Abstract

Heightened state anxiety can have a deleterious impact on memory for faces. In this paper we investigated whether anxiety: (1) moderates the own-ethnicity bias (OEB), and (2) impairs face recognition accuracy at the encoding or retrieval phase of an OEB face-recognition task. Using a typical OEB task, anxiety was induced during encoding and retrieval in Experiment 1, but only during retrieval in Experiment 2. An OEB was found in both experiments but anxiety did not moderate the OEB in either experiment. In Experiment 1, anxious participants were poorer at face recognition for both own- and other-ethnicity faces. In Experiment 2 anxiety did not impair face recognition. Together, these studies suggest that anxiety impaired participants' encoding, but not retrieval, of faces. The implications of these findings are discussed.

The own-ethnicity bias (OEB; also called the own-race bias or cross-race effect) is the tendency for people to better recognize faces of members of their own ethnic group (Malpass & Kravitz, 1969). The OEB is typically driven by a higher false-alarm rate for other-ethnicity faces: people tend to report having seen other-ethnicity faces that they have not seen (Meissner & Brigham, 2001). This tendency has obvious implications for eyewitness identification, as people may be more likely to wrongly identify an innocent ethnic out-group member as the person they saw committing a crime.

People who witness a crime often experience a temporarily-heighted state of anxiety during the episode (Christianson, 1992). Anxiety is characterized by increased physiological arousal and worry over future threats (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). State anxiety refers to current anxious affect whereas trait anxiety refers to the dispositional tendency to experience anxiety more frequently and/or more intensely (Spielberger et al., 1983). Anxiety is distinct from stress, which does not necessarily involve worrying thoughts and is characterized by persistent arousal, strain and a lower threshold for distress (Lovibond & Lovibond, 1995). This paper examines the potential effect of state anxiety (henceforth anxiety) on the OEB.

Anxiety can have a detrimental effect on face memory, and recent theorizing suggests that anxiety impairs memory by interfering with encoding (Deffenbacher, Bornstein, Penrod & McGorty, 2004; Morgan et al., 2004). Given that eyewitness testimony can have a powerful influence over whether a jury decides to convict (Devenport, Penrod & Cutler, 1997), it is important to understand whether anxiety interferes with face recognition at the level of encoding, and whether anxiety moderates the OEB. Theoretically, anxiety might affect other-ethnicity face recognition in two

ways: (1) anxiety may lower recognition accuracy for all faces, regardless of ethnicity and/or (2) anxiety may increase or decrease the OEB by increasing the use of categories or stereotypes.

Anxiety, recognition accuracy, and face encoding processes

Substantial evidence shows that anxiety can impair eyewitness memory (for a review see Deffenbacher et al., 2004). During person perception, anxiety can reduce memory for individuating information about other people (Valentine & Mesout, 2009). However, it may be possible to overcome anxiety-related face-memory deficits, to some degree, by applying deeper processing strategies while learning faces (Mueller, Bailis & Goldstein, 1979).

In a meta-analysis, Deffenbacher et al. (2004) observed that, across numerous studies, anxiety impaired face recognition in line-ups in which the target was present, but not in line-ups where the target was absent. The authors speculated that anxiety may aversively affect the quality of people's encoding of faces, a notion that has been echoed by others (Morgan et al., 2004). In conjunction with Mueller et al.'s (1979) observation that greater depth of processing can potentially ameliorate the effect of anxiety on face recognition, these findings imply that anxiety can cause face-encoding deficits. More recently, studies show that anxiety reduces face-recognition accuracy, but such studies typically examine people experiencing anxiety when both encoding faces to, and retrieving faces from, memory (e.g., Attwood, Penton-Voak, Burton, & Munafò, 2013), which do not isolate any effect of anxiety on encoding. If anxiety disrupts face encoding, memory deficits in recognition of faces (regardless of ethnicity) should occur for people who are highly anxious while viewing faces, but not for those who are highly anxious

only while attempting to recognize faces. To our knowledge there is no direct experimental evidence that anxiety impairs face encoding in an OEB task.

