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Strength of visual percept generated by famous faces perceived without awareness: Effects of affective valence, response latency, and visual field ☆

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Abstract

Participants who were unable to detect familiarity from masked 17 ms faces (Stone & Valentine, 2004, in press-b) did report a vague, partial visual percept. Two experiments investigated the relative strength of the visual percept generated by famous and unfamiliar faces, using masked 17 ms exposure. Each trial presented simultaneously a famous and an unfamiliar face, one face in LVF and the other in RVF. In one task, participants responded according to which of the faces generated the stronger visual percept, and in the other task, they attempted an explicit familiarity decision. The relative strength of the visual percept of the famous face compared to the unfamiliar face was moderated by response latency and participants' attitude towards the famous person. There was also an interaction of visual field with response latency, suggesting that the right hemisphere can generate a visual percept differentiating famous from unfamiliar faces more rapidly than the left hemisphere. Participants were at chance in the explicit familiarity decision, confirming the absence of awareness of facial familiarity.

Keywords: Non-conscious perception; Facial identity; Awareness; Visual masking; Affect; Attitude; Response latency; Hemisphere; Disgust

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1. Introduction

There is much evidence that facial expressions can be detected pre-consciously and can influence psychophysiological and behavioural responses without awareness of the particular expression (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.

The generation of an appropriate response to a facial expression that is recognised without awareness of the expression is often interpreted in terms of the importance to the individual of detecting and reacting to the emotion of others. Many stimuli in the environment are scanned pre-consciously, and those with the greatest salience, e.g., emotional faces as opposed to neutral faces, are prioritised for processing. This raises the question of whether a famous face would be prioritised for processing in competition with an unfamiliar face when both are perceived without awareness of familiarity. Given evidence that famous faces can be recognised as specific individuals without awareness of facial identity (Banse, 1999, 2001; Stone, Valentine, & Davis, 2001) or familiarity (Stone & Valentine, 2004, in press-a, in press-b), it seems plausible that a known face would be judged more salient than an unknown face. One effect of prioritising a face for processing might be that the face would generate a stronger visual percept, even though the visual percept was vague, partial, and insufficient to permit awareness of facial identity or familiarity. The relative strength of the consciously experienced visual percept generated by famous and unfamiliar faces was investigated in the present experiments.

Participants performed three tasks in which masked 17 ms faces were presented in simultaneous pairs of one famous and one unfamiliar face, one face in the left visual field (LVF) and the other in the right visual field. Each pair of faces was matched on age, sex, race, pose, and facial expression. In the perceptual comparison, participants selected the face that generated the stronger consciously experienced visual percept. The rationale was the observation from previous experiments that most participants are able to gain some vague, partial visual impression of the stimulus faces, or at least the impression of "something there." In the explicit familiarity decision, participants attempted to select the famous face in each pair: this was the task reported in Stone and Valentine (2004, in press-b). Overall performance at chance would indicate the absence of awareness of facial familiarity, and by assumption, the absence of awareness of facial identity. In the attention orientation task, the faces were followed by a dot-probe consisting of two small dots, either horizontal (..) or vertical (:), presented in either the LVF or the RVF, in a location corresponding to the centre of one of the famous–unfamiliar faces. Participants performed a speeded two-alternative forced-choice discrimination on the type of dot-probe. Orientation of attention to the famous face in a pair would be shown by faster or more accurate responses to the dot-probe in the same visual field as the famous face than in the opposite visual field. This task is reported in Stone and Valentine (in press-a).

Each participant defined each famous person as either good or evil (Experiment 1) or low- or high-disgust evoking (Experiment 2) in a rating procedure subsequent to the experimental tasks. It was expected that the perceptual comparison would be moderated by the participants' affective response to the famous face. Several conceptual accounts have been proposed to explain how feedback connections from high-level attributes of a stimulus can modify the strength of earlier perceptual representations of the stimulus (e.g., Di Lollo, Enns, & Rensink, 2000; Kanwisher, 2001; Martens, Wolters, & van Raamsdonk, 2002; Vogel, Luck, & Shapiro, 1998). These accounts propose that a stimulus proceeds through stages of processing from early perceptual analysis to identification and extraction of identity-dependent properties, e.g., affective valence. This can occur before awareness of the stimulus identity is achieved. Feedback connections from representations of high-level properties to earlier perceptual representations can modify the strength of these earlier representations. These conceptual accounts explain how an identity-dependent attribute of a stimulus, e.g., affective valence, can modify the strength of the consciously experienced visual percept.

