viewing scenes that contain people, observers spend a large proportion of their time looking at faces (Buswell, 1935; Yarbus, 1967); similar conclusions have been reached in more recent studies (Birmingham, Bischof, & Kingstone, 2008a, 2008b, 2009a; Itier, Villate, & Ryan, 2007). More specifically when looking at faces, we pay particularly close attention to other people's eyes (Argyle & Cook, 1976; Birmingham, Bischof, & Kingstone, 2009b; Itier et al., 2007; Janik, Wellens, Goldberg, & Dellosso, 1978; Levy, Foulsham, & Kingstone, 2013).

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Once we have identified the face we need to work out where the person is looking and follow his/her gaze towards the attended location. Our attentional system is extremely sensitive towards where another person is looking, and it is thought that this sensitivity towards eye gaze develops in the first few days of life (Farroni, Massaccesi, Pividori, & Johnson, 2004). Hood, Willen, and Driver (1998) demonstrated that 3-month-old babies make more saccadic eye movements towards peripheral targets when the gaze of the person depicted in the centre of the screen looked in the same direction than when he looked in the other direction, which suggests that eyes can automatically shift a baby's attention. Towards the end of their first year, babies start to spontaneously orient their attention towards objects that are looked at by adults (Butterworth & Jarrett, 1991; Scaife & Bruner, 1975).

Much of the attentional orienting in response to eye gaze is investigated using a modified Posner cueing task (Posner, 1980) in which participants are required to detect a target that appears either in a looked-at location or on the opposite side. Using this type of task, Ristic, Friesen, and Kingstone (2002) found stronger attentional cueing effects in children (3–5 years) than in adults. Similarly, Kuhn et al. (2011) used an overt gaze-following paradigm in which participants were instructed to make an eye movement that was either congruent or incongruent of a centrally presented distractor gaze. They found significantly larger levels of gaze following in children (8–11 years) than in adults, which suggested that children have more difficulties inhibiting an other person's gaze direction (see also Gregory, Hermens, Facey, & Hodgson, 2016). Together, these results suggest that children's attentional resources are more strongly influenced by social cues than are those of adults.

Whilst attentional orienting in response to directional eye gaze is thought to share characteristics with exogenous attentional mechanisms (Driver et al., 1999; Friesen, Ristic, & Kingstone, 2004; Kuhn & Kingstone, 2009; Ricciardelli, Bricolo, Aglioti, & Chelazzi, 2002), it is acknowledged that these social attention mechanisms are heavily influenced by top-down processes. A full understanding of joint attention requires us to understand these top-down processes. For example, we are more likely to follow the gaze of certain individuals such as people who are of high status (Dalmaso, Pavan, Castelli, & Galfano, 2012), or of our own political persuasion (Liuzza et al., 2013) or race (Dalmaso, Galfano, & Castelli, 2015). Whilst several papers have reported gaze following to be independent of emotional expression (Bayliss, Frischen, Fenske, & Tipper, 2007; Hietanen & Leppanen, 2003; Holmes, Richards, & Green, 2006), it has become apparent that when participants were required to detect an emotionally salient target, the emotional expression does influence gaze cueing, with stronger cueing for fearful than for happy faces (Bayliss, Schuch, & Tipper, 2010; Kuhn & Tipples, 2011; Pecchinenda, Pes, Ferlazzo, & Zoccolotti, 2008), which suggests that joint attentional processes may be more strategic than previously thought (Baron-Cohen, 1995).

In light of this strategic control over social attentional processes, it is likely that children and adults will prioritize a different set of cues. Experimental evidence suggests that children are more effective in processing information of their peers than adults. For example, Anastasi and Rhodes (2005) asked children and adults to study photographs of children and adults, and in a subsequent recognition test both adults and children recognized own-age faces more accurately than other-age faces. This own-age bias in face recognition is well established in the literature, and the predominant theoretical accounts of the own-age bias suggest that it reflects more extensive experience with members of the same age group than with other age groups (Hills & Lewis, 2011; Kuefner, Macchi, Picozzi, & Bricolo, 2008).

