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Positive and Negative Emotion Enhances the Processing of Famous Faces in a Semantic Judgment Task

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Previous work has consistently reported a facilitatory influence of positive emotion in face recognition (e.g., D'Argembeau, Van der Linden, Comblain, & Etienne, 2003). However, these reports asked participants to make recognition judgments in response to faces, and it is unknown whether emotional valence may influence other stages of processing, such as at the level of semantics. Furthermore, other evidence suggests that negative rather than positive emotion facilitates higher level judgments when processing nonfacial stimuli (e.g., Mickley & Kensinger, 2008), and it is possible that negative emotion also influences latter stages of face processing. The present study addressed this issue, examining the influence of emotional valence while participants made semantic judgments in response to a set of famous faces. Eye movements were monitored while participants performed this task, and analyses revealed a reduction in information extraction for the faces of liked and disliked celebrities compared with those of emotionally neutral celebrities. Thus, in contrast to work using familiarity judgments, both positive and negative emotion facilitated processing in this semantic-based task. This pattern of findings is discussed in relation to current models of face processing.

Keywords: face processing, semantics, emotion, affect, eye movements

Previous work has examined the influence of emotion in face processing, and positive emotion has consistently been found to facilitate recognition (e.g., Bate, Haslam, & Hodgson, in press; D'Argembeau et al., 2003). However, this work has mostly investigated the influence of emotion on recognition judgments, with little exploration of the role of these processes when making higher level semantic judgments. Not only are the latter important in the context of the multiple decisions we make about people, but there is also evidence that negative rather than positive emotion facilitates higher level judgments when processing nonfacial stimuli (e.g., Mickley & Kensinger, 2008). Thus, despite having little influence on familiarity judgments, it is possible that negative emotion may influence higher level judgments in face processing. The present article addresses this issue, using eye movement indicators to assess the influence of emotional valence while participants make semantic judgments in response to famous faces.

Several studies have explored the role of emotion in face recognition. These investigations have manipulated either emotional expression (Bate et al., in press; D'Argembeau et al., 2003; Kaufmann & Schweinberger, 2004) or emotional feelings toward a person (Bate, Haslam, & Hodgson, 2009; Singer, Kiebel, Winston, Dolan, & Frith, 2004), and these studies mostly investigated the influence of emotion in the discrimination of familiar from novel faces. It has consistently been reported that positive emotion facilitates the speed and/or accuracy of familiarity judgments, compared with both negative (Bate et al., in press; D'Argembeau et al., 2003; D'Argembeau & Van der Linden, 2007) and neutral conditions (Bate et al., in press; Kaufmann & Schweinberger, 2004). Thus, increasing evidence suggests a facilitatory role for positive emotional valence in face recognition, whereas there is little support for a similar influence of negative emotion.

Whether emotional valence also influences other judgments that we make about people is relatively unknown. It is important to note that recent evidence suggests that different neurological systems are activated in response to vivid recollection and experiencing a sense of familiarity, and this effect was modulated by emotional valence. Specifically, Mickley and Kensinger (2008) found that negatively valenced stimuli that were vividly remembered recruited temporo-occipital regions associated with sensory processing more than positive or neutral stimuli, whereas the encoding of positively valenced stimuli activated the cingulate gyrus and bilateral frontal and parietal areas more than negative or neutral stimuli. In explaining their findings, the authors argued that positive and negative items are processed in fundamentally different ways, with negative emotion evoking more detailed analytical processing and positive emotion eliciting a schematic, heuristic type of processing (see Bless, Schwarz, & Wieland, 1996; Fredrickson & Branigan, 2005). Thus, negatively valenced items

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may be more vividly recollected because of increased sensory processing during encoding, whereas enhanced gist-based processing of positive information may lead to increased feelings of familiarity. Applying these findings to the face recognition literature, we expected positive emotion to facilitate familiarity judgments—as has consistently been reported in the literature to date—but negative emotion to facilitate processing when more detailed, higher level processing is required. In models of face recognition (e.g., Bruce & Young, 1986), such processing is more likely when we tap biographical or semantic details about a person or their name. The only known study to investigate the influence of emotion at later stages of face processing was conducted by Gallegos and Tranel (2005). They presented healthy participants and neurological patients who had undergone temporal lobectomies with famous faces displaying happy or neutral emotional expressions. Both groups of participants were quicker at naming celebrities when they displayed a happy, compared with a neutral, expression, indicating that positive emotion may also have a facilitatory influence at later stages of processing. However, this study did not include a negative condition, and the influence of negative emotion at more detailed levels of face processing remains unknown.

