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Do social utility judgments influence attentional processing?

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ABSTRACT

Research shows that social judgments influence decision-making in social environments. For example, judgments about an interaction partners' trustworthiness affect a variety of social behaviors and decisions. One mechanism by which social judgments may influence social decisions is by biasing the automatic allocation of attention toward certain social partners, thereby shaping the information people acquire. Using an attentional blink paradigm, we investigate how trustworthiness judgments alter the allocation of attention to social stimuli in a set of two experiments. The first experiment investigates trustworthiness judgments based solely on a social partner's facial appearance. The second experiment examines the effect of trustworthiness judgments based on experienced behavior. In the first, strong appearance-based judgments (positive and negative) enhanced stimulus recognizability but did not alter the size of the attentional blink, suggesting that appearance-based social judgments enhance face memory but do not affect pre-attentive processing. However, in the second experiment, in which judgments were based on behavioral experience rather than appearance, positive judgments enhanced pre-attentive processing of trustworthy faces. This suggests that a stimulus's potential benefits, rather than its disadvantages, shape the automatic distribution of attentional resources. These results have implications for understanding how appearance- and behavior-based social cues shape attention distribution in social environments.

1. Introduction

Humans make hundreds of decisions every day. Often, these choices depend heavily on the signals people receive from their interaction partners (Behrens, Hunt, Woolrich, & Rushworth, 2008). For example, facial expressions contribute important information to appearance-based social decision-making. Research shows that faces displaying negative emotions, such as fear and anger, are pre-attentively processed (Eastwood, Smilek, & Merikle, 2003; Fox et al., 2000; Öhman, Lunqvist, & Esteves, 2001). This attentional negativity-bias is explained by an adaptive evolutionary drive to avoid threat (Cosmides & Tooby, 2000). However, recent research showing that valuable stimuli are also pre-attentively processed has begun to suggest that reward-related information may bias attention in a similar fashion (Anderson, Laurent, & Yantis, 2011; Dux & Marois, 2009; Roelfsema, van Ooyen, & Watanabe, 2010) and that positive emotional expressions facilitate target detection (Hodsall, Viding, & Lavie, 2011). While threat detection may be important in many contexts, it may be less influential in the everyday social environments people typically experience.

One factor that may shape decision-making in ordinary social contexts is people's judgments of those with whom they interact. These social judgments are important because they guide expectations about how a partner might behave (Cosmides, 1989; Cosmides & Tooby, 2000; Frith & Frith, 1999). Appearance-related social judgments are particularly influential (Willis & Todorov, 2006). For example, research shows that the degree to which an individual

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looks trustworthy influences a range of decisions including financial investments (van't Wout and Sanfey, 2008), the interpretation of verbal information (Hassin & Trope, 2000), wagering behavior (Schlicht, Shimojo, Camerer, Battaglia, & Nakayama, 2010), legal decisions (Porter, ten Brinke, & Gustaw, 2010), and voting (Olivola & Todorov, 2010).

Nonetheless, appearances are not always accurate (Porter, England, Juodis, van Brinke, & Wilson, 2008). Research has therefore begun to examine how behavioral experience alters social judgments. This work shows that people's behavior significantly influences others' judgments such that truthful, consistent, and prosocial behaviors lead to more positive interpersonal evaluations (Ames & Johar, 2009; Bayliss & Tipper, 2006; Heerey & Velani, 2010). Thus, these findings suggest that both appearance- and experience-based judgments influence social decisions.

Recently, research has begun to suggest that social judgments may be akin to economic value judgments (Chang, Doll, van't Wout, Frank & Sanfey, 2010) because they shape expectations about the utility or subjective desirability of interacting with a particular social partner. For example, the presence of social rewards such as genuine smiles increases stimulus utility and influences subsequent economic decisions (Shore & Heerey, 2011). Moreover, people assume that interaction partners who look attractive or trustworthy, or engage in prosocial behavior will provide positive outcomes and other social rewards (Delgado, Frank, & Phelps, 2005; Wilson & Eckel, 2006). This evidence therefore suggests that social cues lead to joint economic and social judgments of interaction partners, which subsequently influence decisions by biasing people's expectations about those partners.

