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Orientation of attention to nonconsciously recognised famous faces

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The nonconscious orientation of attention to famous faces was investigated using masked 17 ms stimulus exposure. Each trial presented a simultaneous pair of one famous and one unfamiliar face, matched on physical characteristics, one each in left visual field (LVF) and right visual field (RVF). These were followed by a dot probe in either LVF or RVF to which participants made a speeded two-alternative forced-choice discrimination response. Participants subsequently evaluated the affective valence (good/evil) of the famous persons on a 7-point scale. Higher accuracy of dot probe discrimination in the same visual field (VF) as the famous face suggested that attention was oriented towards faces of persons evaluated ''good'', but a reverse orientation effect was observed for those evaluated ''evil''. The awareness check presented the same face pairs under the same conditions, and participants were at chance in a task of selecting the famous face in each pair. The results suggest that famous faces can be identified without awareness, and that attention is attracted by the faces of famous persons not regarded as ''evil''.

There is much evidence that facial expressions can be detected preconsciously and can influence psychophysiological and behavioural responses without awareness (e.g., Dimberg & Ohman, 1996; Dimberg, Thunberg, & Elmehed, 2000; Johnsen & Hugdahl, 1991, 1993; Mogg & Bradley, 1999; Murphy & Zajonc, 1993; Niedenthal, 1990; Ohman, Esteves, & Soares, 1995; Robinson, 1998; Saban & Hugdahl, 1999; Whalen et al., 1998; Wong, Shevrin, & Williams, 1994). All of these studies presented masked faces for very brief exposure duration (target-to-mask stimulus onset asynchrony—SOA—of less than 35 ms). Participants were at chance in two-alternative forced-choice tasks of identifying the expression, confirming the absence of awareness.

Mogg and Bradley (1999) investigated the orienting of attention towards facial emotional expressions without awareness. Two masked 14 ms facial

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photographs of the same person were displayed simultaneously, one each in LVF and RVF, with one face displaying an emotional expression, either happy or angry, and the other a neutral pose. These were followed by a dot probe in either the LVF or RVF to which participants made a speeded two-alternative forced-choice response. Mogg and Bradley (1999, experiment 3) reported that participants' attention was oriented towards angry faces but not towards happy faces, and interpreted their result as preconscious detection and orientation of attention to potentially threatening facial expressions.

The nonconscious recognition of facial emotional expressions is often interpreted in terms of the importance to the individual of detecting the emotion of others. Many stimuli in the environment are scanned and identified preconsciously, and only those with the greatest salience are prioritised for attentive processing. Robinson (1998) reviewed a wide variety of experiments on the nonconscious perception of facial emotional expressions and theorised the existence of a preconscious mechanism, which he termed the ''valence detector'': This mechanism responds to any emotionally valenced stimulus and results in the orientation of attention towards the stimulus. The question arises of whether facial identities, like facial expressions, can attract attention without awareness. It would seem plausible that a known face is more salient than an unknown face and therefore more likely to attract attention.

The present study used a procedure based on Mogg and Bradley (1999). Masked 17 ms faces were presented in simultaneous pairs of a famous and an unfamiliar face, matched on physical characteristics. One face was presented in the LVF and the other in the RVF. These were followed by a dot probe in either LVF or RVF to which participants made a speeded two-alternative forced-choice discrimination response. The logic was that if facial identity can be detected preconsciously, the famous face in each pair would attract attention more than the unfamiliar face. Then the speed and/or accuracy of responses should be higher to a dot probe in the same VF as the famous face compared to the opposite VF.

A separate awareness check task was performed after the attention orientation task to investigate whether participants might have been aware of any of the masked faces. The same masked 17 ms famous-unfamiliar face pairs were presented simultaneously, one face in each visual field, while participants attempted to select the famous face. A level of accuracy not above chance would support the claim that faces were not consciously perceived. Two experiments using this awareness check task have been reported in Stone and Valentine (2004). The task was performed as described, and then the famous persons were evaluated by the experimental participants as ''good'' or ''evil'' (experiment 1) and liked or disliked (experiment 2). Thus, each trial presented either a good/liked-unfamiliar pair, or an evil/disliked-unfamiliar pair of faces. Performance in discriminating famous from unfamiliar faces was at chance, but accuracy was lower for evil/disliked faces than for good/liked faces. In experiment 2, accuracy was below chance for disliked faces and above chance for liked faces. The same result was observed in the analysis by items: Participants who evaluated a famous person as disliked selected this face with below chance accuracy, but participants who evaluated the same person as liked selected the face with above chance accuracy. This suggests the possibility that faces of famous persons regarded as good/liked may attract attention while the faces of famous persons regarded as evil/disliked do not. Experiment 1 of Stone and Valentine (2004) was the awareness check for the third group of participants in the present experiment.

Stone, Valentine, and Davis (2001) had previously reported that responses to famous faces perceived without awareness differed according to valence. Experiment 1 found that skin conductance responses to masked 17 ms faces were higher to the faces of famous persons subsequently evaluated ''good'' than to the faces of persons evaluated ''evil'', but did not distinguish between famous and unfamiliar faces. (Responses tended to be higher to good faces than to unfamiliar faces, but tended to be lower to evil faces than to unfamiliar faces.) This suggests the possibility that evil faces are processed somehow differently, maybe to a lesser extent, than good faces, which in turn suggests the possibility that evil faces do not attract attention. When faces were exposed for 220 ms, a duration that permits conscious recognition, there was an effect of familiarity but no effect of valence: Skin conductance responses were higher to famous faces than to unfamiliar faces with no difference between ''good'' and ''evil'' faces. Responses were above chance accuracy in a two-alternative forced-choice of ''good'' or ''evil'' to masked 17 ms faces that were not consciously recognised (experiment 3).