There are grounds for expecting that the relationship between the affect invoked by a stimulus and the strength of the visual percept would vary with response latency, reasoned as follows. Modification of the strength of the consciously experienced visual percept would require some time to become apparent, being dependent on feedback projections. Also, there is evidence from the affective priming literature that automatic effects of stimulus valence are transient (De Houwer, Hermans, & Eelen, 1998; Glaser & Banaji, 1999; Hermans, de Houwer, & Eelen, 1994, 2001; Klauer, Rossnagel, & Musch, 1997; see Fazio, 2001, for a review). Applying these concepts to the present experiments, the activation of affective valence associated with a famous face was expected to modulate the strength of the visual percept within a range of response latencies, not including very fast or slower latencies.

What effect would this modulation have? In the explicit familiarity decision (Stone & Valentine, 2004, in press-b) responses were below chance accuracy to evil-disliked faces and tended to be above chance accuracy for good-liked faces. Participants selected the paired unfamiliar face rather than the famous face if they evaluated the famous person as evil or disliked, and tended to select the famous face if they evaluated the person as good or liked. The attention orientation task suggested that attention was oriented towards a famous face if the person was evaluated as good or neutral, but oriented towards the paired unfamiliar face if the famous person was evaluated as evil (Stone & Valentine, in press-a).

Stone et al. (2001) had previously reported that physiological responses to famous faces perceived without awareness of identity 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.) 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.

These results all seem to suggest that participants who regard a famous person as evil tend to process the masked 17 ms face somehow less strongly than those who regard the person as good. In the present study, it seems likely that the indistinct visual percept of the face would be weakened for participants who evaluate the person as evil, and strengthened for participants who evaluate the person as good, relative to an unfamiliar face. The perceptual comparison task asked participants to select which of the famous and unfamiliar faces in each pair yielded the stronger visual percept. "Accuracy" was defined as the selection of the famous face in each pair. From the above reasoning the expectation was derived that responses to evil faces would be less accurate than responses to good faces, for some range of response latencies, not including very fast or slower latencies.

The present experiments were also designed to investigate another factor: the right hemisphere superiority in processing facial identity (e.g., Grabowska & Nowicka, 1996; Heider & Groner, 1997; Schweinberger, Sommer, & Stiller, 1994; Sergent, MacDonald, & Zuck, 1994), which suggests that the right hemisphere would be expected to generate a stronger visual percept of a famous face than the left hemisphere. However, things are not this simple. Seeck et al. (1997) reported that early ERPs differed between famous and unfamiliar faces only in the right hemisphere, whereas later ERPs differed between famous and unfamiliar faces in both hemispheres. This suggests that the LH may be able to construct a visual percept that distinguishes between a famous and an unfamiliar face, but more slowly than the RH. It follows that a famous face presented in the left visual field and projected to the right hemisphere (LVF-RH) would generate a stronger visual percept than the paired unfamiliar face (presented in the RVF-LH), on short and long latency trials. In contrast, a famous face presented in the RVF-LH would generate a stronger visual percept than the paired unfamiliar face (in the LVF-RH) only on longer latency trials and not on short latency trials. This leads to the prediction that accuracy (selecting the famous face in each pair as having the stronger visual percept) will be higher for famous faces presented in the LVF than the RVF on short latency responses, with no difference in accuracy between LVF and RVF on longer latency responses. Accuracy for famous faces in the RVF should increase from short to long latency responses, while accuracy for famous faces in the LVF should not change with response latency.

The original design intention was to perform analysis within participants, calculating mean accuracy for each participant for the faces rated as good vs. mean accuracy for the faces rated as evil. Experiment 1 posed the problem that the famous persons tended to be rated consistently as either good or evil, so that any differential responding to good and evil faces according to participants' evaluations could be confounded with another factor that differed systematically between the stimuli, e.g., a physical attribute of the faces or the particular photographic image. To overcome this difficulty, the analysis was performed within items, calculating mean accuracy for each item over the participants rating the famous person as good vs. those rating the same famous person as evil. Thus, good and evil stimuli were identical, and the only difference was the participants' attitude towards the famous persons. Uneven numbers of participants contributed to the calculations in the good and evil categories for famous persons whose rating tended to be consistent.

The analysis of Experiment 1 was limited by the small number of items ($n = 10$) and so should be regarded as illustrative and requiring replication. Experiment 2 provides the replication. For convenience, throughout the remainder of this paper, an accurate response will refer to the selection of the famous face in each pair.

2. Experiment 1

2.1. Method

2.1.1. Participants

Participants were 34 students, staff and visitors at Goldsmiths College, London. Each participant's individual performance was at chance in the explicit familiarity task (binomial distribution, one-tailed, cut-off at 65%, $\alpha = 0.05$). Data were excluded from seven participants who failed to identify a minimum of eight faces in total, including two evaluated as good and two evaluated as evil, in the post-experimental evaluation. The remaining 27 participants were 18 female and 9 male, aged between 20 and 51, mean = 27.2, $SD = 7.5$ years.

