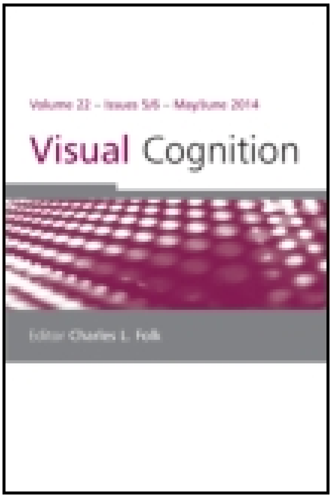

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I just love the attention: implicit preference for direct eye contact

Rebecca Lawson[a]

[a] Department of Experimental Psychology, University of Liverpool, Liverpool, UK

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I just love the attention: implicit preference for direct eye contact

Rebecca Lawson

Department of Experimental Psychology, University of Liverpool, Liverpool, UK

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Seven studies used the Implicit Association Test to measure preference for gaze direction. For faces with neutral expressions, people clearly preferred eyes looking towards them compared to eyes gazing to the right or left (Experiment 1). This preference remained for faces shown turned to the side (Experiment 2) and upside-down (Experiment 3). Even angry faces were preferred with direct compared to averted gaze (Experiments 4 and 5). Furthermore, preference for eye contact did not correlate to performance on the Reading the Mind in the Eyes Test (RMET) or the Autism Quotient (AQ); note performance on the RMET and the AQ was only weakly correlated although both are claimed to measure social cognition. When the faces were replaced by coloured shapes (Experiment 6) or arrows (Experiment 7) people showed a weaker preference for the category label "looking at you" versus "looking to the side". Overall, people revealed a robust preference for direct rather than averted gaze which generalized across face pose and expression. Together with a weaker preference for arrows pointing towards them, this is consistent with people having an implicit preference for self-directed attention.

Keywords*:* Face; Attention; IAT; Self-directed preference; Averted gaze; Direct gaze.

Other people's eyes provide us with important perceptual information about the world. When we look at a face we spend most of our time looking at the eye region (Itier & Batty, 2009), although this effect may be modulated by top-down effects such as culture (Blais, Jack, Scheepers, Fiset, & Caldara, 2008). We

Please address all correspondence to Rebecca Lawson, Department of Experimental Psychology, University of Liverpool, Eleanor Rathbone Building, Bedford Street South, Liverpool, L69 7ZA, UK. E-mail: rlawson@liverpool.ac.uk

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presumably preferentially attend to the eyes because they are particularly informative. For example, they indicate a person's age, gender and identity (Conty & Grezes, 2012; McKelvie, 1976; Schyns, Bonnar, & Gosselin, 2002; see Itier & Batty, 2009, for a review). The eye region of the face also provides socially important information such as a person's intentions, emotions and complex mental states like disgust or scheming (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Baron-Cohen, Wheelwright, & Jolliffe, 1997; Smith, Cottrell, Gosselin, & Schyns, 2005) and shows what someone can see and what they are attending to (Friesen & Kingstone, 1998; Frischen, Bayliss, & Tipper, 2007; Kuhn & Kingstone, 2009).

More specifically, the direction of eye gaze is attended to and influences behaviour from early in development. Infants can follow eye gaze to decide where someone is looking (Brooks & Meltzoff, 2008; Doherty, Anderson, & Howieson, 2009) but it takes many years for children to reach adult levels of competence at interpreting information from the eyes and, in particular, judging eye direction and whether a face is looking at them (Doherty et al., 2009). Infants prefer direct gaze (Farroni, Csibra, Simion, & Johnson, 2002; Farroni, Massaccesi, Menon, & Johnson, 2007). They initially attend to direct gaze based on perceptual properties but by about one year old social and conceptual information from eye gaze modulates their attention (Brooks & Meltzoff, 2002; Jakobsen, Frick, & Simpson, 2013).

Direct gaze signals that someone is looking at you and this perceived eye contact can improve many aspects of cognitive processing (Senju & Johnson, 2009a). For example, compared to averted gaze faces, direct gaze faces are better encoded (Mason, Hood, & Macrae, 2004), easier to recognize (Vuilleumier, George, Lister, Armony, & Driver, 2005) and are processed more configurally (Young, Slepian, Wilson, & Hugenberg, 2014). Gaze direction also has a powerful attentional effect. For example, direct gaze holds attention, making peripheral targets hard to detect (Senju & Hasegawa, 2005) and faces with direct gaze are viewed for longer (Palanica & Itier, 2012). Non-predictive gaze cues (such as a centrally presented, frontal view of a face with averted eyes) can trigger reflexive saccades in the cued direction (Friesen & Kingstone, 1998; Kuhn & Benson, 2007; Kuhn & Kingstone, 2009; Mansfield, Farroni, & Johnson, 2003). Gaze following also occurs in naturalistic settings (Kuhn, Tatler, & Cole, 2009, using videos of magician's tricks; Langton, O'Donnell, Riby, & Ballantyne, 2006, for photographs of scenes) and is sensitive to complex, high-level influences such as the political affiliation of the depicted face, with gaze following predicting voting intentions (Liuzza et al., 2013). Finally, for faces that gaze directly at the participant then look away, validly predictive faces that consistently look towards target objects are perceived as more trustworthy than invalidly predictive faces that consistently look away from target objects (Bayliss & Tipper, 2006).

There are thus a wealth of findings indicating the importance of the eyes and, specifically, the direction of eye gaze (direct versus averted) to both perceptual and social cognitive processes. These results suggest that people pay considerable attention to the direction of gaze. In particular, eye gaze provides a potent, sensitive and continually updated signal about where another person is allocating their attention. Are they attracted to you? Bored by you? Were they hanging on your every word right up until the moment when your friend walked into the room when their attention was immediately diverted? Where eyes are looking provides a powerful cue to guide such spontaneous and socially important inferences.

The present studies investigated the evaluative aspect of this processing of eye gaze, namely whether we prefer faces that look towards rather than away from us because direct gaze faces signal that someone is attending to us and we enjoy this attention. This was investigated using the Implicit Association Test (IAT) to determine whether people show an implicit preference for direct gaze relative to averted gaze. This task was used since it seems well suited to assessing our immediate, unreflective, spur of the moment preferences for stimuli. In our daily interactions with people we are often not consciously aware of monitoring where they are looking and we make rapid, gut decisions about whether somebody likes us and how their interest in us is fluctuating over time. In contrast, explicit measures of preference such as ratings probably elicit slower, more considered, "cooler" decisions. They are likely to involve more complex, high-level reasoning than is used in the IAT and they may be more susceptible to contamination by task demands and other top-down influences. Implicit and explicit measures of preference are often correlated but this is not always the case (Lane, Banaji, Nosek, & Greenwald, 2007; Makin, Pecchinenda, & Bertamini, 2012).

There is some indirect evidence to support the hypothesis that people prefer faces with direct relative to averted gaze but it is not consistent or conclusive. For example, eye gaze can alter social evaluations. People who shift their gaze to look at you or faces with direct gaze are perceived as more likeable and more attractive than faces with averted gaze, though in some studies this has only been found for faces of the opposite sex (Conway, Jones, De Bruine, & Little, 2008; Ewing, Rhodes, & Pellicano, 2010; Main, De Bruine, Little, & Jones, 2010; Mason, Tatkow, & Macrae, 2005; Palanica & Itier, 2012). The positive effects of direct gaze appear to be modulated by both the attractiveness and the emotion of the face though again the evidence here is not consistent (Bindemann, Burton, & Langton, 2008; Ganel, 2011). For example, an imaging study by Kampe, Frith, Dolan, and Frith (2001) reported that facial attractiveness increases activation in reward circuits for faces gazing towards you and reduces activity for faces gazing away. Other studies suggest that activity in the amygdala is driven by gaze direction even when neutral expression faces are presented (Burra et al., 2013). However, importantly, direct gaze can be associated with negative rather than positive social cues. For example, direct staring can signal anger or threat (Emery, 2000) and direct gaze is more arousing: Pönkänen and Hietanen (2012) reported increased skin conductance reflecting a heightened autonomic response to direct compared to averted gaze for neutral and, especially for smiling faces. Finally, people with socially anxiety may experience direct gaze as negative (Wieser, Pauli, Alpers, & Mühlberger, 2009).

The present set of studies used the IAT to directly investigate whether people implicitly prefer faces with direct gaze and, if so, what causes that preference. The IAT is a popular measure of implicit attitudes and preferences (Lane et al., 2007; Nosek, Greenwald, & Banaji, 2005). In IAT studies participants categorize a series of stimuli using one key (e.g., “5”) to respond to two categories of stimuli and another key (e.g., “8”) to respond to two other categories. One pair of categories, the attribute stimuli, has known associations. In the present studies these were positive (e.g., love) and negative (e.g., hate) words. The IAT is used to measure spontaneous preference for the other pair of categories which are termed the target stimuli. Here, the target stimuli were mostly faces which either looked towards or away from the participant. Direct gaze faces were predicted to be preferred relative to averted gaze faces. IAT responses were therefore expected to be faster when categories with the same valence were assigned to the same response key (congruent mapping: positive words and direct gaze faces for one key, negative words and averted gaze faces for the other key) than when they were assigned to different keys (incongruent mapping: positive words and averted gaze faces to one key, negative words and direct gaze faces to the other key). The IAT is necessarily relative since it reflects associations for both of the target categories so it is not possible to determine people’s absolute preference for an individual category (Lane et al., 2007). Thus here the IAT indicated whether direct gaze was preferred more than averted gaze but it could not be used to assess whether direct gaze was perceived as positive or negative.