The present study examined the influence of emotion on semantic judgments made in response to images of famous people. As in our previous work (Bate, Haslam, Tree, & Hodgson, 2008, Bate et al., 2009; Bate et al., in press), we monitored the visual scanpath while participants performed this task. This methodology is particularly useful in the present context, as measures of the visual scanpath have been used to document differences in information-processing strategy as a function of stimulus type (Althoff & Cohen, 1999) and, in doing so, has the capacity to capture processing differences as a function of emotional valence. Indeed, previous studies have used indices of the visual scanpath to examine information-processing strategies applied in viewing faces that differ in familiarity (Althoff & Cohen, 1999; Barton, Radcliffe, Cherkasova, Edelman, & Intriligator, 2006; Bate et al., 2008), emotional expression (Bate et al., in press; Green, Williams, & Davidson, 2003) and perceived emotional response (Bate et al., 2009). These studies all provide evidence of a facilitation, in response to either increased familiarity or emotional salience, as indicated by a reduction in the visual sampling of a face.

We adopted this methodology in the present study. Participants viewed famous faces that tend to be liked, disliked, or emotionally neutral and were asked to decide whether each celebrity depicted the face of an entertainer or a nonentertainer. Following the work of Mickley and Kensinger (2008) and Gallegos and Tranel (2005), we predicted that both positive *and* negative emotional valence would enhance processing compared with neutral celebrities, and this would be indicated by faster reaction times, fewer fixations, shorter fixation durations, fewer regions sampled, and fewer regionally repetitive pairs of fixations.

Method

Participants

Twenty healthy participants (12 female, 8 male) with no history of psychiatric illness took part in this experiment. Participants were recruited from an existing participant pool held by the School of Psychology at the University of Exeter in Exeter, United Kingdom, consisting of members of the local community who are occasionally invited to take part in departmental research. All participants were right handed (as indicated by self-report), and all reported normal or corrected-to-normal vision. The participants were aged between 40 and 65 years (M = 52.75, SD = 6.29), and were native English speakers who had lived in the United Kingdom since birth. Participants took part in this experiment in exchange for a small monetary payment. Informed consent was obtained from all participants before the onset of the experiment, and ethical approval for this study was granted by the Ethics Committee at the School of Psychology, University of Exeter.

Apparatus and Materials

Thirty famous people were selected for use in this experiment on the basis of findings from a pilot study. In this pilot, 49 participants (31 female, 18 male) aged between 40 and 71 years (M = 53.71 years, SD = 6.87) were asked to rate the familiarity and emotional valence of 120 celebrities. For each face, participants were asked to answer the question "Is this person familiar?" and to rate their familiarity on a Likert-type scale ranging from 1 (*not at all familiar*) to 7 (*highly familiar*). A similar Likert-type scale ranging from 1 to 7 was used to assess the emotional valence of each celebrity, on which 1 = *dislike very much*, 4 = *neutral*, and 7 = *like very much*. The final stimulus set comprised 30 (15 male and 15 female) of the 120 celebrities who were judged to be highly familiar by at least 80% of the participants (i.e., scored a 5, 6, or 7 on the Likert-type scale). The 30 celebrities were also selected on the basis of (a) their emotional valence and (b) their occupation (as the manipulation for the semantic judgment). Specifically, 10 individuals were selected who were consistently rated as "liked," 10 who were consistently rated as "disliked," and 10 who were consistently rated as "neutral" (see Appendix). These ratings were made on the basis of a Likert-type scale; a rating of 1 or 2 indicated "disliked," a rating of 4 indicated "neutral," and a rating of 6 or 7 indicated "liked." Again, at least 80% of participants had to agree upon the intended valence of each celebrity. There were five male and five female celebrities in each set. Furthermore, for each valence (i.e., liked, disliked, neutral), five celebrities were selected who were entertainers (e.g., singers, comedians), and five fell into a nonentertainer category (e.g., politicians). Whereas "liked" celebrities tended to be popular actors or sports stars, "disliked" celebrities were also selected from these occupational categories but tended to be those who had committed a crime or unfavorable act that was reported in the media (e.g., Gary Glitter or Mike Tyson).