Social interactions, especially with multiple partners, contain more information than people can process (Foulsham, Cheng, Tracy, Henrich, & Kingstone, 2010). Therefore, biases based on social judgments may shape decision-making in more subtle ways as well. For example, research has shown that non-social reward cues change stimulus utility, and that this influences the pre-attentive processing of rewarded stimuli (Anderson et al., 2011; De Martino, Kalisch, Rees, & Dolan, 2009; Dux & Marois, 2009). If social utility judgments influence neural processing in a similar fashion, we predict that social stimuli eliciting strong judgments should likewise capture attention, suggesting one mechanism by which those stimuli shape social decisions and behavior. Specifically, the ability of an interaction partner to capture attention, even for a short while, may bias the information one gains during an interaction involving that partner. Therefore, social judgments may bias decision-making by guiding attention toward or away from particular partners, thereby determining the information people acquire and use in subsequent decisions.

Here, we ask how appearance – (Experiment 1) and behavior-based (Experiment 2) social utility judgments affect the allocation of attention to social stimuli. Understanding how such judgments shape the perception and attentional processing of stimuli provides an important clue about how social judgments influence decision-making processes. To measure differences between stimuli in terms of attention capture, we utilized an attentional blink (AB) paradigm (Raymond & O'Brien, 2009; Raymond, Shapiro, & Arnell, 1992). The AB is an elegant way of measuring the degree to which different stimuli automatically capture attention. In AB tasks, participants must detect two visual stimuli presented at varying time points in a rapid stream of images. If the second stimulus occurs within 500 ms of the first, it is often undetected (Chun & Potter, 1995), causing an impairment in perceptual encoding known as the attentional blink (Raymond et al., 1992). Interestingly, participants are less likely to miss a target presented within 500 ms of another when the target is emotionally salient (Keil & Ihssen, 2004). If social judgments increase the motivational or emotional salience of social stimuli this should cause those stimuli to capture attention, even when they are presented within the window of the attentional blink (i.e., within 500 ms following another target).

2. Experiment 1

Here, we investigate whether appearance-based social utility judgments affect the recognition of faces when they appear within versus after the window of the attentional blink. In this experiment, we use judgments of trustworthiness, as this trait is judged quickly, reliably and automatically from physical appearance (Berry & Brownlow, 1989; Engell, Haxby, & Todorov, 2007; Olsen & Marshuetz, 2005; Todorov, Pakrashi, & Oosterhof, 2009; Todorov, Said, Engell, & Oosterhof, 2008; Willis & Todorov, 2006). We predict that when stimuli appear outside the window of the attentional blink, recognition will be better for faces judged to be high or low in trustworthiness compared to average (medium) rated faces, because faces with more extreme ratings are thought to be more salient than average faces (Singer, Kiebel, Winston, Dolan, & Frith, 2004; Winston, Strange, O'Doherty & Dolan, 2002).

For stimuli presented within the window of the attentional blink, however, the literature suggests two opposing predictions. If valuable or positive stimuli reduce the attentional blink (e.g., Anderson et al., 2011; Raymond & O'Brien, 2009), one might predict trustworthy, but not untrustworthy or neutral faces to be preferentially processed and therefore to attenuate the attentional blink. Alternatively, based on research showing that less trustworthy faces are more likely to be remembered (e.g., Yamagashi, Tanida, Mashima, Shimoma, & Kanazawa, 2003), one might anticipate a reduced attentional blink for faces that are low, rather than average or high in trustworthiness.

2.1. Method

2.1.1. Participants

Fifty-five undergraduate psychology students (17 male, mean age = 21.07 SD = 3.97) participated in the study for partial course credit. All participants gave written informed consent and the University's Ethics Committee approved the study (likewise for Experiment 2 below).

2.1.2. Stimuli

The task used three types of stimuli: faces, abstract images and image masks. The face stimuli consisted of natural gray-scale images of actors' faces. Actors were photographed in neutral poses, with eye-gaze directed toward the viewer. Photos were presented in an elliptical window that closely cropped the face. There were 36 faces (18 male), all of which were pre-rated for trustworthiness by an independent sample of 48 participants. Male and female faces were rated as equally trustworthy ($p = .15$). Based on these judgments, we split the faces into two sets. The first set consisted of 24 faces all rated as average in trustworthiness. These faces served as 'novel' faces in an attentional blink recognition task (see procedure). The second face set consisted of 12 faces rated as high in trustworthiness (four faces), of average trustworthiness (four faces) or low in trustworthiness (four faces). Each level had two male and two female faces. A gender (male, female) by trust rating (high, average or low) ANOVA ensured that male and female faces were similarly trustworthy ($p = .28$) and that faces differed in trustworthiness across the rating categories ($p < .001$). High trustworthy faces ($M = 5.78$ SD = 0.34) were rated higher than average faces ($M = 4.49$ SD = 0.18), which in turn, were higher than low trustworthy faces ($M = 2.93$ SD = 0.49) on a 9-point Likert scale (1 = Extremely untrustworthy; 9 = Extremely trustworthy).