The choice of category labels can play a critical role in IAT effects. For example, Mitchell, Nosek, and Banaji (2003; see also De Houwer, 2001) presented the same set of people as stimuli but varied the categorization tasks to be based on either race or occupation. They found that participants preferred a set of black athletes to white politicians when they categorized on the basis of occupation, but they preferred the same white politicians relative to the black athletes when categorization was based on race. However, Mitchell et al. (2003) also demonstrated that preference was not driven solely by the category labels since IAT effects were modulated by whether the particular people used to represent the categories of blacks and whites were liked or disliked by participants (see also Bluemke & Friese, 2006; Govan & Williams, 2004). Similarly, Han, Czellar, Olson, and Fazio (2010) showed that the construal of IAT items by a participant influences how they are evaluated and that these construals can readily be altered by preceding experimental manipulations. Thus in an IAT both the category labels and the specific stimuli presented determine how a category is construed and this, in turn, determines how it is evaluated.

EXPERIMENT 1

An IAT task was used to investigate whether there is an implicit, positive preference for faces looking towards you rather than away from you. Participants categorized positive and negative words and they also categorized frontal photographs of faces with neutral expressions that either looked towards or away from the participant, see Figure 1. The keypress response to faces gazing towards the participant was associated with positive words (in the congruent block) and with negative words (in the incongruent block). The order of these two blocks was counter-balanced. If people prefer faces that look towards them they should perform better on the congruent than the incongruent block.

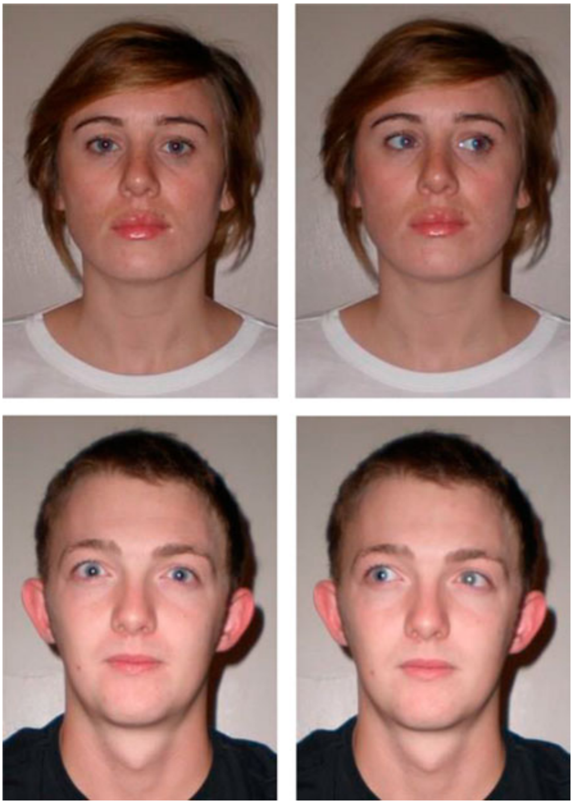

Figure 1. Examples of the neutral expression face stimuli presented in Experiment 1. Top, a female face looking towards and away (to the right) from the viewer. Bottom, a male face looking towards and away (to the left) from the viewer.

Method

Participants

Thirty-two people participated. In the studies reported here no participant took part in more than one study and most participants came from the same population, namely young, undergraduate psychology students at the University of Liverpool, UK. This population is around 60% female, is about 90% white and has a median age of 19. Participants volunteered to take part, with most receiving course credit for doing so. In studies testing multiple groups successive participants were assigned to different groups.

Materials

In the studies reported here stimuli were created by the author unless otherwise specified and all of the photographs showed young, white adults, none of whom were known to the participants. In Experiment 1 six lower-case words with clear, positive attributes (joy, love, peace, wonderful, pleasure and excellent) and six lower-case words with clear, negative attributes (evil, angry, terrible, rotten, nasty and horrible) were used. In addition, two photographs of each of six people were presented, see Figure 1. One photograph showed the person looking directly ahead and the other showed the person looking to the right side (one female and two males) or the left side (one female and two males). Care was taken to minimize other differences such as head turns between each pair of photographs (Doherty & Anderson, 2001). These differences could have been eliminated if eye gaze had been manipulated using image processing software, but such techniques can introduce other artefacts. Also, importantly, IAT research suggests that it is the construal of category labels which determines preference rather than subtle differences between stimuli (De Houwer, 2001; Mitchell et al., 2003).

Design

Participants did an easy, speeded categorization task. The design and number of trials used were based on the recommendations of Nosek et al. (2005) and Lane et al. (2007). First, participants did a block of 24 trials during which they learnt to respond using one of two keys (5 or 8) to the faces gazing towards them and the other key to faces gazing away from them. Next they did a block of 24 trials in which they learnt to respond with one of the same two keys (5 or 8) to positive words and the other key to negative words. The third block of 72 trials presented both words and faces and people had to respond with the key mappings that they had been taught in the initial two training blocks. The fourth block of 48 trials re-trained participants to respond to gaze-towards and gaze-away faces using the reverse mapping of keys (8 or 5) as they had learnt in the first block. Finally, the fifth block of 72 trials presented both words and faces and people responded to the words as they had been taught initially but to the faces using the re-mapped keys that they had been re-trained with in the fourth block.

Of the two combined blocks (blocks 3 and 5), one had a congruent mapping (the same key was used to respond to both positive words and direct gaze faces whilst the other key was used for negative words and averted gaze faces) and the other had an incongruent mapping (positive words and averted gaze faces with one key; negative words and direct gaze faces with the other key). The order of presentation of the congruent and incongruent blocks was counterbalanced across participants, as was the assignment of response key (5 or 8) to categories. This resulted in half the participants doing the congruent block first and, of this group, half always responding to the positive words using the 5 key and the other half always using the 8 key. Instruction screens preceded every block.

Trials within each block were presented in a random order. The 72 trials in each of the two combined blocks comprised two subblocks. The first comprised the initial 24 trials and the second comprised the final 48 trials. The two subblocks followed immediately from each other so the participant was not aware of them; they differed only with respect to the amount of practise that the participant had when doing them. Within each block and subblock there were equal numbers of each type of trial. For example, for the final subblock of 48 trials in each combined block there were 24 face trials (12 looking towards and 12 away from the participant) and 24 word trials (12 positive and 12 negative words) and within each of these sets of 12 trials there were two presentations of each of the six individual word and face stimuli.

Procedure

The stimulus that was to be categorized was presented in the centre of the computer monitor. Category labels appeared above and below it to remind participants of the key-mapping. For example, in the face-only block the label "looking at you" might appear at the top of the screen whilst "looking to the side" was shown at the bottom of the screen and in a subsequent combined, congruent block the words "good words + looking at you" could appear at the top of the screen with "bad words + looking to the side" appearing at the bottom of the screen. Participants received feedback comprising the word "correct" or "wrong" appearing in the centre of the monitor and on incorrect trials they also heard a low double-beep sound.

In standard IAT tasks the two response keys used are typically on the right and left of the keyboard. However, in this study participants had to decide whether faces gazed to the side or not. In order to avoid eliciting a Simon effect (Lu & Proctor, 1995) the response keys used the number pad and were vertically aligned (the 5 key is directly below the 8 key) and the keyboard was placed such that these two keys were in line with both the participant's body midline and the midline of the computer monitor. Stimuli were presented until the participant responded. Participants were instructed to respond as quickly as possible whilst minimizing errors, using the index and middle finger of their dominant hand.

Results

Implicit association was tested by comparing performance across the two combined blocks to see if people performed better with the congruent mapping compared to the incongruent mapping. In this and all of the subsequent experiments the data from the combined blocks was analysed using the method recommended by Greenwald, Nosek, and Banaji (2003) and Lane et al. (2007). This was as follows: first, trials slower than 10 s were removed (only 0–5 trials per experiment) as well as any participants with over 10% of RT less than 300 ms (no participants were replaced in Experiment 1). Next, an error penalty was applied to all incorrect trials such that the RT was replaced by the mean RT for all correct trials in that subblock plus twice the standard deviation of the correct responses.[1] The mean RT was then calculated. This was first done separately for each of the two subblocks within each of the two combined (congruent and incongruent) blocks (so, here, for the first 24 trials and the last 48 trials of each combined block). In addition the standard deviation was calculated across both of the first-third subblocks and across both of the final two-thirds subblocks of the congruent and incongruent blocks (so for all 48 trials in the two first-third subblocks and then, separately, for all 96 trials in the two final subblocks). For the first-third subblocks and then, separately, for the final two-thirds subblocks, the (incongruent-congruent) mean RT difference was divided by the standard deviation for that pair of subblocks. Finally, the average of this number for the first-third and for the final two-thirds subblocks was taken as the D-score for that participant. The D-score is closely related to the effect size measure d (Cohen, 1977; see footnote 1 in Nosek et al., 2005).

The overall mean D-score in Experiment 1 (+0.56) had a medium effect size and was significantly greater than zero, $t(31) = 11.551$, $p < .001$, see Figure 2, indicating that people preferred direct gaze faces relative to averted gaze faces. All 32 participants had a positive D-score. Overall performance was much better in the congruent (796 ms, 2.9%) than the incongruent (1060 ms, 6.6%) blocks.

Discussion

In Experiment 1 participants revealed a clear implicit preference for photographs of faces gazing towards them compared to faces gazing away from them. The remaining studies reported in this paper sought to understand the cause of this preference. Specifically, predictions from four accounts were tested. These accounts are introduced here and are then discussed further in relation to specific

[1] As a check all of the analyses reported in this paper were repeated using an alternative error penalty suggested by Greenwald et al. (2003), namely adding 600 ms to the mean for correct subblock trials. These analyses produced very similar results to those reported here and they did not alter the pattern of significant differences.