2.1.2. Stimuli

Photographs of famous and unknown faces of a uniform quality were digitised to produce images of 16 greys, 150×200 pixels in size. The stimulus set comprised 10 pairs of one famous with one unfamiliar face. The faces in each pair were matched on sex, race, and approximate age, and showed a similar pose and facial expression. Names and examples of stimuli are given in Appendices A and B. The mask was a collage of parts of unfamiliar faces, of the same size as the famous and unfamiliar faces.

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 series of experiments. 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.

2.1.3. 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.

2.1.4. Design

Participants performed three separate tasks with masked 17 ms faces, always in the sequence of attention orientation, explicit familiarity, and perceptual comparison. The perceptual comparison task was always performed last in order to maximise the likelihood that participants had started to gain some visual percept of the masked faces. The attention orientation task was described in Section 1.

The explicit familiarity and perceptual comparison tasks were similar: the explicit familiarity task asked participants to select the famous face in each pair, while the perceptual comparison task asked participants to select the face that yielded the stronger visual impression. The dependent variable was accuracy of response, and a correct response was scored by selecting the famous face. Each face pair was presented four times, with the famous face appearing twice each in left and right visual fields, for a total of 40 trials, presented in a single block. The sequence of presentation was randomised by the computer for each participant. Valence (evil or good) was derived from an evaluation given by each participant for each famous person after the three tasks of attention orientation, explicit familiarity, and perceptual comparison.

2.1.5. Procedure

Participants performed individually in a darkened, air-conditioned room at a constant level of background lighting. Stimulus presentation was identical in both tasks. The two faces were each 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.

The sequence of events on each trial was as follows: central fixation cross for 500 ms, forward masks for 100 ms, famous and unfamiliar face for 17 ms, backward masks for 100 ms, question "left or right" in the centre of the screen displayed until the participants responded. The explicit familiarity response was made by pressing one of two keys: to the left of the keyboard to indicate the face in the LVF, and to the right of the keyboard to indicate the face in the RVF. In the perceptual comparison task there was a third response option of "about equal" made by pressing a key in the centre of the keyboard. Response time and accuracy were recorded by the computer. Each trial was initiated by the response to the previous trial after an inter-trial interval of 1 s.

Participants were informed that 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. Each pair of faces would contain one famous person and one unfamiliar person. In the explicit familiarity task, participants were asked to select on which side of the screen the famous face had appeared. 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 question, and respond. They were informed that it was OK to guess if they were unable to see anything of the faces. Participants were asked to look at the central fixation cross before each trial and to respond as quickly and accurately as possible. The perceptual comparison task was similar, with two differences: the instructions asked participants to select the face that generated the stronger visual percept, and a third response option of "about equal" was offered. After each task, participants were asked whether they had been able to recognise any of the faces displayed during the experiment, and were strongly encouraged to guess.

The participant was shown the famous faces one at a time in a random sequence and asked to identify each person, either by name or by sufficient biographical detail to uniquely pinpoint the person. After the face identification, the participant was shown the famous faces again, one at a time, in a different random sequence, and asked to rate each person on a 7-point scale from -3 (very evil) through 0 (neutral) to $+3$ (very good). Participants were asked to evaluate the person, not the face, considering any knowledge they had of the person. Participants were told, "There are no right or wrong answers, it is entirely your own opinion. Please do not think too long and give your first impression." Finally, participants were debriefed and thanked for their participation.

2.2. Results

If a participant could not correctly identify a famous face in the post-experimental identification, all trials for this combination of participant and item were excluded from the analysis (4.8% of trials). All participants insisted they had been unable to recognise any of the faces during the experimental tasks. Trials were excluded if the response time was faster than 100 ms (probable anticipations; including the backward mask this was 200 ms from face offset; 0.1% of trials) and over 2000 ms (5.5% of trials). A face was categorised as evil for a participant if the valence rating was below zero, and as good if the valence rating was 0 or above, to distinguish between evil faces and the rest. A correct response was scored as the selection of the famous face. The presence of a third response option of "about equal" in the perceptual comparison, which could not score as a correct response, resulted in mean accuracy (selecting the famous face in each pair) below 50%.

2.2.1. Explicit familiarity

Response accuracy per item (mean = 0.470, $SE = 0.016$) was obviously not above chance, confirming the absence of awareness of facial familiarity, and by assumption, of facial identity. As reported in Stone and Valentine (2004, Experiment 1), accuracy was lower in participants who evaluated a famous person as evil than in participants who evaluated the same target person as good.