To test whether the natural face images differed in low-level image characteristics across levels of trustworthiness, we used a 2-dimensional discrete fast Fourier transform (in MATLAB) to decompose each image into its component frequencies to produce a power spectrum with 30 frequency bands (Diop, Alexandre, & Moisan, 2012). Using mixed-model ANOVA, we compared signal power within the frequency bands. Face gender (male, female) and trustworthiness condition (low, average, high) were both between-subjects variables and frequency (30-levels) was the within-subjects factor. As with most natural images, there was greater low-frequency than high-frequency information within the face set ($p < .001$). There was also a main effect of gender such that female faces had more low-frequency information than did male faces ($p < .001$). Male and female faces did not differ in terms of power in the higher frequency bands, meaning that the face-gender × frequency band interaction was also significant ($p < .001$). Importantly, there were no differences in power spectra across trustworthiness conditions ($p = .56$), nor was there a frequency band × trustworthiness condition interaction ($p = .99$). The 3-way interaction was not significant ($p > .99$).

The remaining stimuli included 20 computer-generated, gray scale, abstract images made up of either circles or squares; and 20 face 'masks' made by splitting face images into 4 × 5 grids and randomly shuffling the pieces (see Fig. 1).

2.1.3. Procedure

Participants began the task by rating each of the 12 pre-rated faces on a series of traits. Although we were only interested in trustworthiness, in order to avoid demand characteristics associated with participants guessing the relevant trait, they rated each face for happiness, anger, attractiveness, outgoingness, friendliness, and trustworthiness using a 10-point Likert scale (0 = not at all, 9 = very much so). Participants made all ratings for a face before rating the next face. The computer presented the faces in random order and the traits appeared in random order for each face. Participants' ratings were similar to those of the previous sample. As above, high trustworthy faces ($M = 5.53$ SD = 1.21) received higher ratings than average faces ($M = 4.31$ SD = 1.29), which received higher ratings than low trustworthy faces ($M = 2.77$ SD = 1.36; p-values < .001).[1]

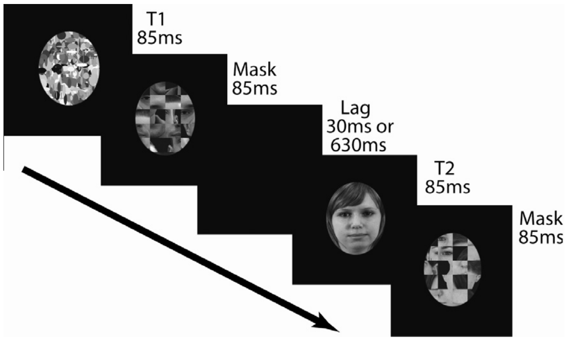

Fig. 1. Trial timeline for the attentional blink task. Participants saw an RSVP stream consisting of two image-pairs separated by a blank screen of variable length.

Following the rating procedure, participants completed a simple 1-back task that allowed them to become familiar with the 12 faces. Faces were presented in random order and participants made a key press response each time they saw a face appear twice in a row (faces appeared as 1-back targets with equal probability). Each face was presented for 750 ms, with a 250 ms blank screen between presentations. There were 56 presentations of each face (672 trials total) split over 3 blocks, with an average of 29 one-back trials per block. There were no differences in the frequency with which participants responded to each face when it was a 1-back target ($p = .72$).

Participants then completed an attentional blink (AB) task to assess whether appearance-based judgments of trustworthiness affected the recognition of faces when these were presented during or after the window of the attentional blink. Participants searched for two targets T1 (an abstract image) and T2 (a face) in a rapid serial visual presentation (RSVP; see Fig. 1). On each trial, participants viewed the RSVP stream and answered a question about each target they had seen.