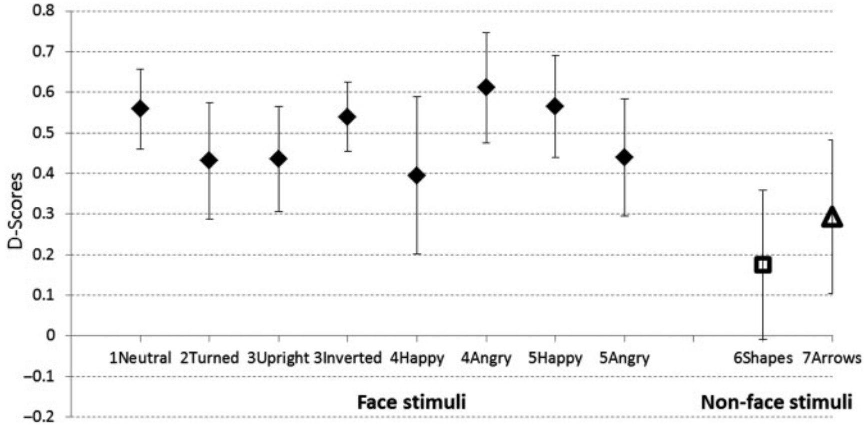

Figure 2. Mean D-scores across the different groups tested in Experiments 1–7. The x-axis shows D-scores on the IAT for: neutral expression faces in Experiment 1 (1 Neutral); neutral, turned faces in Experiment 2 (2 Turned); neutral, upright and neutral, upside-down faces in Experiment 3 (3 Upright, 3 Inverted); happy and angry faces in Experiment 4 (4 Happy, 4 Angry); happy and angry faces in Experiment 5 (5 Happy, 5 Angry); coloured shapes in Experiment 6 (6 Shapes); and arrows in Experiment 7 (7 Arrows). Note that the D-score for frontal faces in Experiment 2 (+0.37) is not shown as this condition was run within-participants with the turned faces. Error bars show 95% confidence intervals appropriate for the between-subjects variation across the group data here.

experiments. They comprised a face-specific, gaze hypothesis and three domain-general hypotheses: The *symmetry preference account* was tested in Experiment 2. This argues that direct gaze may be preferred because frontal views of faces are more symmetrical when they have direct compared to averted gaze. It is well established that people generally prefer more symmetrical stimuli and, in particular, they usually prefer more symmetrical faces (Little & Jones, 2003). This account predicts that any preference for direct gaze should be eliminated for turned views of faces since here direct gaze does not produce more symmetrical stimuli than averted gaze.

The *gaze hypothesis* was tested in Experiments 3, 4 and 5. This proposes that direct gaze is preferred because it provides a positive social cue that another person likes you and is interested in you. Conversely, averted gaze may be interpreted as a negative evaluation of you; for example, it can signal ostracism (Wirth, Sacco, Hugenberg, & Williams, 2010). This hypothesis predicts that preference for direct gaze should be modulated by the emotional expression of a face. There should be a stronger preference for direct gaze for happy faces relative to neutral expression faces and a reversal of gaze preference for angry faces, i.e., averted gaze faces should be preferred. This hypothesis is face-specific so it also predicts that the preference for faces with direct gaze should be weaker for less face-like stimuli and should not generalize to a preference for socially irrelevant stimuli, such as arrows, to point towards rather than away from you.

The *perceptual fluency account* was tested in a combined analysis of Experiments 1–5. It proposes that direct gaze stimuli are easier to process and this is why they are preferred (see Oppenheimer, 2008, for a short review of processing fluency and perceptual fluency). For example, Constable, Bayliss, Tipper, and Kritikos (2013) recently reported that, after interacting with stimuli, people's preferences may alter to prefer stimuli that they processed more fluently whilst Makin et al. (2012) argued that the relative ease of processing symmetrical stimuli was the underlying reason that they were preferred in a series of IATs. In Experiment 1 averted gaze faces may have been harder to process because they were more variable than direct gaze faces as they could gaze in different directions (both left and right).

Finally, the novel *preference for self-directed attention hypothesis* was tested in Experiments 6 and 7. This suggests that, first, gaze provides a salient cue about where attention is being directed and, second, that people prefer attention to be directed towards themselves regardless of its valence. This hypothesis predicts that we like direct gaze faces because they provide a reliable indication that somebody is attending to us. This hypothesis may seem similar to the self-referential positivity bias (Lobmaier & Perrett, 2011; Lobmaier, Hartmann, Volz, & Mast, 2013) which suggests that we are biased to perceive stimuli directed towards us as more positive. For example, Lobmaier and Perrett (2011) reported that smiling faces were more likely to be interpreted as directing attention towards the observer and the reverse for fearful, angry and neutral faces. However, in contrast to the self-referential positivity bias, the hypothesis that people prefer self-directed attention does not distinguish between whether positive or negative attention is being directed towards the viewer. This account therefore predicts that direct gaze will be preferred for angry faces as well as for happy faces. Also, the hypothesis that we prefer self-directed attention predicts that any stimulus that focuses attention on us should be preferred, irrespective of whether that stimulus is socially relevant (such as faces) or irrelevant (such as arrows).

EXPERIMENT 2

Experiment 2 tested whether the preference for direct gaze established in Experiment 1 was based on a more general preference for symmetry. People generally like symmetrical stimuli, particularly faces (Little & Jones, 2003). They find bilaterally symmetrical faces more attractive than asymmetrical faces (Rhodes, 2006) and more symmetrical faces are explicitly preferred (Vingilis-Jaremko & Maurer, 2013). Faces with direct eye gaze may therefore be preferred because they are more symmetrical than faces with averted gaze. In order to test this account, in Experiment 2 in separate blocks participants were shown faces which were either frontal views (as in Experiment 1) or three-quarters views

Figure 3. Examples of the stimuli presented in Experiment 2. Top, a frontal view of a neutral expression female face looking towards and away from the viewer. Bottom, the same female face with her head turned, looking towards and away from the viewer.

where the face was turned sideways, see Figure 3. If the preference for direct gaze is based on symmetry then it should be obtained for frontal views, replicating Experiment 1, but it should be eliminated by presenting turned views of faces.

Method

There were 24 participants. The method was identical to Experiment 1 except that all participants did two IAT tasks, one with frontal views of faces and the other with turned views of faces, and a new set of photographs were produced. The order of presentation of the two IAT tasks was counterbalanced across participants. The new photographs showed each face with both direct and averted gaze for a frontal view of the head, as in Experiment 1, and for a view of the head turned to the right side (for one male and two females) or to the left side (for one male and two females), see Figure 3.

Results

No participant was replaced. Replicating Experiment 1 the D-score was significantly greater than zero for frontal views of faces, $t(23) = 4.391$, $p < .001$, see Figure 2, so people preferred direct relative to averted gaze. Performance was much better for the average of the congruent subblocks (797 ms, 2.5%) compared to the average of the incongruent subblocks (935 ms, 5.6%) and 20/24 participants had a positive D-score.

The D-score was also significantly greater than zero for turned heads, $t(23) = 6.260$, $p < .001$, so here, too, people preferred faces with direct compared to averted gaze. Performance was again much better for the average of the congruent subblocks (835 ms, 3.4%) compared to the average of the incongruent subblocks (996 ms, 6.8%) with 21/24 participants having a positive D-score.

An ANOVA with the within-participants factor of head position was not significant, $F(1,23) = 0.405$, $p = .5$, partial $\eta^2 = 0.02$. D-scores were similar for frontal views (+0.37) and turned views (+0.43) of faces, with medium effect sizes in both cases. This ANOVA was repeated including the between-subjects factor of IAT order (frontal views first or turned views first) and there were, again, no significant effects.

Discussion

Replicating Experiment 1, Experiment 2 again revealed a clear preference for direct gaze relative to averted gaze for frontal views of faces, see Figure 2. Importantly, this result was extended to a preference for direct gaze when the head was turned to the side. Here, the direct gaze faces were less symmetrical than the averted gaze faces. This latter result shows that the preference for direct gaze was not being driven by a general preference for more symmetrical stimuli, so the symmetry preference hypothesis was not supported.

EXPERIMENT 3

Experiment 3 went on to test the gaze hypothesis. This proposes that direct gaze is preferred relative to averted gaze because it provides a positive social cue that another person likes you and is interested in you. This account states that people have a face-specific preference for direct gaze so manipulations which make it harder to detect a face and to interpret its social relevance should reduce this preference. Experiment 3 used one such manipulation which has been commonly employed in face research, namely presenting faces upside-down (Rossion &

Gauthier, 2002). The impact of this on face-specific processing is still under debate but it is clear that people show much reduced effects of face expertise when presented with upside-down compared to upright faces. They also appear to find it more difficult to detect faces per se (Brandman & Yovel, 2012; Taubert, Apthorp, Aagten-Murphy, & Alais, 2011). It seems to be harder to process upside-down faces holistically so people may rely more on local processing of individual features compared to when they view upright faces. The processing of upside-down faces may therefore be more similar to that of non-socially relevant objects rather than involving face-specific processes (Van Belle, De Graef, Verfaillie, Rossion, & Lefevre, 2010; Xu & Tanaka, 2013). Thus according to the gaze hypothesis the preference for direct gaze should be weaker or even absent when faces are presented upside-down.

Method

There were 48 participants. The method replicated that of Experiment 1 except that one group of 24 participants saw only upright faces and the other group saw only upside-down faces and a new set of photographs were produced. These photographs depicted three males and three females, each of which was shown with direct and averted gaze and they were either presented upright or upside-down, see Figure 4.

Results

No participant was replaced. Replicating Experiments 1 and 2, the D-score was significantly greater than zero for the upright face group, $t(23) = 6.964$, $p < .001$, indicating that people preferred direct relative to averted gaze faces. People performed much better in the congruent subblocks (787 ms, 4.0%) than the incongruent subblocks (938 ms, 7.6%) and 22/24 participants had a positive D-score.