Own-age biases have also been investigated in terms of gaze following in adults, though little is known about whether it also applies to children. Using a covert attentional gaze-cueing task, Slessor, Laird, Phillips, Bull, and Filippou (2010) found stronger gaze-cueing effects for younger adults for younger faces than for older faces, though this difference was no longer apparent in the older adults (mean age 72 years). The authors suggested that this age difference in the own-age effect may be due to motivational differences, in that younger adults may chose to prioritize processing the gaze of those of their own age, as they may seem more relevant to them. Younger adults are more likely to see older people as being in their out-group, whilst older individuals are more likely to classify members from both age groups as belonging to their in-group (Chasteen, 2005). The own-age differences in face processing (i.e., face recognition) for both children and younger adults suggest that both adults and children are likely to perceive each other as out-groups, and we predict own-age biases in social attentional processes for both groups.

Vygotsky's (1978) theory on social learning also predicts an own-age bias in social attentional processes. His theory suggests that children have an actual developmental level and an immediate potential for development, and it is within this proximal zone of development in which optimal learning occurs. Vygotsky's theory predicts that children learn more from those of a similar age, though slightly older, as they are at a comparable developmental stage. In terms of joint attention, Vygotsky's theory predicts that children will be more interested in individuals that are of similar age and also more likely to follow the gaze of other children than that of adults.

Much of the previous work on social attention in adults has been conducted using attentional tasks in which participants are required to detect targets, or move their eyes in accordance with some instruction. Whilst these tasks provide very tight experimental control, they may lose some of the more natural and spontaneous ways in which we deploy attention in our environment (Cole, Skarratt, & Kuhn, 2016; Skarratt, Cole, & Kuhn, 2012). As discussed above, scene-viewing tasks provide a valuable measure of how we prioritize faces, but we can also use these tasks to study how our attention is influenced by where another person is looking. Several studies have shown that whilst we prioritize faces, we also prioritize objects that are looked at by others (Fletcher-Watson, Leekam, Benson, Frank, & Findlay, 2008; Kuhn, Tatler, & Cole, 2009; Leekam, Hunnisett, & Moore, 1998; Zwickel & Vo, 2010). For example, using a simple scene-viewing task in which participants were simply instructed to look at a picture, Fletcher-Watson et al. (2008) showed that people are faster to fixate on objects when they are looked at by the actor in the scene than when the actor looks elsewhere. Assessing the way in which the actor's gaze direction influences a participant's time to fixate on the object and the amount of time that is spent fixating this object provides us with a non-intrusive and natural measure of social attentional processing (i.e., gaze following).

All of the previous work on own-age biases in children has focused on face recognition, rather than gaze following. The aim of the current experiment was to investigate own-age biases in children and adults with respect to joint attentional processes. We presented participants with images that always contained one adult and one child standing side by side, and they either looked towards each other, or each looked at a different object in the scene. This new design allows us to simultaneously measure both whether adults and children prioritize their own-aged individuals and whether they are more likely to follow the gaze of their own-aged individual. We predicted that both adults and children should be faster to fixate their own-aged face, and spent more time doing so, than the other-aged face. Moreover, we also predicted an own-age effect in terms of the time it took participants to fixate the looked-at object, and the amount of time that was spent fixating on it.

Experimental study

Method

Participants

The study was conducted at a local primary school, and all of the children were pupils of the school, and adults were either staff or parents/carers. Socioeconomic status was therefore comparable across groups as they were from the same family groups and catchment area.

There were 70 participants, of which 33 were adults (25 female and 8 male) who ranged in age from 20 to 70 years ($M = 41.9$ years, $SD = 8.74$); and 35 children (22 female and 13 male) who ranged in age from 6 to 11 years ($M = 7.77$ years, $SD = 1.48$).

The study was given full ethical approval from the Brunel University School of Social Sciences Ethics Committee according to guidelines stipulated by the British Psychology Society, and formal consent was given by the parents/carers for themselves and their children/charges.

Materials

Stimuli. Photographs were taken of two people and two common objects that were placed on either side of the person (see Figure 1). Sixteen different image sets were taken, each of which contained different actors. Every photograph included an adult (4 male;

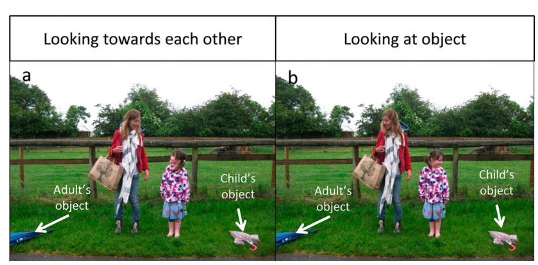

Figure 1. Sample of the photographs. (a) Actors gazing towards each other. (b) Actors gazing at object. To view this figure in colour, please visit the online version of this Journal.