[1] As in most studies of faces that differ in trustworthiness (e.g., Hassin & Trope, 2000), the three types of face stimuli (trustworthy, neutral and untrustworthy) used in this study differed across all trait ratings including trustworthiness. Faces that were rated as trustworthy were also rated as more friendly, attractive, outgoing, etc.; those rated as untrustworthy were also viewed as lower in these same traits; neutral faces fell in between. Todorov et al. (2008) suggest that participants' ratings of trustworthiness reflect a global social factor that drives a range of other judgments, including attractiveness, friendliness, agreeableness, etc. To test this idea formally, we performed a factor analysis on the Experiment 1 face ratings (both the pre-rating sample and the present participants' ratings). Results showed that all the ratings loaded onto a single factor that accounted for 63.49% of the variance.

Each trial started with a fixation cross for 1000 ms followed by an RSVP stream consisting of 5 stimuli (T1, mask, blank screen, T2, mask). Each image was presented for 85 ms except the blank screen, which had either a short (30 ms) or a long (630 ms) duration or lag. The two lag durations created two attentional conditions. When the lag was long (full attention condition), T2 was presented after processing of T1 was complete, meaning it appeared outside the window of the attentional blink and therefore received full attention. When the lag was short (reduced attention condition), T2 was presented within the window of the attentional blink prior to the completion of T1 processing, thus reducing the attention it received (Raymond et al., 1992).

After viewing the RSVP stream participants classified the T1 image as consisting of circles or squares and decided whether the T2 face was familiar (one of the 12 faces they had seen in the 1-back task) or unfamiliar (one of the 24 novel faces not present in the 1-back task). Participants answered each question with a key-press response. There was no time limit for responding. The next trial began immediately after participants responded to the second question.

Participants completed 240 long-lag (full-attention) trials and 240 short-lag (reduced-attention) trials in random order. In half the trials the T2 stimuli were familiar faces (from the 1-back task) and on the other trials, they were novel faces from the set of 24 neutral/average-trustworthiness faces. Face novelty was balanced across long- and short-lag trials. In the case of the familiar faces, which differed on ratings of trustworthiness, trustworthiness level (low, average and high) was balanced across the short- and long-lag conditions. Face gender was also balanced across conditions. T1 stimuli were equally likely to consist of circles or squares (randomly selected from the appropriate image pool), counterbalanced across lag, face novelty, face gender and face trustworthiness (familiar faces only) conditions. Mask images were randomly selected on each trial. The task was programmed and presented using E-prime (Psychology Software Tools, Inc., Pittsburgh, PA).

2.1.4. Data analysis

We classified the AB task responses as hits (correctly identifying familiar faces), misses (responding ‘unfamiliar’ to a familiar face), correct rejections (correctly identifying unfamiliar faces) or false alarms (responding ‘familiar’ to an unfamiliar face). We then used signal detection theory (Green & Swets, 1966) to calculate d' for each participant as a measure of recognition performance for each face category (low-, average- and high-trustworthiness), across the long and short lag conditions. Because the d' calculation is the ratio of the z-transformed probability of making a hit to the z-transformed probability of making a false alarm, we created equal groups of familiar and novel faces by randomly assigning each novel face response to either a high-, average- or low-trust group prior to this calculation. Only trials in which participants correctly identified the T1 stimulus (M = 89.76%, SD = 10.03%) were used in analyses. We applied Bonferroni’s correction for multiple comparisons to all post hoc comparisons (likewise for Experiment 2).

2.2. Results

A $2 \times 2 \times 3$ repeated measures ANOVA with lag condition (short or long), face gender (male or female) and face type (high-, average- or low-trust) as within subjects factors and d' as the dependent variable, showed that there was no main effect of face gender, $F(1,54) = 3.19$, $p = .08$, $\eta_p^2 = .06$, nor did gender interact with any other factors (all p-values > .08). Therefore, we collapsed across face gender for all analyses.

As Fig. 2 shows, a lag condition (short/long) by face type (high-/average-/low-trustworthiness) repeated measures ANOVA showed that participants’ recognition of T2 stimuli was better when attention was full (long lag) than when attention was reduced (short lag), $F(1,54) = 39.36$, $p < .001$, $\eta_p^2 = .42$. T2 recognition also depended on face type, $F(2,108) = 5.50$, $p = .005$, $\eta_p^2 = .09$. Specifically, high- and low-trust faces were better recognized than average faces (p-values < .04), although high- and low-trust faces did not differ from one another in recognition ($p = .19$). There was no trust condition × lag interaction, $F(2,108) = 1.60$, $p = .21$, $\eta_p^2 = .03$.