The D-score was also significantly greater than zero for the upside-down group, $t(23) = 13.082$, $p < .001$, so upside-down faces were also clearly preferred if they had direct rather than averted gaze. Performance was again much better for the average of the congruent subblocks (780 ms, 4.1%) compared to the average of the incongruent subblocks (992 ms, 8.0%) and all 24 participants had a positive D-score.

Comparing the two groups, there was no effect of face orientation, $t(46) = -1.373$, $p = .18$. Any trend was in the opposite direction to that predicted by the gaze hypothesis, with D-scores for those who saw upside-down faces (+0.54) a little greater than those who saw upright faces (+0.44), with a medium effect size for both groups, see Figure 2.

Figure 4. Examples of the stimuli presented in Experiment 3. Top, a neutral expression, upright male face looking towards and away from the viewer. Bottom, the same male face shown upside-down, looking towards and away from the viewer.

Discussion

Experiment 3 replicated Experiments 1 and 2: the upright faces group showed a reliable preference for faces depicted looking towards them rather than away from them. Importantly, this preference extended to a separate group of participants who were shown upside-down faces. The preference for direct gaze was thus not eliminated—or even weakened—by presenting faces upside-down. This result provides evidence against the gaze hypothesis which predicted that upside-down faces would receive less face-specific processing and therefore would show less preference for direct relative to averted gaze.

EXPERIMENT 4

The results so far have shown that varying head position away from a typical, frontal view (whether by a rotation in depth, as in Experiment 2, or a plane rotation, as in Experiment 3) did not affect people's strong implicit preference for direct gaze relative to averted eye gaze. Experiments 4 and 5 went on to examine whether social rather than physical manipulations would influence people's preference for direct eye gaze, as predicted by the face-specific gaze hypothesis. This was achieved by varying the emotional expression of the faces shown.

The mood and emotions expressed by a face can be used to predict the mental states, intentions and probable behaviour of other people. In Experiment 4 participants were either shown happy or angry faces, see Figure 5. Results for the happy faces were expected to reveal a strong preference for direct gaze, consistent with the results for neutral expression faces in Experiments 1, 2 and 3. In contrast, based on the gaze account, preference for the angry faces was predicted to show the opposite pattern: people were predicted to prefer averted relative to direct gaze. This was because an angry person looking directly at you signals that that person may be angry with you. This threatening situation should be interpreted much more negatively than seeing an angry person with averted gaze, since this latter situation suggests that the person's anger is directed at something or somebody other than you (Ewbank, Jennings, & Calder, 2009; Lobmaier & Perrett, 2011). Consistent with this, Sato, Yoshikawa, Kochiyama, and Matsumura (2004) reported a stronger amygdala response for angry faces with direct compared to averted gaze. Also, gaze cueing effects on object preference and

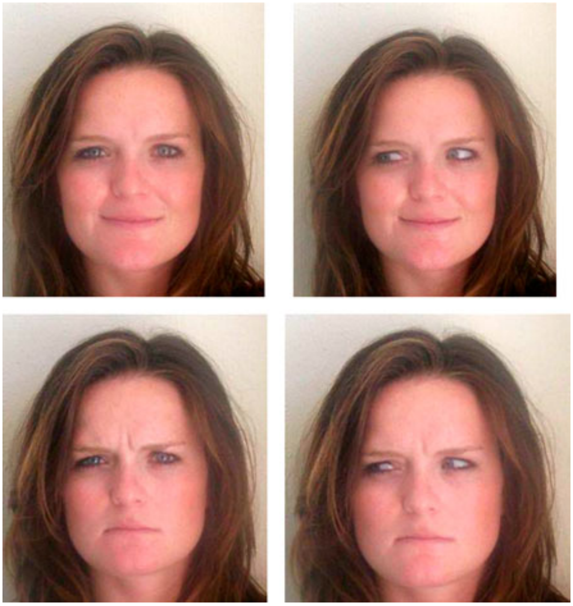

Figure 5. Examples of the stimuli presented in Experiment 4. The same female face with, top, a happy-expression and, bottom, an angry expression, looking towards and away from the viewer.

pleasantness ratings for words have been found to be modulated by the emotional expression shown by the face (Bayliss, Frischen, Fenske, & Tipper, 2007; Bayliss, Schuch, & Tipper, 2010; Pecchinenda, Pes, Ferlazzo, & Zoccolotti, 2008).

Method

There were 48 participants. The method was identical to Experiment 1 except for three points. First, one group of 24 participants saw only happy faces and the other group saw only angry faces. Second, each of the combined blocks comprised two subblocks of 48 trials so these trials were analysed with respect to the first and second half of the block rather than the first third of trials and the last two-thirds of trials. Third, a new set of photographs were produced which depicted two male and four female faces. Each face was shown with direct and averted gaze for each of two expressions, happy and angry, see Figure 5.

Results

No participant was replaced. The D-score was significantly greater than zero for happy faces, $t(23) = 4.214$, $p < .001$, see Figure 2, so people preferred happy faces which had direct relative to averted gaze, consistent with the preference for direct gaze for neutral faces observed in Experiments 1, 2 and 3. Performance here was much better for the average of the congruent subblocks (801 ms, 4.0%) compared to the average of the incongruent subblocks (942 ms, 5.6%) and 18/24 participants had a positive D-score.

Importantly, the D-score was also significantly above zero for angry faces, $t(23) = 9.302$, $p < .001$, so people preferred direct to averted gaze even for angry faces. Performance was again much better for the average of the congruent subblocks (793 ms, 4.3%) compared to the average of the incongruent subblocks (1030 ms, 10.7%) and 23/24 participants had a positive D-score.

Comparing the two groups directly, the effect of facial emotion was not significant, $t(46) = -1.890$, $p = .065$. Furthermore, the trend was for rather larger D-scores for angry faces (+0.61) than for happy faces (+0.40) which was in the opposite direction to that predicted by the gaze hypothesis. There were medium effect sizes in both groups.

Discussion

The preference for direct relative to averted gaze for neutral faces observed in Experiments 1–3 was found to extend to happy faces in Experiment 4. More importantly, and contrary to the prediction of the gaze account, people also clearly preferred direct to averted gaze for angry faces. This latter result provides evidence against the proposal that direct gaze is preferred because it indicates positive social interest in the viewer since this should mean that people prefer averted gaze for angry faces.

EXPERIMENT 5

One concern with Experiment 4 could be that the facial expressions were posed by untrained actors and that, in particular, the angry faces may not have been interpreted as having angry expressions. This possibility was examined in two ways in Experiment 5. First an IAT was conducted which replicated the basic design of Experiment 4 but which used different faces from a pre-existing database with validated emotional expressions (the Radboud Faces Database; Langner et al., 2010). Different groups of participants saw photographs of happy and angry faces, as in Experiment 4.[2] The models for these photographs were trained by an expert to produce happy and angry expressions. Second, as a further manipulation check, a rating study was conducted to determine how accurately the emotional expression of the happy and angry faces used in Experiments 4 and 5 could be identified.

IAT method

There were 48 participants. The method was identical to Experiment 3 except for two points. First, one group of 24 participants saw only happy faces and the other group saw only angry faces. Second, the photographs used depicted two male and four female faces and were taken from the set of Caucasian models in the Radboud face database (Langner et al., 2010; available at http://www.socsci.ru.nl:8180/RaFD2/RaFD?p=main). Each model in the database was trained by a FACS (Facial Action Coding System) coder to show ten emotional expressions including happy and angry.

IAT results

Two participants were replaced because over 10% of their RT were faster than 300 ms in the combined block trials. For the group shown happy faces, D-scores were significantly greater than zero, $t(23) = 9.340$, $p < .001$, see Figure 2,

[2] Experiment 5 used a double IAT design with all participants doing two separate IATs, one with normal contrast faces and the other with contrast-polarity reversed faces, with the order of IATs counterbalanced. The results for the contrast-reversed IATs are not reported here as they did not help to distinguish between theoretical accounts of the preference for direct gaze. However, D-scores remained significantly greater than zero for both happy, contrast-polarity reversed faces (+0.44), $t(23) = 5.518$, $p < .001$, and for angry, contrast-polarity reversed faces (+0.28), $t(23) = 3.430$, $p < .001$.

indicating that people preferred direct relative to averted gaze. Performance was much better for the average of the congruent subblocks (787 ms, 3.1%) compared to the average of the incongruent subblocks (1007 ms, 5.8%) and 23/24 participants had a positive D-score.

For the group shown angry faces D-scores were again significantly greater than zero, $t(23) = 6.318$, $p < .001$, see Figure 2 so even for angry faces people preferred direct compared to averted gaze. Performance was much better for the average of the congruent subblocks (883 ms, 2.7%) compared to the average of the incongruent subblocks (1018 ms, 7.0%) and 21/24 participants had a positive D-score.

An ANOVA was conducted with a between-participants factor of emotional expression. There was no significant difference between the D-scores for happy faces (+0.57) and angry faces (+0.44), $F(1,46) = 1.862$, $p = .2$, partial $\eta^2 = 0.04$. There were medium effect sizes for both groups.

Rating study

A further 37 participants were tested in a rating study to check the accuracy with which the emotional expressions of the faces presented in Experiments 4 and 5 could be identified. The four versions (happy/angry x direct/averted eye gaze) of each of the six faces used in each experiment were each presented twice. On each of these 48 trials participants made an unspeeded decision as to what emotion was shown by the face.

One group of 15 participants made a two alternative forced choice between angry and happy. An ANOVA was conducted on the mean percentage errors over the 12 faces with within-items factors of expression (happy or angry) and gaze direction (direct or averted) and a between-items factor of stimulus set (Experiment 4 versus 5). The only significant effect was an interaction between gaze direction and stimulus set, $F(1,10) = 7.200$, $p = .02$, partial $\eta^2 = 0.42$. Errors were low for both direct (4.4%) and averted (3.3%) gaze faces from Experiment 5 and for direct gaze faces from Experiment 4 (5.0%). Errors were somewhat larger for averted gaze faces from Experiment 4 (10.6%). Thus people were generally accurate at recognizing whether the faces used in Experiments 4 and 5 showed a positive (happy) versus a negative (angry) emotion.