2.2.2. Perceptual comparison: Analysis of valence and response latency

Responses were analysed in six ranges measured from face offset: 200–500 ms, 500–700 ms, 700–900 ms, 900–1100 ms, 1100–1500 ms, and over 1500 ms. The selection of these ranges was a compromise between the desire to include as many ranges as possible, to provide a sensitive analysis of the data, and the desire to maximise the number of items without missing data, which requires fewer ranges: 5 of the 10 items has complete data. The expectation was that response accuracy would be lower for participants who evaluated a famous person as evil than for those who evaluated the same person as good, for some range of response latencies, not including the very fast or slower latencies.

Fig. 1 presents an illustration of the data. No statistical tests were performed because of the small number of items. Fig. 1 shows a tendency for response accuracy to dip for evil faces in the range 500–700 ms, while response accuracy for good faces shows a peak in the same latency range. A similar pattern was observed when partial data for all 10 items were included. This pattern suggests that affective modulation of the strength of the visual percept may occur for responses in the range of 500–700 ms.

2.2.3. Perceptual comparison: Analysis of visual field and response latency

A separate prediction had been made that accuracy for famous faces presented in the RVF should increase from short to long latency responses, while accuracy for famous faces presented

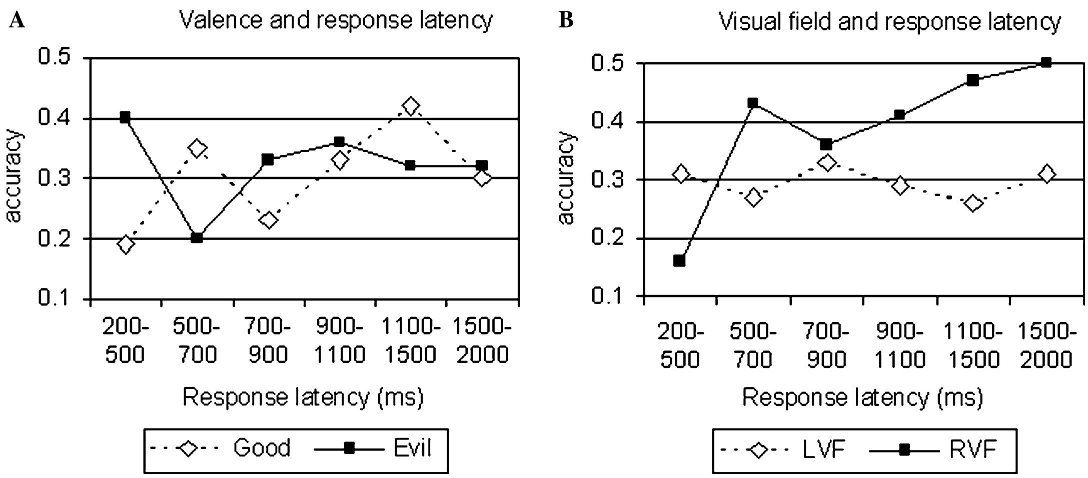

Fig. 1. Mean response accuracy in the perceptual comparison task of Experiment 1, by valence and response latency (A) and by visual field and response latency (B).

in the LVF should be equivalent on short and long latency responses. Data were calculated in the same latency ranges used above, for famous faces presented in the LVF and RVF. One item had missing data. Fig. 1 presents an illustration; no statistical tests were performed because of the small number of items. The data presented in Fig. 1 appear consistent with expectation.

2.3. Discussion

Fig. 1 illustrates the possibility that the strength of the consciously experienced visual percept of a masked 17 ms famous face varied with response latency and affective valence, and with response latency and visual field. The visual percept of an ''evil'' face may have been weakened, and that of a ''good'' face may have been strengthened, for responses in the latency range 500–700 ms. The right hemisphere may be able to construct a stronger visual percept of a famous face than an unfamiliar face at all response latencies, while the left hemisphere may be able to do so only at longer latencies.

The experiment should be regarded as illustrative owing to the small number of items. Experiment 2 was designed to include a much larger number of items to enable a formal statistical analysis.

3. Experiment 2

The number of stimuli was increased from 10 to 60. The famous persons were selected from a previous study on the criterion that they generated mixed evaluations, which would permit a rigorous within-items analysis. Participants were asked to evaluate the degree of disgust evoked by each famous person. The emotion of disgust was chosen because this was thought to underlie the effects previously observed in the explicit familiarity task (Stone & Valentine, 2004, in press-b) and the attention orientation task (Stone & Valentine, in press-a). The emotion of disgust serves to protect against physical or psychological contamination and motivates avoidance of the object of disgust (e.g., Charash & McKay, 2002; Druschel & Sherman, 1999; Izard, 1977; Levenson, 1994; Nabi, 2002; Newhagen, 1998; Rozin, Haidt, & McCauley, 1999). Psychological contamination could occur because of association with an unpleasant individual, and disgust has been specifically related to the avoidance of ideas or persons regarded as morally corrupt (Izard, 1977; Nabi, 2002; Rozin et al., 1999). Thus, disgust was thought to underlie the below chance accuracy of explicit familiarity responses to the faces of famous persons evaluated as evil, and the orientation of attention away from these faces.