From the above review, it seems that three different predictions could be made concerning the orientation of attention to famous faces. Mogg and Bradley (1999) suggest that attention is oriented only to potentially threatening faces, and that might imply orientation only to faces of famous persons subsequently evaluated as ''evil''. On the other hand, Robinson's (1998) proposed valence detection mechanism suggests that attention should be oriented to all valenced faces, that is, to all famous faces in preference to unfamiliar faces. Finally, the results of Stone and Valentine (2004) and Stone et al. (2001), with the possible interpretation that evil faces do not attract attention, might predict orientation only to ''good'' faces, with a different effect for ''evil'' faces.

METHOD

There were three separate groups of participants who performed the experiment with specific variations in the experimental procedure. These will be described below.

Participants

The first group of 45 participants comprised 29 undergraduate students of the Goldsmith's College Psychology Department, and 16 visitors to the Science Museum, London. No participants scored above chance in the awareness check (binomial distribution, one-tailed, cut-off at 67%, alpha = .05). The second group of participants comprised 41 undergraduate students of the Goldsmith's College Psychology Department. One participant's data were excluded from the analysis for above chance performance in the awareness check (binomial distribution, one-tailed, cut-off at 67%, alpha = .05) since for this participant the possibility of some awareness cannot be ruled out. In addition, two participants' data were lost due to failure to follow instructions. The third group of participants comprised 34 students, staff, and visitors at Goldsmiths College, London. The majority, around 90%, were not psychologists. No participants were excluded from the analysis for scoring above chance in the awareness check (binomial distribution, one-tailed, cut-off at 65%, alpha = .05). However, because the number of stimuli was reduced from 18 to 10, data were excluded from 7 participants who failed to identify a minimum of 8 faces, with 2 evaluated good and 2 evaluated evil, in the postexperimental rating task. The first group of 45 participants were aged between 18 and 51; mean 24.1, *SD* 8.7 years. The second group of 38 participants were aged between 18 and 30; mean 21.9, *SD* 3.4 years. The third group of 27 participants were aged between 20 and 51; mean 27.2, *SD* 7.5 years.

None of the participants had taken part in the preexperimental rating tasks. All of the participants were required to have been resident in the UK for a minimum of 10 years by self-report to ensure an acceptable level of familiarity with the famous faces used in the experiment.

Stimuli

Photographs of famous and unknown faces of a uniform quality were digitised to produce images of 16 greys, 150 × 200 pixels in size. A set of 18 famous faces were selected, such that each displayed a frontal pose with a near-neutral expression and the direction of eye gaze pointing directly to the camera. An unknown face was chosen to pair with each famous face such that the two faces were of the same sex, race, and approximate age, and the photographs depicted a similar pose and facial expression. For the third group of participants, the stimulus set was reduced to the 10 famous faces that were most frequently correctly identified by the participants in the first two groups, in order to shorten the experimental procedure. The names of the famous persons are given in Appendix 1, and examples of the stimuli and the mask are given in Appendix 2.

The famous and unknown faces were rated for distinctiveness on a 7-point scale derived from Moore and Valentine (1998). The raters were a separate group of 10 undergraduates from overseas, resident in the UK for less than five years, chosen to minimise the possible influence of face familiarity on the distinctiveness rating: Overseas students were expected to have had less exposure to the famous faces. There was no difference between the famous faces and their matched unfamiliar faces, $t_{items}(17) = 1.74$, n.s..

Photographs were selected with facial expressions as near neutral as possible, but good quality photographs could not always be obtained with perfectly neutral facial expressions. To ensure that facial expression was not confounded with familiarity, the expressions were rated by 11 raters on a 7-point scale ranging from -3 (very negative) through 0 (neutral) to +3 (very positive). There was no difference between the famous faces and their matched unfamiliar faces, $t_{items}(17) = 0.85$, n.s..

The mask was a collage of parts of unfamiliar faces, of the same size as the famous and unfamiliar faces. The dot probe was either ''**..**'' or ''**:**'' (two horizontal dots or two vertical dots) and participants were required to perform a discrimination task, pressing one of two keys to indicate the type of dot probe.

Apparatus

A personal computer running MEL2 software was used to display the faces at a 640 × 480 screen resolution. Response times and accuracy of response were measured and recorded by the computer.

Design

For the dot probe attention orientation task there were three independent within-participant factors: valence of famous person (evaluated by experimental participants), famous face VF (LVF vs. RVF), and dot probe VF (LVF vs. RVF). The dependent variables were speed and accuracy of response to the dot probe. Each face pair was presented eight times, once for each combination of face VF × probe VF × probe type. Thus, for participants in the first and second groups, there were a total of 144 trials (8 combinations of 18 face pairs), and for participants in the third group, there were 80 trials (8 combinations of 10 face pairs). Face pairs were presented in a different random sequence for each participant.

In the awareness check, there were two within-participant factors of valence and visual field of famous face. The dependent variable was accuracy of response; a correct response was the selection of the visual field in which the famous face had been presented. For participants in the first and second groups, each face pair was presented twice, once with the famous face in each VF, for a total of 36 trials; for participants in the third group, the number of trials was increased from 36 to 40 with each famous face appearing twice in each VF. Face pairs were presented in a different random sequence for each participant.