A second group of 22 participants made a six alternative forced choice between angry, disgust, fear, happy, sad and surprise. An ANOVA revealed significant main effects of gaze direction, $F(1,10) = 13.350$, $p = .004$, partial $\eta^2 = 0.57$, and stimulus set, $F(1,10) = 67.727$, $p < .001$, partial $\eta^2 = 0.87$, and a significant interaction between gaze direction and stimulus set, $F(1,10) = 6.041$, $p = .03$, partial $\eta^2 = 0.38$. Errors remained low for both direct (9.1%) and averted (12.5%) gaze faces from Experiment 5. Errors were much higher for direct (47.3%) and, especially, for averted (64.5%) gaze faces from Experiment 4. Thus people could identify the specific emotion shown for the faces used in Experiment 5 but they found this difficult for the faces used in Experiment 4.

Discussion

In Experiment 5 there was a clear and strong preference for direct relative to averted gaze for angry faces as well as for happy faces, see Figure 2, and a rating study established that the emotions expressed by these stimuli could be accurately identified. These results replicate those of Experiment 4 and provide further evidence against the claim of the gaze hypothesis that people prefer direct gaze faces because they provide a positive social cue that another person likes you and is interested in you. This hypothesis predicts that the preference for direct relative to averted gaze for happy faces should reverse for angry faces since direct gaze from an angry face is a particularly negative, threatening social cue.

Combined analysis of results from Experiments 1–5

Data from these first five IAT experiments with faces was used to provide a final test of the gaze account and to test the perceptual fluency account of the preference for direct relative to averted gaze. First, the gaze account was tested by analysing the relation between the IAT and the results of two additional tests, the Autism Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001) and the revised Reading the Mind in the Eyes Test (RMET; Baron-Cohen, Wheelwright, Hill et al., 2001), which both purport to measure people's social cognitive ability. Second, the perceptual fluency account was tested by investigating performance on the IAT training blocks when faces were first presented as a means of independently assessing the relative difficulty of identifying direct and averted gaze faces.

1. Testing whether implicit preference for direct eye gaze (measured using the IAT) is predicted by individual differences in social face processing ability (as assessed by the AQ and RMET)

A final test was conducted of the gaze hypothesis by investigating whether individual differences in social cognition predicted the extent to which direct gaze was preferred over averted gaze. As discussed above, the eye region can give us important social information and it enables us to attribute mental states to other people (Baron-Cohen, 1995). Individuals vary in their ability to extract and use this information. For example, there is developmental evidence that the acquisition of gaze perception abilities may be associated with mentalizing skills and that they may involve shared neural circuits (Campbell et al., 2006; see also Nummenmaa, Engell, von dem Hagen, Henson, & Calder, 2012).

This analysis investigated whether an individual's social cognitive ability, as assessed by two measures of autistic traits, predicted the strength of their preference for direct eye gaze, as assessed by their D-score on an IAT.

Participants in Experiments 2, 3 and 4 were tested on the AQ test (Baron-Cohen, Wheelwright, Skinner et al., 2001) and the revised version of the RMET (Baron-Cohen, Wheelwright, Hill et al. 2001) after doing a gaze direction IAT. The relation between an individual's performance on these three tests was examined using correlations and linear mixed models.

The AQ and RMET have been claimed to assess people's mentalizing ability (i.e. their ability to interpret the actions of another person in terms of their mental state) and their ability to extract socially relevant information from faces. Poor performance by an individual on these tests was predicted to weaken or even reverse the implicit preference for direct eye gaze. This is because people with autism and autism spectrum disorders have abnormal processing of social cues and, in particular, they reveal a range of face processing impairments which may arise from their relative lack of interest in human faces (Jemel, Mottron, & Dawson, 2006; Senju & Johnson, 2009b). For example, they have been found to have specific deficits in judging gaze direction (Ashwin, Ricciardelli, & Baron-Cohen, 2009). They may not preferentially attend to the eye region and may even avoid eye contact so they may prefer averted gaze (Dalton et al., 2005; Senju & Johnson, 2009b; Kylliäinen et al., 2012). They are also relatively poor at extracting social information from faces (Itier & Batty, 2009) and at identifying complex mental states (e.g., scheming) from faces, particularly when only shown the eyes (Baron-Cohen et al., 1997). The gaze hypothesis argues that people like direct eye gaze because it signals positive social interest from somebody. This account therefore predicts that people with stronger autistic traits (as indexed by higher scores on the AQ and poor performance at the RMET) should show a weaker preference for direct relative to averted eye gaze on IAT tasks for the reasons outlined above.

Method and results

Data was collected from all 120 participants tested in Experiments 2, 3 and 4 together with 32 more participants who were run on a variation of Experiment 4 in which a mix of happy and angry faces were presented. These 152 participants (110 female, 42 male) were tested on the AQ and the RMET immediately after doing a gaze direction IAT. The D-score used for participants in Experiment 2 was the average of the separate D-scores for their frontal and head-turned IATs.

The AQ is a self-report questionnaire with 50 statements (such as "I am a good diplomat" or "I find it hard to make new friends") to which participants respond yes or no. Baron-Cohen, Wheelwright, Hill et al. (2001; Baron-Cohen, Wheelwright, Skinner et al., 2001) reported that adults with autism and Asperger syndrome typically score over 32 whereas controls typically score below 20. The mean score for the present cohort was 15 (standard deviation 6.0; range 5–32).

In the RMET participants see 36 photographs of pairs of eyes and they choose which of four possible mental states (e.g., embarrassed, fantasizing, guilty or concerned) best describes what the person depicted is thinking or feeling. Baron-Cohen, Wheelwright, Hill et al. (2001) reported that adults with autism and Asperger syndrome scored a mean of 22 whilst various control groups did better, scoring 26 or above. In the present cohort the mean score was 26 (standard deviation 3.8; range 15–34).

Crucially, the Pearson correlation of the AQ to D-scores was not significant, r(150) = .04, p = .6. Indeed it was not even in the predicted (negative) direction. Likewise, the Pearson correlation of the RMET to D-scores was not significant, r(150) = –.15, p = .06, and the marginal trend was, again, not in the predicted (positive) direction.[3,4] These results thus fail to support the prediction from the gaze hypothesis that people with stronger autistic traits should show a weaker preference for direct relative to averted eye gaze.

2. Testing a perceptual fluency account of the implicit preference for direct gaze

The results of the first five studies were used to test a perceptual fluency account of the preference for direct relative to averted gaze. This account suggests that direct gaze faces are easier to process than averted gaze faces and because of this direct gaze faces are preferred (Oppenheimer, 2008). In the present studies this might, for example, be because direct gaze faces were less variable since the eyes always looked forward whereas the eyes could look either left or right for the averted gaze faces. The perceptual fluency account was tested by comparing the speed of response to direct and averted gaze faces in the initial training block of each study. If faces that are easier to process are preferred this leads to two predictions. First, people should respond faster to direct gaze faces in the initial training blocks, since the D-scores reported above indicate that the direct gaze faces were subsequently preferred in the combined blocks. Second, the size of any advantage for direct over averted gaze faces in the training blocks should correlate to an individual's subsequent D-score, which was based on their congruent and incongruent block data.

A similar approach was taken by Makin et al. (2012). They found evidence that training block performance across a series of IATs was systematically related

[3] To check whether a relationship between the AQ or the RMET and D-scores might have been masked in these correlations by variation in the D-scores across experimental conditions, a linear mixed effects analysis of the relationship between D-scores on the IATs and scores on the AQ was performed using R (R Core Team, 2014) and lme4 (Bates, Maechler, Bolker, & Walker, 2014). AQ was entered as a fixed effect. Experiment condition and, nested within it, IAT order (congruent block before or after the incongruent block) were entered as random effects intercepts. Visual inspection of residual plots did not reveal any obvious deviations from homoscedasticity or normality. A likelihood ratio test of the full model with AQ as a fixed effect against the model without AQ did not reach significance, $\chi^2(1, N = 5) = 0.42, p = .52$. This analysis was repeated using the RMET. The likelihood ratio test of the full model with the RMET as a fixed effect against the model without the RMET did not reach significance, $\chi^2(1, N = 5) = 3.11, p = .08$. These analyses were consistent with the Pearson correlations reported here.

to subsequent D-scores. For example, in their studies where the training block revealed a significant preference for a given type of symmetry there was a significant advantage for that type of symmetry in the D-scores. Conversely, when there was no effect of a symmetry manipulation on the training block there was no effect of that manipulation on D-scores either. Makin et al. used their results to argue that perceptual fluency accounted for the preference for symmetry that they observed in their IATs.

[4] If both the AQ and the RMET measure autistic traits and related skills in social cognition then their results should correlate strongly (and negatively) with each other. Consistent with this, Baron-Cohen et al. (2001a) reported a correlation of –.53 between the RMET and the AQ. For the present data set the Pearson correlation was significant and it was in the predicted direction but it was much weaker ($r(150) = -.20$, $p = .01$). One potentially important difference between the 132 British adults tested by Baron-Cohen et al. (2001a) and the 152 British adults tested here is that their group included 15 people diagnosed with autism and Asperger's. They did not report the correlation between the AQ and the RMET for their controls alone. Instead, for their 103 student controls they just reported that there were significant correlations for two of the five subtests of the AQ (–.27 for social skills and –.25 for communication). This suggests, first, that the overall correlation of the RMET and the AQ may not have been significant for their student control group and, second, that this overall correlation was probably much weaker than the overall correlation of –.53 which they did report for the whole group which included autistic and Asperger's individuals.