A difference in recognition performance between attention conditions indicates the presence of an attentional blink (Raymond et al., 1992). To detect the presence of an AB, we used paired-samples t-tests to compare long- and short-lag trials for each face type (see Raymond & O’Brien, 2009). Interestingly participants’ showed an attentional blink for all three face types (low trust $t(54) = 2.00$, $p = .05$; average trust $t(54) = 5.66$, $p < .001$; high trust $t(54) = 2.78$, $p = .01$), meaning that the recognition of T2 stimuli was significantly reduced in short-lag compared to long-lag trials. Together, these results suggest that strong appearance-based social judgments make stimuli more memorable but only in the long-lag condition. Therefore, appearance-based social judgments do not alter the size of the attentional blink.

2.3. Discussion

As predicted, in the full attention condition, salient faces (those judged to be high or low in social utility) were better recognized than those judged to be of average utility.

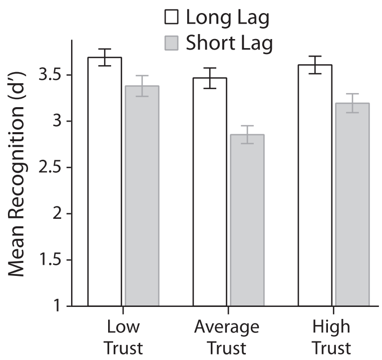

Fig. 2. Experiment 1 results: Participants’ average recognition (d') of faces in both full (long lag) and reduced attention (short lag) conditions according to face type (high-, average- or low-trustworthiness). Error bars indicate +/−1 SEM.

Contrary to prediction, however, salient faces did not receive enhanced pre-attentive processing. The finding, that faces eliciting more extreme social judgments (both positive and negative) are better recalled than those of more average ratings, supports the idea that such social utility judgments enhance memory for these stimuli (Singer et al., 2004). However, appearance-based social utility attributions are not sufficient to alter pre-attentive processing, as evidenced by their failure to attenuate the attentional blink. This suggests that insofar as appearance-based judgments about, for example, an interaction partner's trustworthiness affect social decision-making (e.g., Schlicht et al., 2010; van't Wout and Sanfey, 2008), they do so via other channels than attentional biasing. We note, however, that in our sample, as in others' (e.g., Todorov et al., 2008), social judgments such as attractiveness, friendliness and trustworthiness differ across faces as a single factor. We therefore cannot rule out the possibility that other social judgments contributed to the memory effect.

3. Experiment 2

Although appearance-based social judgments influence behavior towards social partners, sound social decisions require a great deal more information than that conveyed by appearance alone. For example, it is unwise to make important decisions, such as choosing a babysitter, without any knowledge or experience of an individual's behavior. Thus, when no other information is available, social decision-making may rely on appearance-based social judgments. However, as behavioral information becomes available decisions should shift to reflect experience, rather than appearance, as behavior is a more reliable indicator of a person's true social utility than appearance (Chang, Doll, van't Wout, Frank, & Sanfey, 2010; Rudoy & Paller, 2009; Singer et al., 2004). Therefore, Experiment 2 examined social judgments based on an experienced history of behavior.

To generate behavior-based trustworthiness differences, we used a multiple-round investor–trustee game (Berg, Dickhaut, & McCabe, 1995) to familiarize participants with a set of faces. The trained faces served as stimuli in an AB task similar to that in Experiment 1. We predicted that behavioral experience with a partner would shape both recognition and the allocation of attention in the AB paradigm. Specifically, we anticipated that in the full attention trials, faces with both positive and negative behavioral histories (e.g., fair and unfair players in the game) would be better recognized than faces that provided no behavioral feedback during the task (neutral faces). However, on reduced attention trials, behavioral history would bias attention, such that trustworthy faces would overcome the attentional blink (Anderson et al., 2011; Raymond & O'Brien, 2009).

3.1. Method

3.1.1. Participants

Forty-one undergraduate psychology students (14 male, mean age = 21.10 SD = 4.76) participated in the study for course credit and a small monetary bonus, dependent on their earnings in the investor–trustee game.

3.1.2. Stimuli

Experiment 2 used 36 face stimuli (18 males), pre-rated as similar and average in trustworthiness (these included the 24 average-trustworthiness faces from Experiment 1). Abstract images and masks were the same as in Experiment 1.