For both tasks there was one between-participant factor of participant group (three separate groups of participants performed the experiment with specific variations in the experimental procedure).

Stone et al. (2001) suggested that very few faces could be recognised when presented for 17 ms with a mask similar to that used in the present experiment. In that study, faces were presented singly and centrally, and it was expected that conscious identification would be even less likely with faces presented off-centre in simultaneous pairs.

Procedure

Participants carried out the tasks individually in a darkened, air-conditioned room. The attention orientation (dot probe) task was performed before the awareness check task. In both tasks, the two faces were approximately 4.5 cm by 6 cm and were presented at a distance of 9 cm apart, subtending a visual angle of approximately 4° from fixation. The masks were presented in the same screen position as the faces.

In the attention orientation task, participants were required to perform a discrimination: The dot-probe was either ‘‘**..**’’ or ‘‘**:**’’ and the response was made by pressing one of two keys on a keyboard to indicate which type of dot probe had appeared. The basic trial procedure was the same for all participants and is illustrated in Figure 1. The sequence of events on each trial was as follows: central fixation cross for 500 ms, forward masks for 500 ms/100 ms (groups 1–2 and group 3, respectively), famous and unfamiliar face for 17 ms, backward masks for 500 ms/100 ms (groups 1–2 and group 3, respectively), dot

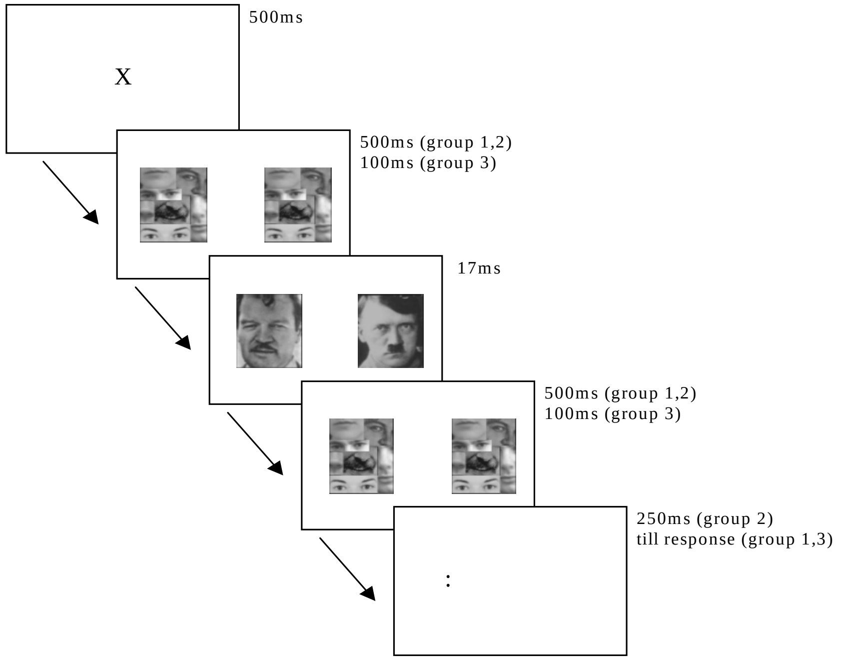

Figure 1. Illustration of the procedure for each trial in the attention orientation task.

probe in a location corresponding to the centre of one of the faces. Thus, the total SOA between the onset of the faces and the onset of the probe was 517 ms/ 117 ms (groups 1–2 and group 3, respectively). The dot probe was displayed either until a response was made or for only 250 ms (groups 1 and 3 vs. group 2, respectively).

Data from the first group of participants showed statistically significant effects of attention orientation in the error data but not in the response times. The second group of participants were presented with a dot probe that remained visible for only 250 ms, intended to encourage faster responding. It was hoped that this would result in lower variation in response times and so increase the prospect of finding a statistically significant effect of attention orientation on response times. Statistically significant effects were still apparent on errors and not on response times, so for the third group of participants, the backward mask duration was reduced from 500 ms to 100 ms, also designed to facilitate detection of a significant effect of attention orientation on response times. This was based on the consideration that the original duration of the backward mask, 500 ms, was relatively long compared to Mogg and Bradley (1999) who used 14 ms, 136 ms, and 68 ms in experiments 1, 2, and 3. Posner and Cohen (1984) reported evidence on the timing of attention orientation towards a peripheral stimulus. They found that attention is oriented towards a peripheral cue stimulus at about 100 ms after cue stimulus onset, shown as facilitation of responses to a target stimulus in the cued peripheral location. However, after around 300 ms, if attention is summoned back to a central location, there is inhibition of responses to a target stimulus in the peripheral cued location. Muller and Rabbitt (1989) broadly agree with these approximate timings while Bachmann (1997) cites 60–150 ms as the optimum cue-to-target SOA to produce attention orientation leading to facilitation of reaction time and accuracy of responses to the target. In participant groups 1 and 2, it is quite possible that attention had returned to the centre before the dot probe onset, because there was an equal probability of the dot probe in either visual field. Hence, the 500 ms duration of the backward mask may have meant that the dot probe appeared during the period when detection of a target in the peripheral cued location was inhibited rather than facilitated. In the experiment reported by Lambert and Sumich (1996) this inhibitory effect was strong in comparison to the desired experimental effect. Driver et al. (1999) point out that the process of encoding a facial stimulus will also require some duration. The timings reported by Posner and Cohen (1984) were in relation to simple peripheral flashes of light and so timings involving more cognitively complex stimuli may be extended. Nevertheless, it does appear that a 500 ms backward mask may have hampered detection of a significant effect on response times in the present experiment. Consequently, the duration of the backward mask was reduced to 100 ms for participants in group 3.