For the interaction of disgust rating with response latency, the predictions were as follows: responses to high-disgust evoking faces would be of lower accuracy on trials with latency in the range 500–700 ms than on shorter or longer latency trials; responses to low-disgust evoking faces would be of higher accuracy in the range 500–700 ms than on shorter or longer latency trials. For the interaction of visual field with response latency, the prediction was that accuracy would increase from short to long latency trials for famous faces presented in the RVF-LH, and show no change for famous faces presented in the LVF-RH.

The response option ''equal'' was removed from the perceptual comparison so that participants were compelled to select either the LVF face or the RVF face on each trial.

3.1. Method

Only the changes from Experiment 1 will be noted.

3.1.1. Participants

Participants were 46 first-year undergraduate students at Goldsmiths College, London. Three participants were excluded whose individual performance was above chance in selecting famous compared to unfamiliar faces in the explicit familiarity decision (binomial distribution, one-tailed, cut-off at 57% correct, $\alpha = 0.05$) since for these participants, the possibility of some awareness cannot be ruled out. Two more participants were excluded who correctly identified fewer than 40 of the 60 items, and one participant who failed to comply with experimental instructions. The remaining 40 participants were 33 female and 7 male, aged between 18 and 44, mean = 22.1, $SD = 6.8$ years. All had watched UK television for at least 5 years by self-report to maximise the likelihood of knowledge of the famous faces.

3.1.2. Stimuli

The stimulus set comprised 60 pairs of one famous with one unfamiliar face. The faces in each pair were matched on sex, race, and approximate age, and showed a similar pose and facial expression. No data were collected to verify equivalence between the famous and unfamiliar faces on distinctiveness, attractiveness, or any other feature on which the stimuli might vary. The intention was to perform analyses within-items, with each famous person rated as low-disgust evoking by some participants and as high-disgust evoking by others, so that systematic variations between famous faces and their paired unfamiliar faces could not explain any observed experimental result. Names and examples of stimuli are given in Appendix A.

3.1.3. Design

Participants performed three tasks on masked 17 ms faces, always in the sequence of attention orientation, explicit familiarity, and perceptual comparison.

In each of the explicit familiarity and perceptual comparison, there were two factors of visual field of famous face (LVF or RVF) and evoked disgust (high or low; defined by each participant for each item). The dependent variable was accuracy of response, and a correct response was scored by selecting the famous face. Each face pair was presented twice, with the famous face appearing once each in left and right visual fields, for a total of 120 trials, presented in a single block. The sequence of presentation was randomised by the computer for each participant.

3.1.4. Procedure

The procedure for the explicit familiarity and perceptual comparison tasks was the same as Experiment 1, with the following changes. One, participants had to make a response within 2000 ms of the onset of the question "left or right" or the program proceeded to the next trial and no response was accepted. Two, the "equal" response option was not allowed so that participants were compelled to select either the LVF or the RVF face.

Three, the evaluation of the famous persons was altered. After identifying the faces, participants were shown the famous faces, one at a time, in a random sequence, and asked to rate on a 7-point scale "how much each famous person disgusts you" (1 = not at all, 4 = moderately, 7 = very much). The emotion of disgust was explained as similar to distaste and disapproval. Participants were asked to evaluate the disgust invoked by the person, not the face, considering any knowledge they had of the person. Participants were told, "There are no right or wrong answers, it is entirely your own opinion. Please do not think too long and give your first impression." Finally, participants were debriefed and thanked for their participation.

3.2. Results

If a participant could not correctly identify a famous face, all trials for this combination of participant and item were excluded from the analysis of all tasks (11.4% of trials). Some faces were recognised during the explicit familiarity or perceptual comparison tasks. Taking a cautious approach, all trials for these combinations of participant and item were excluded from the analysis of both tasks (0.8% of trials). Trials on which no response was made were excluded from the analysis (1.4%/1.2% of trials in the explicit familiarity/perceptual comparison). Trials were excluded as probable anticipations if the response time was faster than 100 ms (including the backward mask this was 200 ms from face offset; 4.6%/6.8% of trials). A correct response was scored as the selection of the famous face.