3.1.3. Procedure

In a multi-round investor–trustee game, participants played the role of the investor with 12 randomly selected faces (6 male) as trustees. At the start of each trial, participants received an endowment of nine points. They then viewed a centrally presented image of the trustee and chose how much of their endowment they wished to invest. The investment matured (tripled), and a feedback display informed participants about the number of points the trustee had returned. Participants played 6 blocks of 50 trials (300 total; 25 trials per face in random order).

Four trustees were randomly assigned to play fairly (2 male), four unfairly (2 male) and four were neutral (2 male). Fair trustees always returned a randomly chosen amount between 40% and 70% of the matured investment, which was always greater than the initial investment amount and consequently defined as fair behavior. Unfair trustees always returned between 0% and 30%, which was always less than the initial amount invested, and thus constituted economically unfair behavior. The exact return percentage was randomly chosen on a round-to-round basis from a uniform distribution. On average, fair players returned 52% of the matured investment (SD = .05) and unfair players returned 13% (SD = .07). Neutral trustees always displayed 'this is a no feedback trial' instead of an investment return. Trustees remained consistently fair, unfair or neutral across all task blocks. To increase participants' motivation to play in an economically advantageous way, participants' knew they would receive a monetary bonus based on their earnings at the end of the experiment.

After the investor–trustee game participants completed the same AB task as in Experiment 1, to assess whether trustee behavior altered the allocation of attention. In this version of the AB task, the 'familiar' T2 stimuli were the 12 faces from the investor–trustee game. The novel T2 faces were the 24 average-trustworthiness face images that had not been included in the game. At the end of the AB task participants completed the BIS/BAS questionnaire (Carver & White, 1994) to assess the degree to which they reported behavioral sensitivity to rewards and punishments in the environment.

3.2. Results

To assess learning in the investor–trustee game we calculated the average of the first five and last five investments to each face (early and late investments, respectively). A 2×3 repeated measures ANOVA with investment average as the dependent variable and investment time (early or late) and trustee behavior (fair, neutral or unfair) as within-subjects variables, showed that participants learned trustee behavior and significantly changed their investments over time, $F(2,80) = 80.92$, $p < .001$, $\eta_p^2 = .67$. Post hoc comparisons showed increased investments to fair playing trustees, $t(40) = 6.73$, $p < .001$, and decreased investments to unfair playing trustees, $t(40) = -8.66$, $p < .001$. However, investments to neutral trustees decreased for the group as a whole, $t(40) = -4.69$, $p < .001$, but increased for some participants, suggesting that some participants' judgments of the 'neutral' trustees were not actually neutral. In order to understand the differences in participants' responses to the neutral trustees, we correlated BIS/BAS scores with investment behavior towards these trustees. Interestingly, we found that the more strongly participants reported being driven to seek rewards and being sensitive to rewards generally, the more they increased their investments to the neutral trustees (drive: $r = .37$, $p = .02$; reward responsiveness: $r = .36$, $p = .02$). This suggests that the more reward-focus participants reported, the more likely they were to treat the neutral faces positively, even though there was no information about financial gains on these trials.

Due to time constraints, participants did not rate the faces for trustworthiness after the task. However, data from a pilot sample of 28 participants showed that investments to the neutral (no feedback) trustees strongly correlated with post-game ratings of those trustees ($r = .55$, $p = .002$). Participants who reduced their investments to the neutral trustees by more than 1.5 points from the early to the late investments rated them as negative ($M = 3.16$, SD = 0.86). Those who increased their investments to the neutral trustees by >1.5 points rated them as positive ($M = 5.25$, SD = 1.03). Participants whose investments did not change toward the neutral trustees continued to rate them as neutral ($M = 4.4$, SD = 1.65). This suggests that investment behavior is a good proxy for ratings. Therefore, we classified neutral trustees on a participant-by-participant basis as fair, neutral or unfair depending on each participant's change in investment toward the trustee. Using the differences between the early and late investments to measure change, we classified faces to whom participants increased their investments by >1.5 points as fair; faces to whom investments decreased >1.5 points as unfair; and faces to whom investments changed by less than 1.5 points as neutral. After this recoding, neutral trustees were divided between fair ($M = 0.44$, SD = 0.75), unfair ($M = 1.87$, SD = 1.26) and neutral ($M = 1.69$, SD = 1.03) conditions. Importantly there were no differences in the numbers of each trustee type after recoding, $p = .11$.