The response time was calculated from the onset of the dot probe. The intertrial interval was 1 second and each trial was initiated by the response to the preceding trial. Participants were informed that before each dot probe two faces would be flashed up very briefly, one on either side of the screen, preceded and followed by a mask comprised of a collage of parts of unfamiliar faces. Participants were told they would find it very difficult to see the real faces and this should be no cause for concern, but they should attend carefully to the screen, wait for the dot probe and respond. Participants were asked to look at the central fixation cross before each trial and to respond as quickly and accurately as possible.

Stimulus presentation was the same in the awareness check but no dot probe was presented. Instead, the question ''left or right?'' appeared until a response was made: To the left of the keyboard to indicate the famous face in the LVF, and to the right of the keyboard to indicate famous face in the RVF. Each trial was initiated by the response to the previous trial after an intertrial interval of 1 second. Participants were informed that two faces would be displayed simultaneously on the right and left of the screen, preceded and followed by a mask, exactly as in the dot probe task. Participants were informed that each pair of faces would contain one famous person and one unfamiliar person, and were asked to detect on which side of the screen the famous face had appeared. Participants were asked to look at the central fixation cross before each trial and to respond as accurately as possible.

After the awareness check, participants were asked whether they had been able to recognise any of the faces displayed during the experiment. They were also asked to estimate their accuracy in the awareness check between 50% (chance performance) and 100% (perfect accuracy); this question was omitted for the third group of participants, since there was no relationship between actual and estimated accuracy for participants in the first two groups. Then they were shown the famous faces used in the experiment, one at a time, and asked to identify each face and to evaluate the affective valence of the person on a 7-point scale (-3 = evil/threatening, 0 = neutral, +3 = good/inviting) considering the participant's knowledge of the famous person. Finally, participants were debriefed and thanked for their participation.

RESULTS

Where a participant could not uniquely identify a face this combination of participant and item was excluded from the analysis (15.3% of trials). To anticipate the results, there were no consistent differences between famous faces presented in the LVF and the RVF. Therefore, the two factors of famous face VF and dot probe VF were collapsed into a single factor of dot probe location (same VF as famous face vs. opposite VF). In the awareness check, there was a single factor of valence.

Faces were categorised according to the participants' own evaluations into ''evil'' (rating of -3 or -2), ''neutral'' (rating of -1 or 0), and ''good'' (rating of 1, 2, or 3). A symmetrical categorisation would have placed faces with a rating of 1 into the neutral category. The decision was taken to categorise the faces as described because this yielded balanced proportions of ratings in the three categories. In turn, this protected the sample size, because a participant had to be excluded from the analysis if no famous persons were placed into any of the three categories. Two participants were excluded from group 1, two were excluded from group 2, and three were excluded from group 3. Thus, remaining sample sizes were 43, 36, and 24 in groups 1, 2, and 3, respectively (total $N =$ 103).

Awareness check

The mean accuracy of responses was calculated for each participant, a correct response being selection of the VF in which the famous face had appeared. Only six participants claimed to have been able to detect facial familiarity in the awareness check and these participants selected the famous face on 49.1% of trials. Actual accuracy was not significantly correlated with participants' estimated accuracy, $r(78) = -0.15$, n.s., (some participants had no estimated accuracy), suggesting that participants lacked insight into their own performance. The mean accuracy of responses was 49.79% which did not differ from chance in a one-sample t-test, $t(102) = -0.26$, n.s..

Dot-probe response time analysis

Incorrect responses to the type of dot probe (5.2% of trials) were excluded, as were responses defined as outliers in a boxplot (5.1% of trials). Analysis of variance (ANOVA) was performed with two within-participant factors of valence (evil, neutral, and good) and dot probe location (same vs. opposite VF as famous face), and one between-participant factor of dot probe duration (response-terminated vs. 250 ms). The only factor to reach significance was the main effect of dot probe duration, $F(1, 101) = 206$, $p < .001$, showing faster responses following the 250 ms dot probe than following the response-terminated dot probe. All other effects were non significant, all Fs < 1.

Dot probe error analysis

ANOVA was performed with the same factors as the analysis of response times. There was a significant main effect of dot probe duration, $F(1, 101) = 11.0$, $p <$ .005, showing more errors to the 250 ms dot probe than to the response-terminated dot probe, moderated by a significant interaction of dot probe duration with dot probe location, $F(1, 101) = 6.99$, $p < .01$. There was a significant interaction of dot probe location with valence, $F(2, 100) = 5.63$, $p < .01$, and simple contrasts revealed that the effect of dot probe location differed between good and evil faces, $F(1, 101) = 9.34$, $p < .005$, and between neutral and evil faces, $F(1, 101) = 7.68$, $p < .01$, but not between good and neutral faces, $F < 1$. All other effects were nonsignificant, all Fs < 1.6, $p > .2$. The two significant interactions were investigated separately.

Regarding the interaction of dot probe duration with dot probe location, paired-samples t-tests with alpha set to .025 revealed that the response-terminated dot probe resulted in a tendency to more errors in the opposite VF than in the same VF as the famous face, $t(66) = 1.96$, $p < .06$, while the 250 ms dot probe resulted in a tendency to more errors in the same VF, $t(35) = 1.77$, $p < .09$. When the dot probe was presented in the same VF as the famous face, more errors were made to the 250 ms dot probe than to the response-terminated dot probe, independent samples, $t(101) = 4.26$, $p < .001$, but when the dot probe was presented in the opposite VF, there was no difference between the 250 ms dot probe and the response-terminated dot probe, $t(101) = 1.02$, n.s.. See Figure 2. It appears that there were more errors to a 250 ms dot probe in the same VF as the famous face than in the other conditions.