Several other studies have reported weak correlations between the RMET and the AQ for non-clinical populations. Ragdale and Foley (2011) found a correlation of just –.08 for 220 British students and adults from the general population. Voracek and Dressler (2006) reported correlations of –.13 for 206 males and –.17 for 217 females for Austrian adults from the general population. Finally, Miu, Pană and Avram (2012) found similar performance on the RMET for a sample of 81 Romanian students selected to have low (<14) and high (>20) AQ scores. These results together with those from the present study (–0.20) suggest that in non-clinical populations there is probably a negative correlation between the RMET and the AQ but that this correlation is likely to be much weaker than the –.53 reported by Baron-Cohen et al. (2001a). Baron-Cohen's correlation was probably inflated due to the inclusion of people diagnosed with autism and Asperger's.

If the correlation between the RMET and the AQ in non-clinical populations is only around –.2, consistent with the findings of the present study, then this calls into question the claim that the two tests are measuring a common set of abilities in social cognition. One reason for this low correlation may be that the response alternatives in the RMET use difficult vocabulary such as "contemplative", "dispirited", "despondent", "incredulous" and "pensive". This test is therefore unlikely to be a pure measure of people's ability to interpret facial expressions because it requires sophisticated language skills. In addition, Ragsdale and Foley (2011) reported that the internal consistency of items in the RMET was poor, even for items representing similar emotions, and that there was no relation between eye gaze direction and accuracy on a particular item. Together this suggests that the RMET may not be an effective test of social cognitive functioning in the non-clinical population. Notwithstanding these concerns about the RMET, an important result from the present study was that even autistic traits assessed using the AQ failed to correlate in the expected direction with people's preference for direct relative to averted eye gaze, contrary to the predictions of the gaze hypothesis.

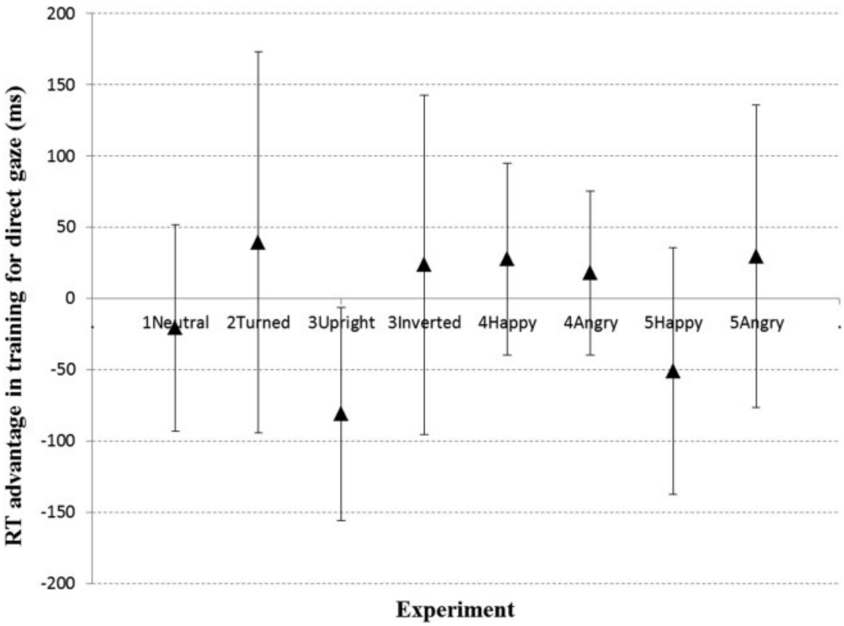

Figure 6. A plot of the mean RT advantage for direct gaze over averted gaze stimuli in the initial training block for faces for the different groups tested in Experiments 1–5. These comprised: neutral expression faces in Experiment 1 (1 Neutral); neutral, turned faces in Experiment 2 (2 Turned); neutral, upright and neutral, upside-down faces in Experiment 3 (3 Upright, 3 Inverted); happy and angry faces in Experiment 4 (4 Happy, 4 Angry) and happy and angry faces in Experiment 5 (5 Happy, 5 Angry). Note that the difference in RT for frontal faces in Experiment 2 (–33 ms) is not shown as this condition was run within-participants with the turned faces. Error bars show 95% confidence intervals appropriate for the between-subjects variation across the group data here.

In contrast, in the present data there was no evidence for either of these predictions of the perceptual fluency account. First, responses to direct gaze faces were not significantly faster than responses to averted gaze faces in the initial training block which presented faces. T-tests revealed no significant difference between the two conditions in 7 of the 8 conditions tested, see Figure 6. The only condition with a significant effect showed a difference in the opposite direction to that predicted, with the upright group in Experiment 3 revealing a small advantage (81 ms) for responding to averted gaze compared to direct gaze faces, $t(23) = 2.246$, $p < .04$.

Second, there was no systematic relation between the difference in RT to averted versus direct gaze faces during training for a given person and that person's D-score based on the subsequent, combined face and word blocks. The correlation was negative (so in the opposite direction to that predicted) for 3 of the 7 conditions and it was weak and non-significant in all cases (r ranged between +.3 and –.3). There was thus no evidence that performance on direct and averted gaze stimuli in the face training block was related to subsequent preference for those stimuli as the perceptual fluency account predicted.

EXPERIMENT 6

The results presented so far provide solid evidence for a powerful, implicit preference for direct compared to averted gaze. Three possible accounts of this effect were tested. None of the accounts were supported so there was no evidence to back the claims that symmetry, perceptual fluency or social attention from faces causes the direct gaze preference. In contrast, the final, fourth account, which suggests that people prefer self-directed attention, is consistent with the results of Experiments 1–5. This account claims that we prefer direct gaze faces because they signal that someone is attending to us and is interested in us. This account proposes that we like self-directed attention regardless of its valence so it is consistent with the results of Experiments 4 and 5 which showed a preference for direct gaze from angry as well as happy faces.

The final two experiments investigated another claim of this account, namely that people prefer stimuli irrespective of their social relevance provided that they direct attention towards us. This claim leads to the prediction that we should only like a category of stimuli labelled faces with direct gaze if the stimuli associated with that category direct attention towards us. This was tested in Experiment 6. Second, in Experiment 7 we tested the prediction that we should like a non-face stimulus, such as an arrow, if it directs attention towards us.

Experiment 6 investigated whether the preference for direct relative to averted gaze was reduced if non-directional, semantically meaningless shapes were shown which could not be construed as directing attention. In contrast, if the preference for direct gaze depends merely on the labels used for the target categories then it should still occur if the photographs of faces presented in Experiments 1–5 were replaced by geometric shapes with no salient orientation. Similar instructions and the same category labels were used as in Experiment 1 so the stimuli were described as if they were faces. People were thus told to respond to the shapes as if they showed faces gazing towards or away from themselves.

Method

There were 32 participants. The method was identical to Experiment 1 except for the following points. Instead of photographs of faces, the participant saw six purple and six blue shapes, see Figure 7. The shapes were selected to have no salient orientation so they did not appear to point in any direction. The assignment of shape colour to the “looking at you” and “looking to the side”

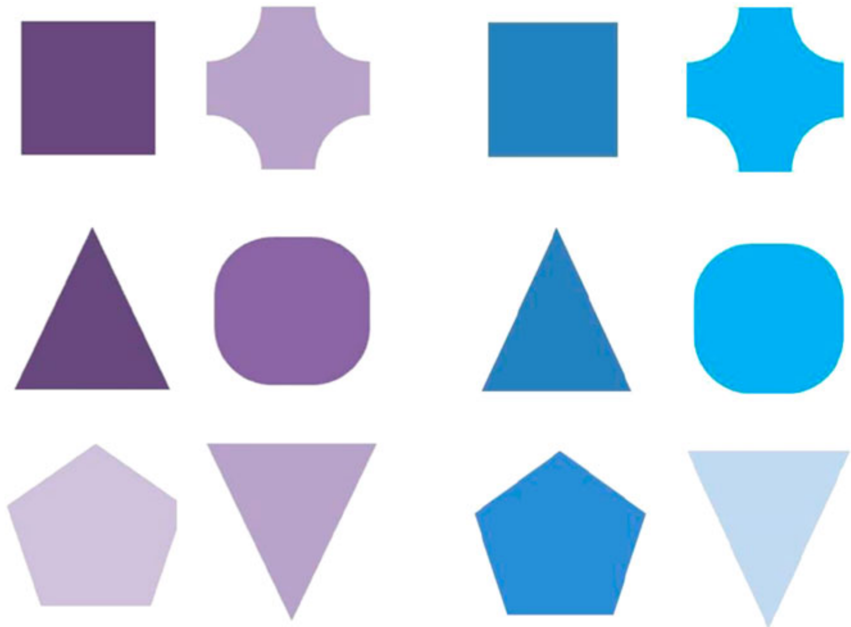

Figure 7. The full set of 12 geometric coloured shape stimuli presented in Experiment 6. The purple stimuli are shown on the left and the blue stimuli on the right.

conditions was counterbalanced across participants. Four words, in brackets, were added to the instructions as follows "You have to decide where each face is looking—whether the eyes are looking straight at you (blue/purple shapes) or to the side (purple/blue shapes)". The labels appearing at the top and bottom of the monitor on every trial were identical to those used in Experiment 1, so on shape trials these were "looking to the side" and "looking at you".

Results

This shape categorization task was harder than the face categorization tasks described so far. This was because, unlike Experiments 1–5, the mapping of stimulus to response was arbitrary so participants had to remember which colour (blue or purple) was associated with a given label. To ensure that overall performance was similar to that of Experiment 1, seven participants who performed poorly in the combined blocks were replaced (five had error rates over 17.5% whilst three had mean correct RT over 1300 ms; one of these three also had high errors).