Categorization and stereotyping could moderate an anxiety—OEB relationship

Increasingly, evidence suggests that categorization processes may contribute to out-group face-recognition deficits (Hugenberg, Miller & Claypool, 2007; Sporer, 2001). Merely categorizing a face as an out-group member appears to be sufficient to impair recognition for out-group faces (Bernstein, Young & Hugenberg, 2007). Outside of the person-perception literature, there is evidence to suggest that anxiety may increase category inclusivity (Mikulincer, Kedem & Paz, 1990). That is, as anxiety increases, exemplars are more likely to be categorized as group members. Given evidence that anxiety may increase categorization (Mikulincer et al.) and that out-group categorization per se can create OEB-like effects (Bernstein et al.), an anxiety-related increase in categorization could also exacerbate the OEB.

In addition, when observing faces, categorization likely precedes the activation of relevant stereotypes (Levin, 1996). Stereotype activation appears to vary as a function of categorization strength, such that stronger categorization leads to greater stereotype activation (Locke, Macrae & Eaton, 2005). Should anxiety increase categorization strength, theoretically stereotypes could be more activated when anxiety is heightened. Stereotypes assist person memory, inasmuch as when people are cognitively loaded they may rely more on stereotypes in order to remember details about other people (Macrae, Milne & Bodenhausen, 1994). Anxiety may increase cognitive load and, thus, reliance on stereotypes in person memory (Wilder & Shapiro, 1989a, 1989b). If anxiety creates cognitive load, and cognitive load increases reliance on stereotyping in person memory,

and stereotyping assists person memory, then anxiety may improve accuracy in cross-ethnicity recognition.

Alternatively, an increased reliance on stereotyping could decrease cross-ethnicity recognition accuracy. Under heightened anxiety it is conceivable that out-group members may be remembered more on the basis of an applicable stereotype rather than on the basis of their individual characteristics. Indeed, Brigham (2008) argued that anxiety-induced stereotyping would exacerbate the OEB because people would be categorised broadly as out-group members rather than being individuated.

In the context of person-perception, several studies suggest that anxiety increases the use of stereotypes when evaluating other people (Wilder & Shapiro, 1989a, 1989b). However, these studies have been criticised for using members of laboratory-created groups as person-perception targets, rather than groups with well-learned stereotypes (see Curtis, 2013; Curtis & Locke, 2005). However, more recent studies, using targets from groups with established stereotypes, have found no evidence that anxiety increases stereotyping; in some cases these more recent studies employed identical anxiety manipulations to earlier studies (Curtis, 2013; Curtis & Locke, 2005, 2007).

In sum, it is possible that anxiety may promote categorisation and, thus, increase the OEB. It is also possible that anxiety may increase stereotyping, which may either: (1) facilitate person memory and, thus, reduce the OEB, or (2) decrease individuation and thus, increase the OEB. However, as noted, recent evidence has not supported previous contentions that anxiety increases stereotyping. Because of this, an anxiety-related increase in the OEB via categorisation seems more plausible than an anxiety-related increase in stereotyping that could either increase or decrease the OEB.

Studies examining Anxiety and the OEB

Several studies suggest that anxiety may moderate the OEB. However, these studies have not examined the effect of anxiety on the OEB directly, and have not considered the potential role of encoding in any anxiety—OEB relationship. For example, Brigham, Maas, Martinez and Whittenberger (1983) examined whether autonomic arousal induced by electric shocks influenced the OEB. Brigham et al. found that shock-induced arousal increased the OEB. The electric-shock manipulation may have conflated arousal, pain, and anxiety, so it was unclear what may have caused the observed OEB increase and, as a result, their methods prohibit clear conclusions about the effect of anxiety on the OEB.