One image of each celebrity was downloaded from the Internet for use in the eye movement test. Each face displayed a neutral facial expression with the mouth closed, and the orientation of the face was forward (see Figure 1). All photographs were edited in F1

Figure 1. Examples of stimuli used in this study.

Jasc Paintshop Pro (Version 9.00). Each face was displayed from the neck upward and on a white background. Each stimulus was adjusted to 650 pixels in height and 500 pixels in width.

Eye movements were recorded using an Eyelink system (SR Research Ltd., Osgoode, Ontario, Canada), comprising a video-based pupil/corneal reflex tracking device with head movement compensation, and sampled at 250 Hz and a spatial accuracy between 0.5° and 1° of visual angle. Eye position was monitored through a miniature infrared CCD video camera mounted on an adjustable headband and aimed at the right eye. Head movement was not restrained by a chin rest for this experiment, because the eye tracker had an optical head-tracking camera integrated into the headband that allowed accurate tracking of the point of gaze without the need to fix the head of the participant. The combined pupil/corneal reflex tracking technique is also robust to translational movements of the head relative to the camera (point of gaze being dependent on the relative, rather than absolute, position of the pupil and corneal reflex in the camera field). We analyzed eye movements using Eyelink Data Viewer software (SR Research Ltd), which allowed periods of fixation to be identified and user-defined areas of interest to be determined within the face images (discussed later). In an initial calibration phase and then during all data collection, eye position on the screen was sent to a Dell host computer, which also collected information about when the stimuli were presented and what behavioral responses were produced.

Procedure

Participants were seated in a quiet room, approximately 60 cm from the screen. An initial calibration procedure was carried out before the onset of the experiment. This procedure began with the presentation of a white dot in the center of a black computer screen. The dot moved consecutively around the edge of the screen until an adequate corneal lock was achieved in each position. Once each participant had successfully completed the calibration phase, they immediately progressed to the experiment. Participants viewed the 30 images in one continuous block, and eye movements were recorded throughout. The images were presented in a random order, with an exposure time of 5 s per face. Participants were required to make a semantic judgment (i.e., "Is this person an entertainer or not?") in response to each face. Responses were made with the use of a joypad, on which they pressed one of two buttons, and response keys were counterbalanced between participants. The initial point of gaze was controlled by the presentation of a centrally positioned fixation dot before each stimulus appeared. The next stimulus was displayed once the participant had fixated the dot. After the test phase, participants viewed the set of famous faces again and were asked to provide familiarity and emotional ratings for each celebrity using the same Likert-type scales as those used in our pilot study.

Eye Movement Parameters, Dependent Measures, and Statistical Analyses

To analyze eye movements, we plotted the scanpath for each face. Eight areas of interest were defined, as used in previous research (e.g., Barton et al., 2006; Bate et al., in press): right eye (left side of space), left eye (right side of space), mouth, nose, chin, right cheek, left cheek, and forehead. As in previous research, the interest areas were drawn on to each face with a freehand marquee tool.

We selected five dependent measures for use in this study. First, we included the standard behavioral indicator of reaction time, measuring the length of time taken to make the semantic decision. We also selected indices that quantified how much information was extracted from a face (number of fixations, average fixation duration, number of regions sampled, and number of consecutive fixations within a region). Further elaboration of these dependent measures can be found in Bate et al. (2008).