D-scores were marginally significantly greater than zero (+0.17), $t(31) = 1.944$, $p = .06$, see Figure 2, so although no face stimuli were presented people still tended to prefer the category of shapes labelled "looking at you" relative to the category labelled "looking to the side". Performance was a little better for the average of the congruent subblocks (794 ms, 9.1%) compared to the average of the incongruent subblocks (830 ms, 10.4%) with 23/32 participants having a positive D-score. These analyses were repeated including all 39 participants tested. This did not alter the pattern of results, with D-scores remaining marginally significantly greater than zero (+0.15), $t(38) = 1.787$, $p = .08$.

D-scores in Experiment 6 were significantly smaller than those in Experiment 1 ($F(1,63) = 14.123$, $p < .001$, partial $\eta^2 = 0.19$); Experiment 2 (marginally significant: $F(1,55) = 3.781$, $p = .06$, partial $\eta^2 = 0.07$; using average D-scores for front and turned heads); Experiment 3 ($F(1,79) = 13.036$, $p = .001$, partial $\eta^2 = 0.14$); Experiment 4 ($F(1,79) = 10.207$, $p = .002$, partial $\eta^2 = 0.17$), and Experiment 5 ($F(1,79) = 12.449$, $p = .001$, partial $\eta^2 = 0.14$).

Discussion

In Experiment 6 the preference for the category labelled "looking at you" relative to the category labelled "looking to the side" was significantly reduced when non-directional, geometric shapes were presented rather than faces, see Figure 2. Just describing a stimulus as representing a face looking towards rather than away from you did not elicit a reliable preference for that stimulus. This result is consistent with the hypothesis that we prefer self-directed attention since this predicts that category labels alone should be much less effective at directing attention than the labels plus face stimuli used in Experiments 1–5. However, this result is also consistent with an alternative, face-specific account which predicts no preference for any non-face stimuli. Experiment 7 was conducted in order to distinguish between these two alternative accounts. Like Experiment 6, Experiment 7 showed non-face stimuli. However, unlike Experiment 6 it presented stimuli (arrows) which direct attention in order to investigate whether arrows pointing towards rather than away from you elicit an effect analogous to the direct gaze preference found in Experiments 1–5.

EXPERIMENT 7

Attentional orienting by arrows develops early. By age six years it is based on conceptual (i.e., learnt, directional) cues rather than perceptual cues, though it develops later than orienting to social directional cues such as eye gaze and pointing (Jakobsen et al., 2013). Arrows, like faces with averted gaze, trigger reflexive eye movements and attentional cueing in the direction indicated by the cue (Brignani, Guzzon, Marzi, & Miniussi, 2009; Kuhn & Benson, 2007; Kuhn

& Kingstone, 2009; Nummenmaa & Hietanen, 2009; Tipples, 2002), although this involuntary orienting of attention by centrally presented arrow and gaze cues may be based on different neural and functional mechanisms (Hietanen, Leppänen, Nummenmaa, & Astikainen, 2008; Marotta, Lupiáñez, & Casagrande, 2012; Marotta, Lupiáñez, Martella, & Casagrande, 2012).

This final study tested the hypothesis that we like any kind of attention to ourselves. This proposes that our preference for faces with direct gaze reflects a more general preference for self-directed attention regardless of its valence or its origin. This account predicts that a preference should be found for non-face stimuli such as arrows if they direct attention towards us. Thus we should prefer arrows shown pointing towards us relative to arrows pointing to the side, consistent with the eye gaze effects reported so far being driven by general attentional cueing. In contrast, if our preference for direct relative to averted eye gaze relies on seeing a face, as the gaze hypothesis predicts, then we should not show a preference for arrows pointing towards us. Consistent with this latter, face-specific prediction, Bayliss, Paul, Cannon, and Tipper (2006) found that people preferred gazed-at objects but that this attentional effect did not generalize to objects which were pointed at by arrows.

Method

There were 32 participants.[5] The method was identical to Experiment 1 except that instead of seeing photographs of faces looking towards or away from them, participants saw photographs of drawings of arrows pointing towards or away from them, see Figure 8.

[5] Eight non-naive colleagues were also tested in Experiment 7. They were familiar with both the IAT methodology and the experimental hypothesis tested here. They produced similar D-scores (mean of +0.16 with 6/8 being positive) as the 32 naive participants. An analysis including all 40 participants again revealed a D-score which was significantly greater than zero (+0.27), $t(39) = 3.272$, $p = .002$. Comparing the results of Experiments 6 and 7, the D-scores were not significantly greater for arrows than for non-directional coloured shapes when these 8 non-naive participants in Experiment 7 were also included, $F(1,70) = 0.580$, $p = .4$. Finally, the D-scores for all 40 participants in Experiment 7 were significantly smaller than those for participants seeing faces in Experiment 1 ($F(1,70) = 8.268$, $p = .005$, partial $\eta^2 = 0.11$), Experiment 3 ($F(1,86) = 6.666$, $p = .01$, partial $\eta^2 = 0.07$), Experiment 4 ($F(1,86) = 5.717$, $p = .02$, partial $\eta^2 = 0.06$) and Experiment 5 ($F(1,86) = 6.758$, $p = .01$, partial $\eta^2 = 0.07$) but not to Experiment 2 ($F(1,62) = 1.304$. $p = .25$, partial $\eta^2 = 0.02$). Thus the results reported in the main analysis for the 32 naive participants were unchanged when data from these eight non-naive participants was included.

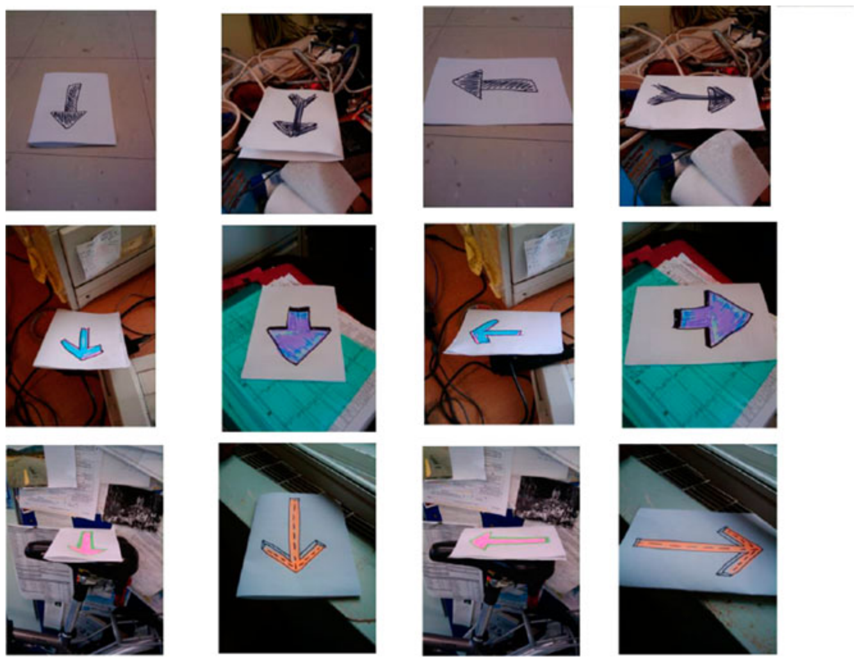

Figure 8. The full set of 12 arrow stimuli presented in Experiment 7. The "looking at you" arrows are shown on the left and the "looking to the side" stimuli (with three arrows pointing left and three pointing right) are shown on the right.

Results

No participants were replaced. The D-score was significantly greater than zero (+0.29), $t(31) = 3.168$, $p = .003$, see also Figure 2, indicating that people preferred arrows that pointed towards rather than away from them. Performance was better for the average of the congruent subblocks (812 ms, 5.8%) compared to the average of the incongruent subblocks (902 ms, 8.3%), with 19/32 participants having a positive D-score.

Comparing the results of Experiments 6 and 7, D-scores were not significantly greater for arrows (+0.29) than for non-directional coloured shapes (+0.17), $F(1,62) = 0.850$, $p = .4$. In contrast, D-scores in Experiment 7 were significantly smaller than when faces were shown in: Experiment 1 ($F(1,62) = 6.391$, $p = .01$, partial $\eta^2 = 0.09$); Experiment 3 ($F(1,78) = 4.778$, $p = .03$, partial $\eta^2 = 0.06$); Experiment 4 ($F(1,78) = 4.011$, $p = .049$, partial $\eta^2 = 0.05$) and Experiment 5 ($F(1,78) = 4.843$, $p = .03$, partial $\eta^2 = 0.06$), though not compared to Experiment 2 ($F(1,54) = 0.782$, $p = .4$, partial $\eta^2 = 0.01$).

One reason for the relatively weak preference for arrows pointing towards rather than away from the observer could be because the direction that the arrows pointed was not clear. There was, though, no evidence from the training blocks to support this suggestion. In Experiment 7 mean RT (886 ms) and errors (5%) were similar to those in Experiment 1 (neutral faces, 822 ms, 5%), Experiment 2 for frontal view of faces (838 ms, 5%), Experiment 3 (upright faces, 793 ms, 7%; upside-down faces, 847 ms, 5%), Experiment 4 (happy faces, 829 ms, 7%; angry faces, 773 ms, 7%) and Experiment 5 (happy faces, 879 ms, 4%; angry faces, 831 ms, 5%) and they were much less than in Experiment 2 for turned faces (1043 ms, 10%).

Discussion

The results of Experiment 7 revealed a clear preference for arrows pointing towards rather than away from the viewer. This finding was directly analogous to the preference for direct relative to averted gaze obtained in Experiments 1–5 for faces. It is consistent with the hypothesis that we like self-directed attention, whether it is elicited by stimuli which are socially meaningful (such as faces, see Experiments 1–5) or not (such as arrows, see Experiment 7). The results provide evidence against the gaze hypothesis since this predicts that the direct gaze preference found for faces should not extend to socially irrelevant stimuli such as arrows.