To investigate the interaction of dot probe location with valence, two separate analyses were performed on evil faces and on good + neutral faces (good and neutral faces were analysed together because simple contrasts had revealed no difference between these faces). A paired samples t-test on the evil faces revealed more errors to dot probes in the same VF as the famous face, $t(102) = 2.53$, $p < .02$. ANOVA on good and neutral faces revealed a main effect of dot probe location, $F(1, 102) = 5.34$, $p < .025$, showing fewer errors to a dot probe in the same VF as the famous face than in the opposite visual field. No other effects were significant. It appears that attention was oriented towards good and neutral faces but there was a reverse orientation effect for evil faces.

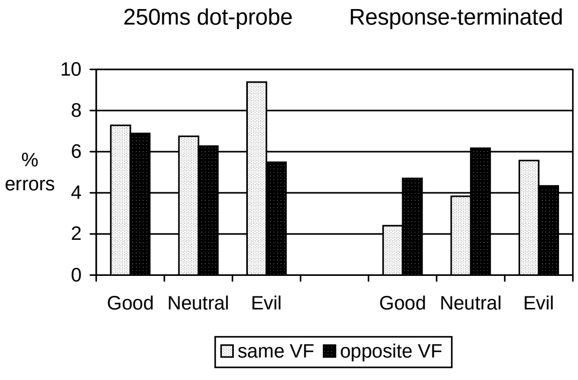

Figure 2. Mean percentage of errors to dot probes in the same and opposite VF to the famous face, for evil, neutral, and good faces, for the 250 ms dot probe and the response-terminated dot probe.

TABLE 1
Dot probe attention orientation task: Means (and standard deviations)

	Good		*Neutral*		*Evil*	
Dot probe duration	*Same VF*	*Opposite VF*	*Same VF*	*Opposite VF*	*Same VF*	*Opposite VF*
250 ms	7.38	6.89	6.75	6.27	9.38	5.49
(N = 36)	(6.6)	(7.1)	(6.8)	(7.8)	(7.8)	(7.1)
Response-term	2.40	4.70	3.83	6.17	5.57	4.34
(N = 67)	(4.2)	(6.3)	(5.1)	(6.9)	(7.4)	(6.5)

Note: Percentage of errors to dot probes in the same and opposite VF to the famous face, for evil, neutral, and good faces, for the 250 ms dot probe and the response-terminated dot probe.

Item analysis

The conclusion that this pattern of results was due to participants' attitude towards the famous persons is dependent on the assumption that there were no systematic physical differences among the evil, neutral, and good faces. There was some agreement among participants about the valence of each famous person, so the sets tended to comprise systematically different faces. To verify that the responses were moderated by valence it is necessary to perform a within-items analysis.

ANOVA was performed with two within-item factors of valence (evil vs. good + neutral) and dot probe location. One face was never evaluated as evil and was excluded. The two-way interaction was significant, $F(1, 16) = 6.97$, $p < .02$. Paired samples t-tests investigated the effect of dot probe location separately for evil faces and good + neutral faces, with alpha set to .025. For evil faces, the tendency was for more errors in the same VF as the famous face (same VF mean = 6.91, $SD = 6.1$; opposite VF mean = 4.83, $SD = 4.0$), $t(16) = -1.76$, $p < 0.1$. For good + neutral faces, there were fewer errors in the same VF as the famous face (same VF mean = 4.65, $SD = 2.0$; opposite VF mean = 6.01, $SD = 2.1$), $t(16) = 2.47$, $p < .025$.

The important result in the item analysis is that significantly different effects were observed for the same famous faces depending on whether the famous persons were evaluated as evil or as good + neutral. This confirms that participants responded to the same face in different ways depending on their attitude towards the famous person. In turn, this supports the argument that the difference was due to the attitude and not to any physical properties of the faces or of the photographs.

The possibility was considered that attention orientation to famous faces was due to some physical variation between characteristics of the famous and unfamiliar faces. Perhaps the famous faces were more attention grabbing than the unfamiliar faces for some reason other than their familiarity. The analysis by items argues against this: The same faces resulted in significantly different orientation effects depending on the participants' attitude towards the famous person. In particular, the observation of a tendency to reverse orientation is hard to explain if the famous faces were inherently more likely to attract attention than the unfamiliar faces.

Additional analyses

Good + neutral faces resulted in a significantly different effect of attention orientation compared to evil faces: the former yielded fewer errors in the same VF than in the opposite VF, suggesting orientation of attention towards the famous face, whereas the latter yielded more errors in the same VF, a reverse orientation effect. Response times did not show any effect. The awareness check showed overall response accuracy at chance from participants who lacked insight into their own performance, supporting the conclusion that the famous faces were not consciously recognised.

Three aspects of these results require explanation. First, the contrasting orientation effects for evil faces and for good + neutral faces. Second, the relationship between the relative proportion of errors in the same and opposite VF and the duration of the dot probe. Third, why there were significant effects on errors and not on response times. Three different explanations will be examined in turn: Inhibition of Return, the Attentional Blink, and participants reactions of disgust towards the evil faces.