Two recent studies have more directly examined whether anxiety influences the OEB (Horry & Wright, 2009; Johnson & Fredrickson, 2005). Horry and Wright (2009) presented participants with a Middle-Eastern and a Caucasian face simultaneously, as part of a dot-probe task (see MacLeod, Mathews & Tata, 1986), to examine whether anxiety directs attention towards threatening ethnic out-group faces. In their second study, Horry and Wright followed the face presentation phase with a recognition phase to examine the OEB and they measured state and trait anxiety. A typical OEB was found and trait (but not state) anxiety was negatively correlated with recognition accuracy, but anxiety did not moderate the OEB. However, as noted above, faces were presented two at a time because these authors' primary aim was to study the effect of stereotypes on visual-attention allocation, whereas standard OEB tasks present faces consecutively rather than concurrently. Additionally, Horry and Wright did not experimentally manipulate anxiety. Thus, it is impossible to say whether the anxiety-face recognition

correlation they observed represented disrupted encoding vs. disrupted retrieval, or whether this relationship would exist were anxiety experimentally manipulated.

Johnson and Fredrickson (2005) examined the influence of several mood states, including fear, on the own-ethnicity bias. Fear was induced by showing participants a clip from a scary movie. Anxiety was measured with a single-item self-report scale (Johnson & Fredrickson, 2005). The OEB was present in both the fear and control conditions. Importantly, there was a weak but significant negative correlation (r = -.21) between anxiety and recognition accuracy for other-ethnicity faces. The correlation suggests that anxiety may moderate the OEB by reducing recognition accuracy for other-ethnicity faces. However, this finding was correlational and does not speak to whether the effect was driven by anxiety interfering with encoding or retrieval. It is clear that more investigation is needed to determine whether anxiety affects the OEB and whether any effects stem from anxiety's influence on encoding and/or retrieval of faces in an OEB task.

The Present Experiments

In our experiments, we investigated whether anxiety moderates the OEB and whether anxiety impairs face recognition by interfering with encoding. As the review above indicates, researchers have yet to rigorously test either possibility. The current research combined a standard OEB face recognition paradigm with anxiety-induction protocols to test the hypotheses that anxiety would: (1) increase or decrease the OEB, and/or (2) reduce face-recognition accuracy by interfering with encoding. In Experiment 1, participants were allocated to either an anxiety or control condition, and anxiety was induced before the encoding phase so that participants in the anxiety condition were

anxious during both face-learning and recognition. In Experiment 2, anxiety was induced after face-learning, but before the recognition phase, so that anxious participants were only anxious during retrieval but not during encoding.

Experiment 1

Method

Participants

Fifty-three Caucasian undergraduate students, enrolled in first year psychology at the University of Western Sydney, received partial course credit for their participation in this experiment. Two participants' data were excluded from analysis because of computer problems during testing. This left a total of 51 participants, of these 26 were randomly allocated to the anxiety condition and 25 were allocated to the control condition. Participants were aged between 18 and 44 (M = 22.32, SD = 6.10). Although there were more females (N = 32) than males (N = 19), gender is reportedly unrelated to the OEB (Smith, Stinson & Prosser, 2004) and no gender effects were found in our experiments.

Apparatus and Stimuli

Face Images. Faces were of college-aged African American or Caucasian males. Different photographs of the same individual were used for the learning and recognition phases. Each pair of photographs differed unsystematically in brightness, background hue, and closeness to camera. The African American faces were sourced from college basketball player profiles on-line. Caucasian faces were photographed by researchers for use in face-perception research. All photographs were cropped to remove distinguishing clothing. For 21% of the Caucasian faces two photographs were available for use separately in the learning and recognition phases, these included subtle differences in

expressions and hair style. For all African American, and the remaining Caucasian, faces a second photograph was not available, because of this, photos were mirrored and the distance and background colour were changed so that photographs were not identical.[1] These differences ensured that the task was testing recognition of facial features, not visual characteristics of particular photographs. The OEB computer program drew randomly from a set of 560 photographs (280 photo pairs). As our participants were Caucasian, Caucasian faces were considered own-ethnicity and African American faces were other-ethnicity.

Anxiety Measure. The State Trait Anxiety Inventory (STAI; Spielberger et al., 1983) was used to measure participants' current and typical levels of anxiety. The state and trait scales are 20 items each and are responded to on a 4-point scale to form a composite score that can range from 20-80. Larger values indicate higher anxiety. The STAI is a valid and reliable measure (Spielberger et al., 1983).