To determine AB task results based on trustee values, we used the same signal detection approach as in Experiment 1. We calculated d' as a measure of the sensitivity of recognition performance for each face type (fair, neutral, and unfair) at each lag condition (short and long). Only trials in which participants correctly identified the T1 stimulus ($M = 90.80\%$, SD = 7.48%) were used in analyses.

As Fig. 3 shows, an attention condition (full or reduced) by trustee behavior (fair, neutral or unfair) repeated measures ANOVA showed that participants' recognition accuracy was generally better for full attention (long-lag) trials compared to reduced attention (short-lag) trials, $F(1,40) = 17.46$, $p < .001$, $\eta_p^2 = .30$. However, there was also a main effect of trustee behavior, $F(2,80) = 13.33$, $p < .001$, $\eta_p^2 = .25$, such that fair trustees were recognized better than unfair or neutral trustees (p-values < .01). There were no differences in recognition of unfair and neutral partners ($p = .14$). This suggests that behavior-based social utility attributions affect the recognition of social stimuli. The attention-condition by trustee behavior interaction approached significance, $F(2,80) = 2.69$, $p = .07$, $\eta_p^2 = .06$, suggesting that trustee behavior shaped trustee utility judgments such that fair trustees captured attention to a greater degree than did neutral and unfair trustees.

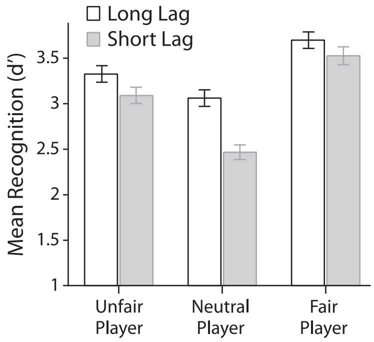

Fig. 3. Experiment 2 results: Participants' average recognition (d') of faces in both full (long lag) and reduced attention (short lag) conditions according to return strategy (unfair, neutral or fair) in the investor–trustee task. Error bars indicate +/−1 SEM.

As predicted, paired samples t-tests confirmed the presence of an attentional blink for both unfair ($t(40) = 2.01$, $p = .05$) and neutral trustees ($t(40) = 5.44$, $p < .001$) but not for fair trustees ($t(40) = 0.96$, $p = .35$), suggesting that the images of fair trustees were pre-attentively processed. That is, the appearance of a fair trustee within a rapid series of images overcame the attentional blink, thereby facilitating perceptual recognition, even when attentional resources were otherwise engaged.

3.3. Discussion

These results showed that judgments based on behavioral experience alter the involuntary allocation of attention to social stimuli. Specifically, trustees who acquired positive social values in the investor–trustee game were better recognized in both the full and reduced attention conditions, compared to partners with acquired neutral and negative social values. Indeed, participants showed no attentional blink for the trustworthy faces. This result opposes the frequently expounded idea that people should allot more attention to untrustworthy individuals due to their potential to cause harm (Cosmides & Tooby, 2000). Rather, these results suggest that a stimulus's potential benefits alter pre-attentive processing thereby biasing attention towards trustworthy faces. These results have important implications for understanding how the behavioral signals people send shape attention distribution in social environments.

4. General discussion

Together, these results show two important things. First, people who elicit strong social impressions, both positive and negative and regardless of whether these judgments are based on appearance or behavior, are more recognizable. Second, social utility judgments must be based on behavioral experience to alter pre-attentive processing. In Experiment 1, appearance-based social utility judgments, affected face recognition such that faces provoking stronger or more salient judgments (both positive and negative) were better recognized than those with average values. However, when constraints were placed on attention, appearance-based social utility judgments did not reduce the size of the attentional blink. Conversely, when people made social utility judgments based on a behavioral history, these learned judgments led to better recognition of high utility faces, regardless of limits on attention. These results suggest that learned social utility, from cues integrated over time, shapes both interpersonal judgments and the pre-attentive processing of specific social stimuli.

One implication of this research is that appearance-related trait judgments are unlikely to markedly alter how people allocate attention and gather information in social settings. That is, although people may make strong appearance-based judgments (Hassin & Trope, 2000), these appear to affect social decisions at later time-points when cognition is conscious, rather than at pre-conscious processing stages. Because conscious cognition may be more easily modified by controllable mechanisms (Corbetta & Shulman, 2002), people may have more cognitive control over this type of appearance-based social stereotype than previous research implies (Bargh & Williams, 2006).