Inhibition of Return. This explanation suggests that perhaps attention was oriented to evil faces, but was released relatively quickly compared to good and neutral faces, and returned to the centre of the screen in anticipation of the dot probe. Then a dot probe in the same location as the evil face may have been subject to inhibition of return so that responses were less accurate than in the opposite VF. This could explain the reverse orientation effect for evil faces. If this is the case then the reverse orientation effect for evil faces should vary between the 517 ms and 117 ms face-to-probe SOA (participant groups 1 and 2 vs. group 3, respectively). Specifically, the reverse orientation effect should not be apparent at face-to-probe SOA of 117 ms, which is faster than a typical inhibition of return effect (e.g., Bachmann, 1997; Muller & Rabbitt, 1989; Posner & Cohen, 1984). ANOVA was performed on the evil faces with one within-participant factor of dot probe location and one between-participant factor of participant group. The main effect of dot probe location was significant, $F(1, 100) = 6.94$, $p = .01$, but the interaction was not, $F < 1.6$, $p > .2$. This suggests that there was no effect of face-to-probe SOA, which renders the Inhibition of Return explanation unlikely.

Inhibition of Return offers no apparent explanation for the other two aspects of the results: the relationship between the relative proportion of errors in the same and opposite VF and the duration of the dot probe, and why there were significant effects on errors and not on response times. Altogether, it seems unlikely that Inhibition of Return could explain the observed results.

Attentional Blink. The Attentional Blink (AB; Raymond, Shapiro, & Arnell, 1992) refers to the observation that when items are presented in rapid succession, attention to one item, the target, produces interference in the response to a subsequent item, the probe, if the probe is presented within a few hundred milliseconds following the target. That was the case in the present experiment: The faces, equivalent to the target, were followed within a few hundred milliseconds by the dot probe. Raymond et al. (1992) observed a necessary condition for the AB to be that another item, the +1 item, should immediately follow the target. In the present experiment, the backward mask, equivalent to the +1 item, immediately followed the face, so this condition was met. Various models have been proposed to account for the AB (e.g., Chun & Potter, 1995; Jolicoeur, 1998; Potter, Straub, & O'Connor, 2002).

One point of difference between the present experiment and previous research on the AB is that the AB has been observed only when participants were required to report the target (e.g., Raymond et al., 1992). In the present experiment, no response was made to the faces. This difference may be irrelevant when it is considered that the conclusion that participants must be required to report the target was based on the use of letters as stimuli. Single letters are not likely to be regarded as important environmental stimuli, and it seems plausible that single letters would not have attracted much attention without the requirement to report them. Faces, in contrast, are far more salient than single letters. There is considerable evidence that faces are processed for identity in an involuntary way, even when processing of facial identity is detrimental to the task, and even when facial identity can never be brought into consciousness (e.g., De Haan, Bauer & Greve, 1992; De Haan, Young, & Newcombe, 1987a, 1987b; Sergent & Signoret, 1992). It seems clear that the attentional blink requires that the target must occupy attention, but whether this in turn requires that the target must be reported is less obvious, and has not been demonstrated using faces as stimuli.

A second point of difference between the present experiment and previous research on the AB is that targets (faces) in the present experiment were never reported. Relevant to this, Moroni, Boucart, Humphreys, Henaff, and Belin (2000) investigated whether failure to identify the target would eliminate the AB. Two agnosic participants were presented with streams of letters and streams of pictures, and required to identity a target and a later probe. For letters, the AB was equivalent to control participants. For pictures, there was a prolonged AB, irrespective of whether the target was reported or not. Moroni et al. concluded that processing of the target, even when it did not result in identification, nevertheless recruited sufficient attentional resources to produce an AB. Also, Grandison, Ghirardelli, and Egeth (1997) and Seiffert and Di Lollo (1997) reported significantly negative correlation between target identification accuracy and magnitude of the AB on a subsequent probe, that is, participants who identified fewer targets produced a stronger AB. Therefore, in the present experiment, the target faces may have caused an AB, even though they were all presented below the threshold for conscious report.

A third point of difference between the present experiment and most research on the AB is that the dot probe in the present experiment was not itself masked. However, Kawahara, Di Lollo, and Enns (2001) found an AB on the accuracy data for an unmasked probe if the task required identification of a degraded probe rather than merely detection. In the present experiment, the effect was observed on accuracy data for unmasked dot probes, the task required dot probe identification, and the dot probes were hard to identify, consisting of two small dots differentiated only by their spatial relation.

Kristjansson and Nakayama (2002) showed that the AB is not spatially constant. Following the allocation of attention to the target site, discrimination of a probe can be better at locations further from the target site than at locations closest to the target site. They proposed a region around the attended site where attentional resolution is particularly poor, worse than in more distant locations. This could account for the observation of more errors to dot probes in the same VF as an evil face than in the opposite VF on the assumption that the evil face attracted attention and created an AB that was stronger in the same VF than in the opposite VF.

Regarding the first aspect of the results requiring explanation, the AB can explain why the reverse orientation effect was observed for evil faces and a simple orientation effect occurred for good and neutral faces. According to Seiffert and Di Lollo (1997), any operation that increases the difficulty of processing the target will increase the magnitude of the AB. It may also be the case that any factor that increases the importance of target processing will also increase the magnitude of the AB. The evaluated evil character of a famous person might well be such a factor. Then a stronger AB for evil faces compared to good and neutral faces would result from the higher salience of the evil faces. This is analogous with the superior attention holding power of angry faces compared to other facial expressions (e.g., Eastwood, Smilek, & Merikle, 2003; Fox et al., 2000; Fox, Russo, Bowles & Dutton, 2001; Fox, Russo, & Dutton, 2002).