mean age 34 years) and a child (7 males; mean age 8.2 years); in one version of the picture the two people looked at each other, whilst in the other version the people looked at the object that was located on their side. Each image set contained a different pair of objects (e.g., hats, cardigans, coats, bags, umbrellas, chairs, stuffed toys, toy cars, toy bikes, and paper crowns), which were always equidistant from each of the actors. The lateral position of the child and the adult was counterbalanced, and both the child and adult heads were equidistant from fixation, and equidistant from the camera, thus ensuring that they were similar in size.

We used a simple Latin square design, which produced two sets of pictures to ensure that each participant only saw one set of pictures. All participants saw eight images where the actors looked towards each other and eight images where the actors looked at an object. Participants were pseudo-randomly assigned to one of these blocks, and the images in the block were presented in randomized order.

Equipment. A desk-mounted Eyelink 1000 eye tracker (SR Research Ltd, Osgoode, Canada) was used to monitor eye movements at 1000 Hz. Participants rested their chin on a chin rest while looking at a computer monitor (21″ CRT monitor; screen resolution 1024 × 768 pixels; 85 Hz). The experiment was compiled and run using Experiment Builder (SR Research Ltd, Osgoode, Canada).

Procedure

After signing the consent form, participants were informed that they would be presented with 16 different photographs and were asked to simply look at them. No further task instructions were provided. Participants were positioned 57 cm from the screen, and their eye movements were calibrated using a standard 9-point calibration and validation procedure (maximum average error = 0.5̊). Each trial began with a central black fixation point on a white background, which participants were required to fixate before the experimenter initiated the trial. Each image was presented for 5 seconds, and participants were offered a break halfway through the experiment.

Data preparation. Eye movements were analysed using Data Viewer (SR-Research). For each image four different interest areas were defined. These included (a) the child's face, (b) the adult's face, (c) the object that was looked at by the adult, (d) the object that was looked at by the child. Whilst there were slight differences in interest areas sizes between the different image pairs, the interest area sizes within each pair were identical.

Two different eye movement measures evaluated (a) time to fixate the interest area, which measured the time between the onset of the image and the first fixation landing on the interest area; and (b) dwell time on interest area, which measured the proportion of time that was spent fixating a particular interest area. Data from two adults were lost due to eye tracking problems.

Results

Attending to faces

We analysed participants' viewing behaviour in terms of the time it took to fixate on the faces (Figure 2a). Data from one adult and one child were excluded, as they did not fixate the face interest areas. An analysis of variance (ANOVA) with age group (adults vs. children) as a between-subjects factor and gaze (each other vs. object) and actor (adult vs. child) as within-subjects factors found a significant main effect for age group, $F(1, 64) = 4.30$, $p < .042$, $\eta_p^2 = .063$, illustrating that adults ($M = 969$, $SE = 57.6$) fixate the faces more rapidly than the children ($M = 1135$, $SE = 55.9$).

Crucially there was a significant Group × Actor interaction, $F(1, 64) = 25.4$, $p < .0001$, $\eta^2 = .28$. The adults fixated the adult face significantly more rapidly than the child face, $t(32) = 2.89$, $p = .007$, whilst the children fixated the child face more rapidly than the adult face, $t(34) = 4.08$, $p < .0001$.

There was no significant main effect of gaze, $F(1, 64) = 0.85$, $p = .35$, $\eta^2 = .013$, actor, $F(1, 64) = 1.87$, $p = .18$, $\eta^2 = .028$, Gaze × Actor interaction, $F(1, 64) = 0.092$, $p = .76$, $\eta^2 = .001$, Gaze × Group interaction, $F(1, 64) = 0.323$, $p = .57$, $\eta^2 = .005$, or Group × Actor × Gaze interaction, $F(1, 64) = 0.184$, $p = .67$, $\eta^2 = .003$.

Next, we analysed the proportion of time that was spent fixating the faces (dwell time) (Figure 2b). Data from all of the participants were included for this analysis. An ANOVA with age group (adults vs. children) as a between-subjects factor and gaze (face vs. object) and actor (adult vs. child) as within-subject factors found a significant Group × Actor interaction, $F(1, 66) = 26.2$, $p < .0001$, $\eta^2 = .284$. The adults spent significantly more time fixating the adult face than the child face, $t(32) = 3.91$, $p < .0001$, whilst the children spent significantly more time fixating the child face than the adult face, $t(34) = 3.54$, $p = .001$.