We conducted analyses on data collected from each dependent variable within the reaction time period (i.e., until participants pressed a button on the joypad). The data obtained for each stimulus were then classified into emotional categories (i.e., liked, disliked, and neutral) on the basis of each participant's ratings of the images. Thus, although participants generally agreed with our emotional classification of famous faces, we nevertheless separated the images on the basis of each individual's categorization. Furthermore, to ensure any differences in processing between the three emotional conditions could be attributed to emotional valence and not familiarity, we only included celebrities that were rated as highly familiar by each participant (e.g., awarded a 5, 6, or 7 on the Likert-type scale). On this basis, 61 trials were removed across all participants (M = 3.05 per participant, SE = 0.88). After these controls had been applied, the mean number of celebrities in the disliked, liked, and neutral categories were 8.20 (SE = 0.96), 10.40 (SE = 0.80), and 11.55 (SE = 0.99), respectively. Repeated measures ANOVAs indicated there was no difference in familiarity ratings between the two semantic conditions, $F(1, 16) = 0.414$, $p = .529$; or the three emotional conditions, $F(2, 32) = 2.320$, $p = .115$; nor did the two interact, $F(2, 32) = 1.701$, $p = .199$.

To examine the influence of emotion on each of our dependent measures, we calculated the mean score for each variable separately for the three conditions and placed them into a repeated measures ANOVA. To examine our hypothesis that the processing of both liked and disliked celebrities would be facilitated relative to emotionally neutral celebrities, we conducted two planned comparisons. Second, we looked for any difference in the processing of liked compared with disliked celebrities. Holmes's sequential Bonferroni procedure was applied to correct for multiple comparisons. Accordingly, we used an alpha of 0.017 to assess the significance of the comparison with the lowest p value, an alpha of 0.025 for the second lowest p value, and 0.05 for the comparison with the highest p value (analyses that failed to reach significance under this correction are identified in the main text). A zero-order r statistic indicates the effect size for each comparison. AQ: 1

Results

Accuracy in discriminating entertainers from nonentertainers was high (M = 80.17%, SE = 2.37) and did not differ according to semantic condition, $F(1, 19) = 0.119$, $p = .734$; or emotional condition, $F(2, 38) = 2.213$, $p = .123$. Analysis of response latencies indicated that semantic decisions varied according to emotional condition, $F(2, 32) = 7.693$, $p = .004$; and this did not interact with semantic condition, $F(2, 32) = .987$, $p = .384$ (see Table 1). In line with our hypotheses, response latencies were T1

Table 1
Mean Values (and Standard Errors) for Each Dependent Measure as a Function of Emotional Valence

Variable	Disliked	Liked	Neutral
Reaction time (ms)	1,703.45 (117.29)	1,862.04 (129.96)	2,303.34 (169.85)
Fixation count	5.37 (0.41)	6.23 (0.72)	7.35 (0.68)
Fixation duration (ms)	290.49 (13.80)	274.87 (14.26)	278.27 (9.47)
Region count	2.88 (0.13)	3.09 (0.21)	3.68 (0.26)
Regionally repetitive pairs of fixations	3.77 (0.26)	4.55 (0.45)	5.69 (0.54)
Proportion left	54.64 (2.87)	45.21 (2.56)	45.53 (2.43)