The second aspect of the results requiring explanation is the relationship between the relative proportion of errors in the same and opposite VF and the duration of the dot probe. The AB can offer an explanation for this observation, as follows. All famous faces tended to hold attention so that some time was required to switch attention from the famous face to the dot probe. On some trials, participants had not switched attention from the famous face to the 250 ms dot probe before the latter vanished, resulting in an AB. This is supported by the observation of significantly more errors to the 250 ms dot probe than to the response-terminated dot probe. The tendency for more errors in the same VF as the famous face was due to the greater severity of the AB in the same VF than in the opposite VF (Kristjansson & Nakayama, 2002). With the response-terminated dot probe, participants had more time to switch attention from the famous face to the dot probe, and so the AB was reduced. This resulted in fewer errors overall, and fewer errors in the same VF compared to the opposite VF because of the spatial orientation of attention. This explains why there were more errors to a 250 ms dot probe in the same VF as the famous face but more errors to the response-terminated dot probe in the opposite VF. The AB is particularly compatible with the observation of more errors to a 250 ms dot probe in the same VF as the famous face compared to the other combinations.

Regarding the third aspect of the results requiring explanation, that there was a statistically significant effect of attention orientation on errors but not on response times, the AB, as described above, accounts for this observation. Kawahara et al. (2001) found an AB on the accuracy data for an unmasked probe if the task required identification of a degraded probe rather than merely detection. What still requires explanation is the contrast with the results of Mogg and Bradley (1999) in which statistically significant effects were found on response times. Only a speculative answer can be offered: That famous faces hold attention more strongly than unfamiliar faces with angry expressions, so that an AB occurred in the present experiment but not in Mogg and Bradley (1999), whose results were due simply to the spatial orientation of attention.

Altogether, the AB has explanatory power for all three aspects of the results: (1) the contrasting orientation effects for evil faces and for good + neutral faces; (2) the relationship between the relative proportion of errors in the same and opposite VF and the duration of the dot probe; and (3) significant effects on errors and not on response times. The AB should be considered a plausible account of the present data.

Reactions of disgust towards the evil persons. Participants may have oriented towards the paired unfamiliar face in preference to the evil face. This might seem unlikely on the basis that the face of a person considered to be evil poses significance for the individual, and should therefore be attended. Further, if the evil faces were regarded as potentially threatening then they should have captured and held attention, by analogy with angry facial expressions in the study by Mogg and Bradley (1999). However, it is not clear without specific evidence that the faces evaluated as evil were perceived as potentially threatening. It is possible that participants oriented away from the evil faces in order to avoid an unpleasant emotional experience that the perception of these faces would invoke. This would be consistent with the observations of Stone et al. (2001) and Stone and Valentine (2004), described in the introduction, that evil faces seem to be processed, in some way, to a lesser extent than good faces. Two other possibilities for participants' emotional reactions to the evil faces are disgust and anger-irritation. The set of famous faces included a number of criminals and politicians so reactions of anger-irritation or disgust seem very plausible.

The emotion of disgust serves to protect against physical or psychological contamination by a noxious substance or idea. It motivates avoidance of the object of disgust and turning of attention elsewhere, thus preventing incorporation into the self (e.g., Charash & McKay, 2002; Druschel & Sherman, 1999; Izard, 1977; Levenson, 1994; Nabi, 2002; Newhagen, 1998; Rozin, Haidt, & McCauley, 1999). Disgust has been specifically related to the avoidance of ideas or persons regarded as morally corrupt (Izard, 1977; Nabi, 2002; Rozin et al., 1999). It seems plausible that a person regarded as morally corrupt, for example a criminal, or a person associated with noxious ideas (e.g., a politician) would invoke a reaction of disgust, and that this would result in the orientation of attention away from the face of that person.

Considering anger-irritation, several researchers have reported that anger towards an object results in a tendency to approach the object (Berkowitz, 1999; Buss & Perry, 1992; Carver, 2001; Darwin, 1872/1965; Ekman & Friesen, 1975; Harmon-Jones, 2001, 2003; Izard, 1977; Levenson, 1994; Newhagen, 1998). In addition, Berkowitz (1999) proposed that stimuli having strong associative links to previous anger-arousing experiences are capable of eliciting anger fairly automatically, which supports the orientation of attention without awareness.

It seems plausible that participants' reactions of disgust would lead to orientation away from evil faces, while reactions of anger-irritation would lead to orientation towards evil faces. This can be examined by comparing ratings of disgust and anger-irritation between faces that were oriented-away, predicted to be higher in disgust, and faces that were oriented-towards, predicted to be higher in anger-irritation. The main effect for evil faces was reverse orientation but this pattern was not shown for all faces: 9 showed reverse orientation, 6 showed no difference, and 2 faces showed orientation towards the famous face. The last two sets were combined to increase the power of the analysis. The analysis considered the orientation effect only where the face was evaluated as evil, and so one item never evaluated as evil was excluded from the analysis.

Ratings of irritation and disgust were not recorded from the experimental participants, so the ratings were obtained from 13 postexperimental participants, all students of Goldsmiths College, London. The names of the famous persons were presented in a random sequence and participants were asked to rate each person according to ''how much the person irritates you, on a scale of 1 (not at all) to 7 (intensely)''. The names were presented again and participants were asked to rate each person according to ''how much the person disgusts you, on a scale of 1 (not at all) to 7 (intensely)''. The mean irritation rating and the mean disgust rating were calculated for each item. This can provide only an indication of how the famous persons may have been viewed by the experimental participants. Nonetheless, the possibility of an effect moderated by disgust was considered worth exploring. Means (and *SD*) were as follows: for the reverse orientation faces, irritation mean = 3.69 (0.94), disgust mean = 4.21 (1.83); for the positive-null orientation faces, irritation mean = 3.16 (0.80), disgust mean = 2.34 (0.45).