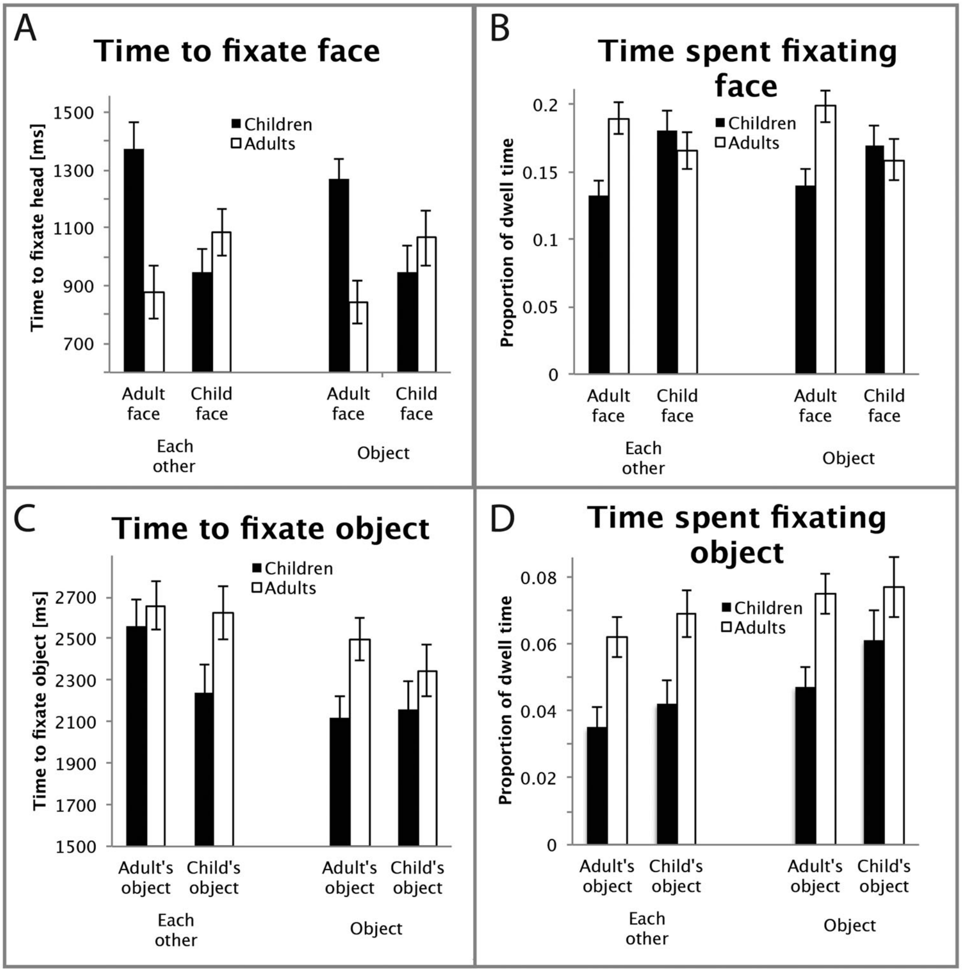

Figure 2. Mean times to fixate the interest area and mean dwell times for the adults and the children for conditions where the actors looked.

There were no significant main effects of gaze, $F(1, 66) = 0.017$, $p = .89$, $\eta^2 = .001$, actor, $F(1, 66) = 0.29$, $p = .59$, $\eta^2 = .004$, Gaze × Age interaction, $F(1, 66) = 0.057$, $p = .81$, $\eta^2 = .001$, or Age × Gaze × Actor interaction, $F(1, 66) = 0.04$, $p = .84$, $\eta^2 = .001$, but a significant Actor × Gaze interaction, $F(1, 66) = 4.22$, $p = .044$, $\eta^2 = .06$. However, as none of the simple effects were significant it is difficult to interpret this interaction in a meaningful way.