3.2.1. Explicit familiarity

Response accuracy per item (mean = 0.509, $SE = 0.009$) was at chance, $t(59) = 0.99$, ns, confirming the absence of awareness of facial familiarity, and by assumption, of facial identity.

3.2.2. Perceptual comparison: Analysis of evoked disgust and response latency

A face was categorised as high-disgust evoking for a participant if the rating of disgust was 5 or above, and as low-disgust evoking if the rating was 4 or below (minimum rating was 1 and maximum was 7). Responses were analysed in three latency ranges, measured from stimulus face offset: 200–500 ms, 500–700 ms, and 700–2000 ms. These were chosen because the 500–700 ms range had suggested lowest accuracy for evil faces, and a peak in accuracy for good faces, in Experiment 1. The proportion of trials in each latency range was 0.36, 0.29, and 0.35, respectively.

ANOVA was performed with two within-item factors of evoked disgust (high vs. low) and response latency (200–500 ms vs. 500–700 ms vs. 700–2000 ms). The dependent variable was mean response accuracy. Fifteen items had missing data. The two-way interaction of evoked disgust with response latency was significant, $F(2,43) = 4.24$, $MSE = 0.045$, $p < .03$. Paired comparisons revealed that for the high-disgust faces, 500–700 ms latency responses were less accurate than shorter or longer latency responses, $F(1,44) = 6.80$, $MSE = 0.128$, $p = .012$, while shorter and longer latency responses did not differ from each other, $F = 0$. For the low-disgust faces, 500–700 ms latency responses tended to be more accurate than shorter or longer latency responses, $F(1,44) = 2.49$, ns, and shorter and longer latency responses did not differ from each other, $F < 1$. See Fig. 2 and Table 1.

3.2.3. Perceptual comparison: Analysis of visual field and response latency

ANOVA was performed with two within-item factors of famous face visual field (LVF vs. RVF) and response latency (200–500 ms vs. 500–700 ms vs. 700–2000 ms). The dependent variable

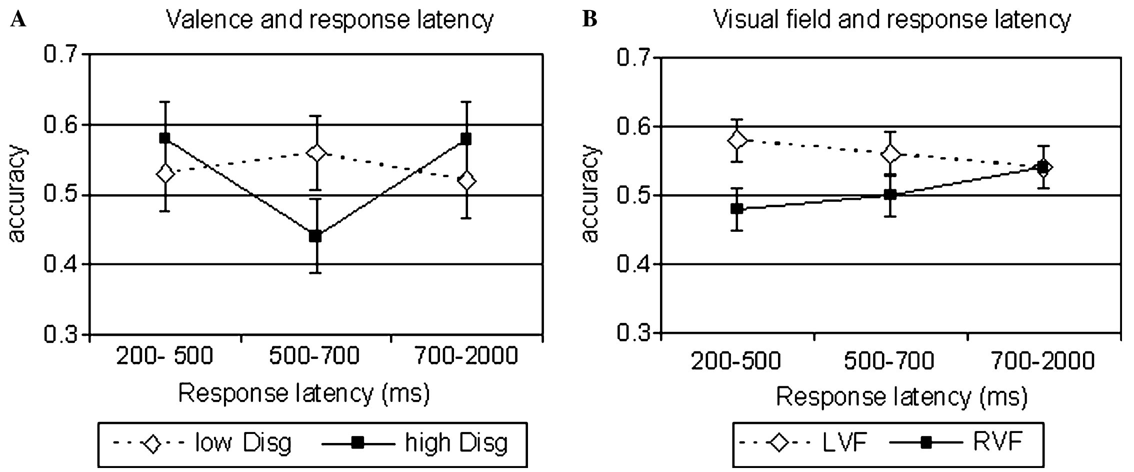

Fig. 2. Mean response accuracy in the perceptual comparison task of Experiment 2, by valence and response latency (A) and by visual field and response latency (B). Bars represent 95% confidence intervals calculated according to Eq. (4) of Loftus and Masson (1994).

Table 1
Mean accuracy (and standard error) by response latency and degree of evoked disgust ($n = 45$) or visual field ($n = 60$)

Response latency (ms)	Evoked disgust		Visual field	
	High	Low	LVF	RVF
200–500	0.579 (0.036)	0.529 (0.023)	0.583 (0.021)	0.476 (0.021)
500–700	0.439 (0.044)	0.560 (0.021)	0.562 (0.021)	0.500 (0.022)
700–2000	0.577 (0.034)	0.520 (0.019)	0.538 (0.023)	0.543 (0.020)

Data from Experiment 2.