The strength of the preference for arrows pointing towards the viewer was less than that for a face gazing at the viewer, see Figure 2. It remains to be seen whether this reduced preference for arrows pointing towards rather than away from the viewer (and also for shapes labelled as "looking at you" rather than "looking away from you" in Experiment 6) reflects the extent to which these different types of stimuli direct attention towards the viewer, as predicted by the hypothesis that we prefer self-directed attention.

GENERAL DISCUSSION

The present studies showed that people have a clear preference for faces shown gazing towards them relative to faces with averted gaze when tested using the implicit IAT task (Experiments 1–5). This preference was robust to physical manipulations such as presenting faces with the head turned (Experiment 2) or upside-down (Experiment 3) and it generalized to a threatening emotional expression (anger; Experiments 4 and 5). It was not related to the ease of processing the face stimuli in the training blocks (see Figure 6) or to a person's mentalizing and social cognitive skills (as assessed using the AQ and the RMET). People also showed a related preference for non-face stimuli. People preferred arrows pointing towards them relative to arrows pointing away (Experiment 7) and there was even a trend for people to prefer geometric, non-directional shapes which were labelled as showing a face "looking at you" relative to "looking to the side" (Experiment 6).

In all of these studies participants were told to respond on the basis of gaze direction. These results therefore do not address the question of whether there is a spontaneous preference for direct relative to averted gaze. However, follow-up studies investigating this issue suggest that the preference for direct gaze may require participants to explicitly process gaze information (Lawson, in preparation). The present results also do not specify people's absolute preference for categories since the IAT necessarily reflects the relative strength of association across two target categories (Lane et al., 2007). To address this I am conducting further studies using the single category IAT (Karpinski & Steinman, 2006) to measure people's absolute preference for direct gaze and, separately, for averted gaze.

These results do not support the claims of the face-specific *gaze hypothesis* which is the most obvious explanation of why direct gaze is preferred relative to averted gaze. This account proposes that we like direct gaze because it provides a positive social cue that another person likes you and is interested in you. It assumes that the preference for direct eye gaze is specific to faces and that it should reduce if stimuli are less face-like (for example, by showing upside-down rather than upright faces, as in Experiment 3) and it should be eliminated if stimuli are not socially relevant (such as arrows, as in Experiment 7). It also predicts that the preference should be reversed for angry faces (as opposed to neutral or happy faces, as tested in Experiments 4 and 5) with averted gaze preferred relative to direct gaze. None of these three predictions were supported. Finally, there was no evidence for a fourth prediction of the gaze hypothesis, namely that the strength of an individual's preference for direct gaze should relate to their mentalizing and social cognitive abilities as assessed by the AQ and RMET.

The present results indicate that our preference for direct relative to averted gaze is not a face-specific phenomenon and cannot be explained by the gaze hypothesis. Three more general reasons why people might like direct gaze were examined:

The *symmetry preference account*. This proposes that frontal views of direct gaze faces are preferred because they are more symmetrical than averted gaze faces. This was tested by showing turned heads. Here direct gaze faces were not more symmetrical than averted gaze faces. Nevertheless a robust preference for direct gaze was found for turned heads so the symmetry preference account was not supported.

The *perceptual fluency account*. This account predicts that stimuli that are easier to process and so are responded to faster should be preferred. It was examined by analysing the results of the training blocks. Response times to direct and averted gaze faces were similar during training with no systematic advantage for direct gaze stimuli (see Figure 6). Furthermore, no relation was found between face categorization performance during training and an individual's subsequent D-score. Thus no evidence was found to support the predictions of the perceptual fluency account.

In contrast, the present results are consistent with a fourth account which proposes that we *prefer self-directed attention.* This account suggests that we like any attention that is directed towards us. As a consequence we like direct gaze because it indicates that another person is attending to and is interested in us. This preference for self-directed attention should not depend on the valence of stimuli (for example, the emotional expression of a face) or the social relevance of stimuli (so it should extend to non-face stimuli such as arrows). These predictions were confirmed and so this account provides the best explanation of the present results.

The hypothesis that we like any self-directed attention is consistent with the finding that self-relevant associations are prioritized (Sui, He, & Humphreys (2012), and the claims that we have an automatic, attentional bias towards self-related information (Alexopoulos, Muller, Ric, & Marendaz, 2012) and that, typically, we have strongly positive implicit evaluations of ourselves. Together our focus on self-related stimuli and our positive self-evaluation produce an implicit egotistical bias which means that we prefer targets associated with ourselves, including employers, jobs, locations or people with a similar name to our own (Pelham, Carvallo, & Jones, 2005). There is abundant laboratory-based evidence for implicit egotism, though there is debate as to the strength of its effects in the real world (e.g., Simonsohn, 2011a, 2011b). Notwithstanding this debate, the present hypothesis makes a narrower claim, namely that people always prefer attention to be directed towards themselves. This claim is not consistent with the finding by Lobmaier and Perrett (2011; see also Kloth, Altmann, & Schweinberger, 2011; Lobmaier, Tiddeman, & Perrett, 2008) that people are more likely to claim that a happy face (rather than a neutral, fearful or angry face) is looking at them. Here, emotional expression biased judgements of the direction that another person was attending, suggesting that people prefer positive stimuli to be directed towards themselves as predicted by the self-referential positivity bias (Lobmaier & Perrett, 2011). In contrast, in the present studies the preference for direct relative to averted eye gaze was not modulated by emotional expression. This result supports a simpler account, namely that we prefer self-directed attention from any stimulus, whether positively or negatively valenced: people like any kind of attention to themselves. It remains to be seen whether a common theoretical account can explain why emotional expression influences perceived gaze direction but not the preference for direct gaze.

A strong prediction of the hypothesis that we prefer self-directed attention is that this preference should not be influenced by the social relevance of stimuli. This claim might appear inconsistent with the present finding that the preference for arrows pointing at the viewer was significantly weaker than the preference for faces gazing towards the viewer, see Figure 2. However, here, as in most previous research, the relative effectiveness of the eye gaze and arrow cues in directing attention was not assessed prior to running the studies (but see Birmingham, Bischof, & Kingstone, 2009). It seems likely that simple perceptual factors such as the size and contrast of the stimuli used could be important in modulating preference. Santiesteban, Catmur, Coughlan Hopkins, Bird, and Heyes (2014) reported similar levels of attentional cueing for arrows and avatars. However, in their study the direction of facing may have been easier to discern for their arrows than their avatars since the critical, directional area was much larger. In contrast, the arrows used here may have been less effective at directing the viewer's attention than eye gaze for the face stimuli and this could explain the relatively weak preference for arrows pointing towards the viewer.

Our preference for self-directed attention may help to explain the inward bias reported by Palmer and colleagues (Palmer, Gardner, & Wickens, 2008; Sammartino & Palmer, 2012). When people are explicitly asked about their aesthetic preference for the spatial location of objects within a framed scene they consistently reveal an inward bias. Palmer et al. (2008) found that people disliked side views of objects that faced outwards so that the most salient part of the object (such as the head of an animal or the nose of a face) was nearest to the edge of the frame. In their first and third studies they also found that people preferred front-facing objects to be placed at the centre (rather than the side) of the frame. Only 3/10 of their objects were animate and their studies were not designed to examine the effects of eye gaze direction. Nevertheless, at least part of the inward bias that they observed may have arisen from a preference for stimuli that direct attention towards the viewer (for central, front-facing objects) rather than away from the viewer (for front-facing objects presented to the left or right of a scene, or for side-views of objects facing outwards). Furthermore, the hypothesis that we prefer self-directed attention predicts that faces depicted at the edge of a scene should be preferred if they gaze out of the picture, directly towards the viewer, rather than if they gaze in toward the centre of the depicted scene. More generally, if we prefer direct eye gaze then, all else being equal, we should choose to portray people with direct gaze and we should prefer portraits of people who have direct rather than averted eye gaze. There are complications in testing these latter claims. For example, there have often been cultural traditions against making direct eye contact, particularly with powerful people. However, given this caveat, Morin (2013) reported evidence that European and Korean painters preferentially depicted people with direct gaze.

In conclusion, an IAT task was used to measure implicit preferences for a variety of stimuli which signalled where attention was being directed. This task was chosen to be well-suited to assessing the rapid, unreflective and ubiquitous evaluations that we make about what other people are attending to during our everyday social interactions. We are continually making and updating decisions about whether somebody is interested in us and how their attention to us is changing over time. The cue provided by where someone is looking plays an important role in these spontaneous evaluations. The studies reported here provide clear evidence for the existence of a strong implicit preference for direct relative to averted gaze (see Figure 2). The results of a range of manipulations and analyses suggest that it is caused by our preference for any self-directed attention: we really like being at the centre of attention. This account proposes that our preference for self-directed attention does not depend on either the social significance or the valence of the stimuli being presented. A counter-intuitive prediction arising from these claims is that self-directed attention from a negative, non-face stimulus (such as a gun shown pointing towards you, indicating that attention is focussed on you) should be preferred (relative to a gun shown pointing away[6]). The conclusion that we prefer to have attention focussed on ourselves complements a wide range of empirical findings that show that people have an automatic, attentional bias towards information about themselves and strong positive evaluations of themselves. However, in related research areas investigating effects such as gaze cueing and implicit mentalizing it has proven difficult to distinguish between face-specific, social cognitive accounts and alternative, domain-general accounts. Understanding such phenomena requires innovative and carefully controlled studies which compare performance across socially relevant stimuli (such as eyes, faces and avatars) and control, directional stimuli which can also bias attention (such as arrows; Bayliss, Bartlett, Naughtin, & Kritikos, 2011; Birmingham et al., 2009; Guzzon, Brignani, Miniussi, & Marzi, 2010; Santiesteban et al., 2014). It will therefore be important to seek converging evidence using different methodologies to support the present, domain-general interpretation of why we prefer faces that gaze towards rather than away from us.

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