faster for liked celebrities, $F(1, 16) = 11.605$, $p = .004$, $r = .648$; and disliked celebrities, $F(1, 16) = 17.307$, $p = .001$, $r = .721$; compared with emotionally neutral celebrities. There was no difference in reaction time between liked and disliked celebrities, $F(1, 16) = 1.073$, $p = .316$. A similar pattern of performance emerged on the eye movement measures. Emotional condition influenced the number of fixations elicited to a face, $F(2, 32) = 6.077$, $p = .007$; and this effect was not influenced by semantic condition, $F(2, 32) = 1.097$, $p = .346$. Specifically, fewer fixations were elicited to liked faces compared with neutral faces, $F(1, 16) = 13.616$, $p = .002$, $r = .678$; and the difference between disliked and neutral faces was marginally significant, $F(1, 16) = 4.169$, $p = .058$. There was no difference between the liked and disliked conditions, $F(1, 16) = 1.877$, $p = .190$. The number of facial regions sampled was also influenced by emotional condition, $F(2, 32) = 11.134$, $p = .001$; and this was not influenced by semantic condition, $F(2, 32) = 0.956$, $p = .396$. Fewer regions were sampled for liked faces, $F(1, 16) = 21.023$, $p = .001$, $r = .754$; and disliked faces, $F(1, 16) = 6.349$, $p = .023$, $r = .533$; compared with neutral faces, and there was no difference for disliked compared with liked celebrities, $F(1, 16) = 1.240$, $p = .282$. Emotional condition also influenced the number of regionally repetitive pairs of fixations elicited to a face, $F(2, 32) = 8.366$, $p = .003$; and this effect did not interact with semantic category, $F(2, 32) = 0.660$, $p = .524$. Specifically, fewer regionally repetitive pairs of fixations were elicited to liked faces, $F(1, 16) = 18.842$, $p = .001$, $r = .735$; and disliked faces, $F(1, 16) = 10.168$, $p = .006$, $r = .623$; compared with emotionally neutral faces. Again, there was no difference between the liked and disliked conditions, $F(1, 16) = 3.186$, $p = .093$. The only measure not influenced by emotional valence was average fixation duration, $F(2, 32) = 0.157$, $p = .885$; nor did the emotional and semantic conditions interact for this measure, $F(2, 32) = .607$, $p = .551$. In summary, both positive and emotional valence facilitated processing compared with emotionally neutral faces. This was evident in both faster reaction times and reduced visual sampling of faces.

Discussion

This study is the first to examine the influence of emotional valence on semantic judgments in response to familiar faces. In line with previous work that investigated the role of emotion in familiarity judgments, we found that positive emotion facilitated face processing relative to emotionally neutral faces. It is important to note that a similar finding emerged for negatively valenced faces. This pattern of findings suggests that both positive and negative emotions can facilitate face processing at the level of semantics.

The finding that negative emotion influences face processing when making semantic judgments supplements those reported in previous research, where negative valence facilitated processing in the context of more detailed analysis, albeit with a different stimulus type (Mickley & Kensinger, 2008). The latter findings have been attributed to differences in the processing strategy used to encode positive and negative stimuli. Indeed, it has been suggested that negative emotion evokes a detail-oriented analytical strategy, whereas positive emotion elicits a schematic, heuristic strategy (Bless et al., 1996; Fredrickson & Branigan, 2005). This explanation fits well with increasing reports of a facilitatory influence of positive emotion when participants make familiarity judgments of faces, with little evidence of a corresponding facilitation for negative faces (Bate et al., in press; D'Argembeau et al., 2003; Kaufmann & Schweinberger, 2004). The finding reported here provides further support for the account by providing the first evidence that negative emotion influences face processing during semantic judgments.

It is important to note, however, that there was also evidence of a facilitation with positive emotion, which requires explanation. It is generally accepted that accessing information about people occurs in a sequential fashion, with facial familiarity processed before biographical detail (e.g., Bruce & Young, 1986). Whereas positive emotion seems to boost processing at the level of familiarity, negative emotion may be reserved for later stages of processing when more detailed information about a person is accessed. Thus, the finding that positive emotion also influenced the semantic judgment task may simply reflect a boost in initial processing at the level of familiarity rather than an influence at the point of accessing biographical detail. Indeed, the sequential nature of person identification requires familiarity to be processed even when the task involves a higher level semantic judgment. It is, therefore, possible that both positive and negative emotions influenced semantic judgments because of an early boost in processing for positive stimuli and a later boost for negative stimuli when semantic information was required. Furthermore, the finding that positive emotion also facilitated processing relative to neutral stimuli fits well with the study reported by Gallegos and Tranel (2005). These authors found positive emotional expressions facilitated the naming of famous faces compared with a neutral condition, indicating that positive emotion also facilitates more detailed levels of processing. Although this study did not include a negative condition, the positive facilitation can be explained by an early boost in processing for these stimuli.