Gaze following

Our next analysis evaluated the degree to which the actor's gaze direction influenced whether participants fixated the looked-at object, in terms of both the time it took them to fixate the object (Figure 2c) and the amount of time they spent fixating it. Data from six children were disregarded as they did not fixate on one or both of the object interest areas. An ANOVA with age group (adults vs. children) as a between-subjects factor and gaze (each other vs. object) and actor (adult target vs. child target) as within-subjects factor on time to fixate the object found a significant main effect of gaze, $F(1, 60) = 7.68$, $p < .007$, $\eta^2 = .113$, illustrating that participants fixated objects more rapidly when they were looked at by the actors. There was also a significant main effect for group, $F(1, 60) = 5.77$, $p < .019$, $\eta^2 = .088$, suggesting that children were faster ($M = 2268$ ms, $SE = 80.1$) to fixate the targets than adults ($M = 2533$ ms, $SE = 75.1$).

There was no significant gaze by group interaction, $F(1, 60) = 0.064$, $p = .80$, $\eta^2 = .001$, actor, $F(1, 60) = 0.11$, $p = .074$, $\eta^2 = .002$, gaze by actor interaction, $F(1, 60) = 0.65$, $p = .42$, $\eta^2 = .011$, or gaze by actor by group interaction, $F(1, 60) = 2.60$, $p = .11$, $\eta^2 = .041$.

Participants were significantly faster to fixate the target object when they were looked at by one of the actors, but this was independent of age group and did not interact with the actor.

Next we analysed the percentage of time that was spent fixating the objects (Figure 2d). An ANOVA with age group (adults vs. children) as a between-subjects factor and gaze direction (face vs. object) and actor (adult vs. child) as within-subjects factors found a significant main effect of gaze direction, $F(1, 66) = 8.73$, $p = .004$, $\eta^2 = .117$, illustrating that participants spent more time fixating objects that were looked at by the actor than when the actors looked at each other. There was also a main effect of age group, $F(1, 66) = 9.31$, $p < .003$, $\eta^2 = .124$, illustrating that adults fixated the objects for longer ($M = 0.071\%$, $SE = 0.006$) than the children, ($M = 0.046\%$, $SE = 0.006$).

There was no significant gaze by age interaction, $F(1, 66) = 8.73$, $p = .004$, $\eta^2 = .12$, and no significant actor by group interaction, $F(1, 66) = 1.67$, $p = .21$.

Finally, there was a significant main effect of actor, $F(1, 66) = 9.73$, $p < .003$, $\eta^2 = .128$, demonstrating that participants generally spent more time fixating child actors' objects. All other main effects and interactions were non-significant (all ps > .20).

General discussion

Our objective was to investigate own-age biases in social attentional processes between adults and children. We focused on two aspects of the joint attention process, namely the extent to which people attend towards an individual's face, and the extent to which they fixate objects that are looked at by this person (i.e., gaze following). Participants viewed images that always contained a child and an adult who either looked towards each other or each looked at an object located on their side. Observers consistently fixated the actors' faces and did so very rapidly, though the adults did so more rapidly than the children. Most importantly though, the children were faster to fixate the child's face than the adult's faces, whilst the adults were faster to fixate on the adult's face than the child's face. The children also spent significantly more time fixating the child's face than the adult's face, and the opposite pattern of results was found for the adults. With regard to prioritizing faces, there is a clear own-age effect for both adults and children, in that own-aged faces are prioritized.

Next we evaluated the degree to which the actor's gaze direction influenced whether participants' eyes fixated on the looked-at object. Participants were significantly faster to fixate on the objects when they were looked at by the actor, and they also spent significantly more time doing so. These results clearly illustrate that people prioritize objects that are looked at by others (i.e., gaze following) and concur with previous studies (Fletcher-Watson et al., 2008; Kuhn et al., 2009; Leekam et al., 1998; Zwickel & Vo, 2010). However, rather surprisingly, we did not observe any own-age bias in the degree to which this gaze following occurred.

Our results illustrate an own-age bias in terms of prioritizing faces, but not in terms of gaze following. Most of the previous research on own-age biases has focused on face recognition, and a range of explanations have been offered for this bias. For example, it has been suggested that own-age biases stem from people of different ages having more experience in processing faces within their own age group (Bruyer, Mejias, & Doublet, 2007). This theory predicts that experience with other age groups should reduce the bias. Indeed, supporting this view, teachers and midwifes, who are both well acquainted with adults and children, show a smaller own-age bias in face processing than typical undergraduate students (Harrison & Hole, 2009). Our adult participants were all either parents or child carers, who had much experience in interacting with children, and it is thus unlikely that the own-age bias reported here can be explained by differences in experience.