was mean response accuracy. No items had missing data. The two-way interaction of famous face visual field with response latency was significant, $F(2,58) = 4.55$, $MSE = 0.021$, $p < .02$. Paired-samples t tests (with α set at 0.0167) revealed that 200–500 ms responses were more accurate when the famous face was in the LVF than the RVF, $t(59) = 3.99$, $p < .001$, and 500–700 ms responses tended to be more accurate for famous faces in the LVF than the RVF, $t(59) = 2.10$, $p = .04$, while 700–2000 ms responses showed no difference between LVF and RVF, $t(59) = -0.17$, ns. For famous faces in the LVF, 200–500 ms and 700–2000 ms responses were equally accurate, $t(59) = 1.66$, ns, while for famous faces in the RVF, 700–2000 ms responses were more accurate than 200–500 ms latency responses, $t(59) = 2.51$, $p = .015$. See Fig. 2 and Table 1.

3.3. Discussion

The observation of overall accuracy at chance in the explicit familiarity decision confirms that faces were perceived without awareness of familiarity, and by assumption, without awareness of identity.

In the perceptual comparison, when the famous person was rated high-disgust evoking, the relative strength of the visual percept of the famous compared to the unfamiliar face changed with response latency, being lower on 500–700 ms latency trials than on shorter or longer latency trials. When the famous person was rated low-disgust evoking, the relative strength of the visual percept for the famous compared to the unfamiliar face did not vary with response latency, although there was a non-significant tendency for response accuracy to be highest at the 500–700 ms range. This pattern of results supports the prediction for the perceptual comparison task regarding high-disgust evoking faces.

The perceptual comparison showed higher response accuracy for LVF faces than RVF faces on short latency trials, with no difference on long latency trials. Accuracy increased with response latency for RVF faces but not for LVF faces. This pattern of results supports the concept that the right hemisphere can construct a stronger visual percept of a famous than an unfamiliar face more rapidly than the left hemisphere.

4. General discussion

The explicit familiarity decision showed overall accuracy at chance in Experiments 1 and 2, confirming the absence of awareness of facial familiarity and, by assumption, of facial identity.

The perceptual comparison showed an interesting pattern: the relative strength of the visual percept of a famous face compared to an unfamiliar face varied with response latency and participants' attitude towards the famous person. For participants who rated the famous person as evoking high disgust, the visual percept of the famous face was relatively strong on short latency trials (below 500 ms), then declined on trials with latency in the range 500–700 ms, before increasing again on longer latency trials (over 700 ms). A tendency for this pattern was observed in Experiment 1 (the small number of items did not permit statistical tests) and confirmed in Experiment 2. The relative weakness of the visual percept of high-disgust evoking faces on 500–700 ms latency trials was attributed to re-entrant feedback from the representation of the affective valence to the earlier representation of the visual image of the face. The feedback required some time to become effective and was also transient, so the visual percept was relatively strong on shorter latency trials (below 500 ms) and on longer latency trials (over 700 ms).

Conceptual models of feedback processing, mentioned in Section 1, will be described in some more detail in order to interpret the present findings. Vogel et al. (1998) proposed that processing of visual stimuli proceeds in two stages: the perceptual stage that identifies stimuli and occurs without awareness, and a post-perceptual stage of processing that may result in awareness. They suggested that the visual system is able to identify stimuli faster than they can be processed by post-perceptual systems. One implication is that interference with post-perceptual processing (for example, by backward masking) could impair awareness and the accuracy of overt report without impairing perceptual processing. Another implication is that modulation of post-perceptual processing by identity-dependent affective valence could result in enhanced or weakened awareness of the stimulus.

Martens et al. (2002) cite converging evidence that awareness of the presence and identity of a visual stimulus requires an attentional process consisting of a feedback mechanism from high-level representations to preceding low-level representations. This follows a feedforward cycle that activates representations in subsequent processing levels, up to stimulus identity and meaning. Visual awareness is critically dependent on the feedback cycle re-activating early representations in primary visual cortex. Such feedback can be interpreted as a process of binding the high-level representations to the lower-level representations that caused their activation. This would seem to allow the possibility that high-level identity-dependent stimulus properties could modulate the feedback mechanism and so influence the low-level visual representations.

Both of these models (Martens et al., 2002; Vogel et al., 1998) appear to have conceptual similarity with the theorising of Kanwisher (2001) that awareness of a stimulus requires a link between semantic "type" information and spatio-temporal "token" information. This link might occupy the same conceptual function as the post-perceptual stages of Vogel et al and the feedback cycle of Martens et al.