ANOVA was performed with one within-item factor of emotion (irritation vs. disgust) and one between-item factor of orientation (reverse vs. positive-null). The two-way interaction was significant, $F(1, 15) = 5.95$, $p < .03$, and was investigated using independent-samples *t*-tests with alpha at .025 for each individual comparison. There was no difference in ratings of irritation between the reverse orientation faces and the positive-null orientation faces, $t(15) = 1.26$, ns, but ratings of disgust were higher for the reverse orientation faces, $t(15) = 2.81$, $p < .02$ (two-tailed).

This suggests that the orientation effect depended on the degree to which the famous person was regarded as disgusting. When experimental participants oriented away from the evil face the reaction of postexperimental raters tended to be higher in disgust than when experimental participants oriented toward the famous face or showed no effect. This explanation is posthoc and speculative, being based on ratings of irritation and disgust supplied by postexperimental raters rather than by the experimental participants. Nevertheless, it does point to one possible explanation for the reverse orientation effect for evil faces.

The second aspect of the results still requires explanation: The relationship between the relative proportion of errors in the same and opposite VF and the duration of the dot probe. The AB is still required to account for this. Note that the disgust account does not suppose that the AB is stronger for evil faces than for good and neutral faces: The reverse orientation effect is instead explained by orientation away from the evil faces.

The third aspect of the results is why statistically significant effects were found on errors and not on response times. A possible reason could be that good and neutral faces held attention strongly, preventing the shift of attention to the opposite VF, so that the dot probe was not identified accurately. Evil faces repelled attention, so that participants attended to the unfamiliar face instead, and were reluctant to shift attention to the evil face, again leading to lowered accuracy. If good and neutral famous faces hold attention more strongly than unfamiliar faces with angry expressions, and if evil faces repel attention, this could explain why Mogg and Bradley (1999) reported statistically significant effects on response times while the present experiment reported effects on errors.

The Disgust account can explain the reverse orientation effect for evil faces, and (speculatively) why significant effects were apparent on errors rather than on response times. The AB is still required to account for the relationship between the relative proportion of errors in the same and opposite VF and the duration of the dot probe. The Disgust account differs from the AB account in an important respect—the AB account proposes that attention was oriented towards evil faces, while the Disgust account proposes that it was orientated away from evil faces.

DISCUSSION

Attention was oriented towards the faces of famous persons when the persons were subsequently evaluated as good or neutral. A reverse orientation effect was observed for evil faces. The items analysis confirms that the difference was due to participants' attitudes towards the famous persons and not to any systematic differences between the famous and unfamiliar faces. This suggests that the faces were recognised as specific individuals.

The Attentional blink (AB) seems to be a plausible explanation for the entire pattern of results. There is also the possibility of orientation away from the faces of evil persons due to the invoked reactions of disgust. Both accounts offer a reason for the contrast between the present experiment, with a reverse orientation effect for evil faces, and the results of Mogg and Bradley (1999), where attention was oriented towards angry facial expressions. The AB proposes that participants do, in fact, orient towards evil faces. The Disgust account proposes that participants orient away from the faces of famous persons likely to invoke a reaction of disgust, but Mogg and Bradley (1999) did not explore facial expressions of disgust, so the appropriate comparison cannot be made. Future experiments could explore the ability of famous faces to create an AB using paradigms more traditionally employed in investigating this phenomenon. Investigation of the effects of participants' reactions of anger and disgust on the orientation of attention towards the faces of famous persons would also be an interesting line to pursue (and work has started already).

The possibility must be considered that some participants may have been aware of some faces and failed to report this. The awareness check, showing performance at chance, argues strongly against this possibility. Participants could have performed with above-chance accuracy if they had been only vaguely aware of familiarity of only a few faces, and so chance performance is strongly indicative of the absence of awareness.

Effects of attention orientation were observed for good and neutral faces, as predicted by Robinson (1998). It appears that a conclusion that only negatively valenced stimuli can attract attention preconsciously may not be correct in all circumstances. It seems likely that any salient stimulus (a famous face) can attract attention in competition with a less salient stimulus (an unfamiliar face) and therefore be prioritised for attentive processing.

In conclusion, the results reported here suggest that facial identity can be detected preconsciously, and that attention is oriented towards famous faces in preference to unfamiliar faces, as long as the famous person is not regarded as evil.

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APPENDIX 1
Famous faces

Gerry Adams (politician)	Cherie Blair (wife of UK prime minister)
Bill Clinton (US president)	Michael Douglas (film actor)
* Chris Evans (UK TV presenter)	* Richard Gere (film actor)
* Myra Hindley (murderess)	* Adolf Hitler
* Saddam Hussein	* Mick Jagger (singer Rolling Stones)
* J. F. Kennedy (US president)	Richard Nixon (politician)
Michael Portillo (politician)	Vic Reeves (UK TV presenter)
* Cliff Richard (singer)	O. J. Simpson (accused of murder)
* Margaret Thatcher (politician)	* Mike Tyson (rapist)

* Used for participant group 3; all faces used for groups 1 and 2.

APPENDIX 2

Examples of stimuli and the mask