Instead we propose that the own-age bias results from motivational differences. Whilst our children and adults spent much time interacting with each other, they clearly belonged to different groups, and it is thus likely that our participants prioritized the person who seemed more relevant to them. Vygotsky (1978) suggested that learning is facilitated and accelerated if it takes place within one's zone of proximal development, and it therefore stands to reason that people will learn more from those who are of similar age, as they are at a comparable developmental stage. Our own-age bias in face prioritization coincides with Vygotsky's social learning hypothesis. However, we used a fairly crude way of dividing different developmental stages (children vs. adults), and it would be interesting in future to study these developmental changes in more detail within the child population.

Contrary to previous studies (Gregory et al., 2016; Kuhn et al., 2011; Ristic et al., 2002), both children and adults showed equivalent levels of gaze following, and there was no own-age bias for gaze following (cf. Bailey et al., 2014; Ciardo, Marino, Actis-Grosso, Rossetti, & Ricciardelli, 2014; Slessor et al., 2010),[1] though it is important to note that our task differed significantly from these previous studies. In these previous studies, participants were explicitly instructed to detect targets, or move their eyes in a particular direction, whilst our participants simply viewed natural images without being given any further instructions. Moreover, the social cues (i.e., the faces) were presented in isolation, whilst we embedded our social stimuli within a richer context. Whilst our task is still far removed from modelling real social interactions, we feel that it provides an important step towards measuring social attentional processes in more naturalistic settings (see Cole et al., 2016). To the best of our knowledge, none of the previous studies investigating own-age biases in gaze following involved children. A further difference in our study was that the child and adult actors were presented simultaneously. Presenting multiple people within the same scene is likely to increase the extent to which participants process the people's faces and their gaze direction, since these cues provide important contextual information (see Birmingham, Bischof, & Kingstone, 2008b; Yarbus, 1967). Our main motivation for having two people in each scene was that it allowed us to directly assess which of the individuals was being prioritized. In other words, which of the faces did participants fixate first, and whose gaze did they follow first? A closer analysis of our eye movement data revealed that in most cases participants fixated both faces before fixating one of the looked-at target objects, regardless of whether the actors looked towards each other or at the target. It is possible that processing both faces eliminated the own-age effect in gaze following. However, there is also a theoretical account that can explain this null effect. Slessor et al. (2010) argued that the own-age bias in gaze cueing was due to motivational difference in that younger adults are more motivated to follow the gaze of a same-aged person than an older person. Whilst we did expect to find an own-age bias in terms of gaze following, it is reasonable to suggest that the motivational levels for following the gaze of a child and an adult are comparable. Gaze following forms an important part of the child's development, such as language acquisition (Butterworth & Jarrett, 1991), and from an early age children learn to follow the gaze of their adult carer (Leekam, Baron-Cohen, Perrett, Milderst, & Brown, 1997). Whilst children may be more interested in other children, it is likely that they will be just as motivated to follow the gaze of adults as their peers. Similarly, as an adult carer, there is a constant drive to monitor a child's desires and intentions, and thus again there will be a high motivation for following the child's gaze.

Our "social" scene-viewing task allowed us isolate two aspects of the joint attention process, namely the extent to which people attend to an individual's face, and the extent to which they fixate objects that are looked at by this person (i.e., gaze following). Our results demonstrate a clear own-age bias in terms of attending to faces, whereby children and adults prioritize members of their own age group. However, whilst both adults and children prioritized objects that were looked at by others, both groups showed equivalent levels of gaze following, and there was no own-age bias for gaze following. We conclude that whilst children and adults are more interested in their peers, both groups are equally motivated to follow each other's gaze.

Note

1. The lack of own-age bias in gaze following could potentially reflect the fact that both the sample of adult participants and the stimuli included younger and older adults. However, we do not believe this to be the case since the majority of our actors were between 25–40 years old, and there were only two adult actors aged over 50. Similarly, most of our participants (85%) were under 50, and thus we feel that the samples were relatively homogeneous. Moreover, further analysis in which actors and participants were classified as older adults if they were over 50 and younger adults if aged under 50 did not reveal an own-age effect within the adult group.

Disclosure statement

No potential conflict of interest was reported by the authors.

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