Di Lollo et al. (2000) developed an explicit computational model (CMOS) along similar lines of reasoning. The CMOS model explains that processing of a visual stimulus proceeds through sequential levels increasing in abstractness from the visuo-spatial event. Re-entrant neural projections from association cortex attempt to connect with low-level representations in primary visual cortex (a post-perceptual feedback process). Awareness of a stimulus depends on a match between the re-entrant high-level visual representation and ongoing lower-level activity in primary visual cortex. The CMOS model accounts for the effectiveness of backward masking by proposing that the mask replaces the masked stimulus as the object of ongoing lower-level activity, producing a mismatch with the re-entrant visual representation of the stimulus, and so precluding awareness of the stimulus. If the masked stimulus is still generating some attenuated lower-level activity then presumably, a partial match with the re-entrant visual representation can be made, and so a vague, partial visual percept can be experienced. Affective modulation of the re-entrant neural projections from association cortex to primary visual cortex would result in a consciously experienced visual percept whose strength depends on the affect invoked by the stimulus.

Any of these conceptual accounts could explain how an identity-dependent attribute of a stimulus (e.g., affective valence) can modify the strength of the consciously experienced visual percept in the absence of awareness of stimulus identity or even of stimulus familiarity.

The relative strength of the visual percept of famous faces compared to unfamiliar faces also varied with visual field and response latency. The visual percept was stronger for famous faces presented in the LVF (to the right hemisphere) than for famous faces presented in the RVF at short response latency (up to 500 ms), with no difference at longer latencies; the visual percept strengthened from short to long latency trials for famous faces presented in the RVF, and showed no change for famous faces presented in the LVF. This pattern supports the proposition that the right hemisphere can construct a visual percept that distinguishes between famous and unfamiliar faces more rapidly than the left hemisphere (e.g., Seeck et al., 1997).

It is possible that the famous faces may have enjoyed some systematic advantage in the perceptual comparison over the unfamiliar faces, perhaps being more attractive or more distinctive, or perhaps the advantage of perceptual fluency (e.g., Jacoby & Dallas, 1981) since the perceptual system has had previous experience of processing a famous face. Any systematic difference that favoured famous faces over unfamiliar faces could have had the effect of elevating overall response accuracy. However, this factor alone could not explain the pattern of accuracy dependent on response latency for high-disgust evoking faces, or the pattern of accuracy varying with visual field and response latency.

Regarding future studies, event-related potentials might help to shed light on the temporal pattern of differences in neural activity dependent on the degree of disgust evoked by famous faces. Also, fMRI data could clarify those brain regions in which differences in neural activity occur. The generality of these findings could be tested by repeating the experiment using a different class of stimulus, for example words or pictures, or using faces depicting an expression of disgust, rather than facial identities.

In conclusion, when famous faces were presented so briefly that they could not be consciously perceived with sufficient clarity to permit identification or even familiarity detection, they were processed differently according to the participants' emotional reaction to the famous person. The differences reported here appear to relate to the emotion of disgust and are consistent with avoidance or weaker processing of the faces of famous persons evoking a high degree of disgust.

Appendix A. Stimuli

Experiment 1

Pop stars: Mick Jagger, Cliff Richard
Politicians: Adolf Hitler, Saddam Hussein, J.F.Kennedy, Margaret Thatcher
TV presenters: Chris Evans
Film/TV actors: Richard Gere
Others: Myra Hindley (murderess), Mike Tyson (boxer and rapist)

Experiment 2

Pop stars: Victoria Beckham, Cher, Eminem, Liam Gallagher, Geri Halliwell, Whitney Houston, Janet Jackson, Michael Jackson, Mick Jagger, Elton John, Jennifer Lopez, Madonna, George Michael, Elvis Presley, Cliff Richard, Britney Spears, Robbie Williams
Royal family: Prince Charles, Queen Elizabeth, Sarah Ferguson
Politicians: Osama Bin Laden, Tony Blair, George W. Bush, Bill Clinton, William Hague, Adolf Hitler, J.F. Kennedy, John Major, Margaret Thatcher
TV presenters: Michael Barrymore, Cilla Black, Paul Daniels, Chris Evans, Bruce Forsyth, Rolf Harris, Richard Madeley, Anne Robinson, Jonathan Ross, Chris Tarrant, Carol Vordeman
Film/TV actors: Jim Carrey, Martin Clunes, Russell Crowe, Tom Cruise, Leonardo Dicaprio, Michael Douglas, Callista Flockhart, Sarah Michelle Gellar, Hugh Grant, Ross Kemp, Gwyneth Paltrow, Arnold Schwarzenegger, Sylvester Stallone, Catherine Zeta-Jones
Others: Rowan Atkinson (comedian), David Beckham (sports), Richard Branson (entrepreneur), Naomi Campbell (model), Luciano Pavarotti (opera singer), O.J. Simpson (sports)

Appendix B. Examples of stimuli and the mask

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