Although results from the present study cannot provide definitive support for the hypothesis given earlier, the suggestion fits well with evidence from existing studies using event related potentials (ERPs). These studies suggest that we have an early emotional response to a stimulus before structural encoding is complete (e.g., Pizzagalli, Koenig, Regard, & Lehmann, 1999, Pizzagalli, Lehmann, Hendrick, Regard, Pascual-Marqui, & Davidson, 2002). It is thought that these earlier influences of emotion represent rapid categorizations along perceptual routes that run parallel to full structural encoding (Vuilleumier, Armony, Driver, & Dolan, 2003; Winston, Vuilleumier, & Dolan, 2003) while a slower analysis of higher spatial frequency input is taking place in temporo-occipital areas. Several authors have argued that brain regions supporting the reward system (e.g., nucleus accumbens, subenticular extended amygdala) might be implicated in this process, with feedback from these structures mediating activity in the visual cortices through increased vigilance and attention (Heimer, 2000; LeDoux, 2000; Sarter & Bruno, 2000). Thus, the involvement of reward-related neural structures suggests that early influences of emotion may bring about the positive facilitation effect in the case of familiarity. Although negative stimuli may not enjoy the same early boost in processing as positive stimuli, it is possible the influence of negative affect may occur at a later stage, perhaps after a familiarity decision has occurred. Indeed, Mickley and Kensinger (2008) have suggested that positive and negative stimuli are encoded in a different manner, with a more detailed encoding strategy elicited to negative stimuli. Although this added detail at encoding may not enhance familiarity judgments in a recognition test, it may be of more use when participants are accessing more detailed knowledge about a person. However, we can merely speculate on this issue at present, and further research using ERPs could provide more insight into this hypothesis.

A potential confound in the present study is that faces were not strictly controlled for attractiveness. Indeed, the main priorities in stimulus selection were controlling for the strength of emotional feeling toward each person and the degree of familiarity our participants had with each celebrity. Although we eliminated any images in which the person wore glasses or displayed any other distinguishing feature (i.e., prominent facial hair), it was not possible to control for other confounding variables. Facial attractiveness may be another source of positive emotion and therefore could have influenced our results. Future research may attempt to further explore this issue, perhaps using newly learned rather than famous faces and inducing emotional feelings toward each face. This would permit confounding variables (including visual factors and degree of exposure) to be more rigorously controlled.

The findings reported here may further our understanding of disorders of face recognition, such as the Capgras delusion. In this disorder, the perceiver can correctly identify a face but believes that person has been replaced by an imposter. It is thought that this pattern represents a normally functioning cognitive route to recognition but an impaired emotional response (Ellis & Lewis, AQ: 2 2001). Although reports of the Capgras delusion suggest emotion plays an essential role in person recognition, the findings in the present study demonstrate how emotion also influences recognition in healthy participants. It is important to note that, if an appropriate emotional response to a person facilitates our access to biographical and semantic information about that individual, an incorrect emotional response might bring about further confusion when interacting with the semantic system, perhaps causing the delusion in Capgras syndrome.

In summary, this study is the first to investigate influences of emotional valence on semantic judgments in face processing. Although previous work has consistently reported a facilitatory role for positive emotion in familiarity judgments, the findings reported here suggest both positive and negative emotion can facilitate processing at the level of semantics. It is possible this pattern of findings reflects an early boost in processing for positive stimuli but a later enhancement for negative stimuli. Further research with a methodology designed to test temporal processing (e.g., ERPs) could test this hypothesis.

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Appendix

Famous Faces Selected for Used in This Study as a Function of Emotional Condition and Semantic Category

Famous face	Like	Dislike	Neutral
Entertainers	David Jason	Gary Glitter	Anne Robinson
	Dawn French	Michael Jackson	Madonna
	Whoopi Goldberg	Victoria Beckham	Ozzie Osbourne
	John Lennon	Jade Goody	Carol Vorderman
	Stephen Fry	Kate Moss	Lulu
Nonentertainers	Nelson Mandela	George Bush	Mikhail Gorbachev
	Paula Radcliffe	Margaret Thatcher	Boris Johnson
	Princess Diana	Mike Tyson	David Beckham
	Pele	Maxine Carr	Michael Schumacher
	Tony Benn	Jeffrey Archer	Sarah Ferguson

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AUTHOR QUERIES

AUTHOR PLEASE ANSWER ALL QUERIES **1**

AQ1: Author: Is this sentence correct as edited?

AQ2: Author: Please give a reference for Ellis & Lewis (2001) in the Reference list or delete citation from text.