Importantly, despite the fact that the faces in Experiment 1 differed slightly in physical characteristics, we do not believe that our results were driven by lower-level visual differences between these stimuli. Our image analysis only showed differences in low-level image characteristics between male and female faces, both of which were present in the task. However, male and female faces were equally well recognized and all faces were equally familiar. Thus, the recognition advantage for high- and low-trustworthy faces likely depends on social judgments, rather than on any physical differences in the faces themselves.

Interestingly, when social utility judgments were based on behavioral history, rather than appearance, it was positive judgments that shaped the allocation of attention. In this case, learned positive judgments both eliminated the attentional blink and enhanced recognition under the full-attention condition. This result is consistent with a value-based account of attentional processing (Anderson et al., 2011; Raymond & O'Brien, 2009) and contrasts with accounts predicting that untrustworthy faces should capture attention (e.g., Winston, Strange, O'Doherty, & Dolan, 2002). One explanation for how this early processing bias may occur is that reinforcement learning processes may modulate selective attention and thus guide learning of perceptual characteristics (Roelfsema et al., 2010). According to this model, positively valued faces receive more attention and thus their perceptual characteristics should be preferentially learned, compared to negatively valued faces.

These results lend support to the idea that it is goal-related or motivationally salient stimuli that capture attention rather than emotionally negative stimuli (Raymond & O'Brien, 2009). To maximize gains in the investor–trustee game it was equally important to learn which faces would give fair and unfair returns – and participants did indeed learn how to invest with both types of players. However, in the AB task fair faces captured attention better than unfair ones especially under conditions in which attention was limited. This suggests that even when facial trustworthiness is irrelevant to the task, the most salient faces are those with highest social utility. Judgments of social utility may therefore bias the attention allocation in social environments toward high-utility individuals, but only if this value is acquired from behavior. When social utility judgments depend on potentially inaccurate appearance-based data, they do not have the power to highjack attentional resources.

One alternative explanation for the differences in recognition across the two tasks is that greater encoding of the faces may have occurred during the behavior-based task, in which behavior and identity were clearly linked, compared to the appearance-based task, in which simple pattern matching was sufficient for face familiarization. However, despite this potential difference in encoding level across the tasks, we saw similar degrees of recognition for the high and low trustworthy faces in the full attention condition regardless of task. This suggests that even with potentially reduced levels of facial encoding in the appearance-based task, appearance-based trustworthiness was still a salient stimulus feature, even if it was not sufficient to overcome the attentional blink.

One limitation of the Experiment 2 results is that we cannot disentangle the social and monetary values of our stimuli. That is, fair trustees' higher financial values may have biased attentional processing. However, evidence suggests that value computations are relative, rather than absolute (Lim, O'Doherty & Rangel, 2011; Tremblay & Schultz, 1999). Thus, equalizing the faces according to absolute returns (e.g., by enforcing higher investments to unfair faces) is unlikely to have altered the results, as these unfair returns would still have been perceived as losses. Moreover, by enhancing loss size, the value difference between fair and unfair trustees would likely have been amplified. Finally, contrary to previous research (Raymond & O'Brien, 2009), we found that valence mattered in the full-attention as well as in the reduced attention conditions. This suggests that social utility based on behavioral experience is different from that based solely on financial value and influences perceptual recognition even when attention is fully available. To test this idea, we are currently investigating how trustworthiness based on other types of behavioral experience (e.g., deception and honesty, independent of gains/losses) alters social judgment and pre-attentive processing, thereby decoupling social from financial value.

4.1. Conclusions

Social environments are complex and social partners provide many appearance- and behavior-based cues that can change from moment-to-moment. Social interactions, especially those consisting of multiple partners, contain more information than people are able to process (Foulsham et al., 2010). Therefore, they must selectively choose who to attend and who to ignore at each moment in time. This research suggests that in such environments the unconscious allocation of attention will be biased toward interaction partners with whom one has a positive behavioral history. Ultimately, this means that some interaction partners will automatically garner more attention than will others – and that the cues non-attended partners send may be ignored, leading to bias in the acquisition of social information and thereby influencing people's ability to make social decisions at a fundamental level.

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