Procedure

OEB task. The OEB task was presented and recorded on computers with colour monitors. In the face-learning phase, photographs of individual faces were consecutively displayed on-screen for 5 seconds each. Each participant saw 30 photographs, 15 per ethnicity, presented in random order. There were no inter-trial intervals. A 5-minute delay occurred between the learning and recognition phases. During the recognition phase, a further 60 faces were displayed on-screen in random order one at a time. Thirty of these faces were alternate pictures of the faces from the learning phase and 30 were foils. In the recognition phase, participants indicated whether the face had been presented in the learning phase by clicking on a virtual 'old' or 'new' button on-screen. Next, they

rated their confidence about their response; again using a mouse-click, on a 100-point sliding scale, higher values indicated greater confidence. The face-recognition task yielded data for recognition accuracy, confidence ratings, and response latencies.[2]

Anxiety Induction. Participants in the anxiety condition were told that they would be required to give a 3-minute public speech on the topic "the part of your body you are least happy with". They were told that the speech would occur at the end of the experiment (i.e., after the face-recognition task) and that the speech would be recorded on video and would be evaluated by their peers. This anxiety manipulation has been used successfully to increase participants' anxiety in previous studies (e.g., Curtis, 2013). Control participants were told that they would be viewing and anonymously evaluating other participants' speeches, but that they would not be giving a speech themselves. Next, all participants completed the OEB task, then the STAI. The STAI was administered at the end of the experiment because mood effects on person perception may be reduced if participants' attention is drawn to their moods (Gasper & Clore, 2000). Additionally, by measuring anxiety after our core dependent measures, we avoided alerting participants to the intent of the anxiety manipulation.

Results and Discussion

Manipulation Check. State anxiety was significantly higher in the anxiety group (M = 42.81, SD = 10.14) than in the control group (M = 35.44, SD = 10.42), $t(49) = 2.56$, $p = .014$, $d = .73$. Thus, the anxiety induction was successful. The groups did not differ in trait anxiety, $t(49) = .91$, $p = .37$, $d = .26$.

Data Preparation. Hits and false alarm rates were converted to d' scores and c scores, which were log-linear adjusted to allow for scores of zero (Stanislaw & Todorov,

1999). Larger d' scores indicate greater recognition accuracy, and negative *c* values indicate participants' bias towards responding affirmatively that they had seen faces (Stanislaw & Todorov, 1999). Data were screened to ensure that statistical assumptions were met and no assumption breaches were observed.

Face Recognition. Recognition accuracy was analyzed using a 2 (condition: anxiety vs. control) x 2 (face ethnicity: own-ethnicity vs. other-ethnicity) mixed ANOVA, with log-linear d' values as the dependent variable (see Figure 1). The main effect of ethnicity was significant, $F(1, 49) = 23.71$, $p < .001$, $\eta_p^2 = .33$, indicating that participants were better at recognizing own-ethnicity faces ($M = 1.12$, $SD = .67$) than other-ethnicity faces ($M = .63$, $SD = .49$)[3]. Thus, the OEB was observed. The main effect for condition was also significant, $F(1, 49) = 4.33$, $p = .043$, $\eta_p^2 = .08$; anxious participants were less accurate at recognizing faces ($M = .74$, $SD = .45$) than control participants ($M = 1.00$, $SD = .46$). No significant interaction was observed between ethnicity and condition, $F(1, 49) = .12$, $p = .72$, $\eta_p^2 = .003$; thus, anxiety did not moderate the OEB.

(Insert Figure 1 about here)

Response Bias. The OEB is usually accompanied by a higher false-alarm rate for other-ethnicity faces (Meissner & Brigham, 2001). In order to determine if participants changed their response criterion for own- and other-ethnicity faces a 2 (condition: anxiety vs control) x 2 (face ethnicity: own-ethnicity vs other-ethnicity) mixed ANOVA was performed on the log-linear *c* scores. The main effect of ethnicity was significant, $F(1,$

49) = 182.78, $p < .001$, $\eta_p^2 = .79$, participants were more likely to respond affirmatively to other-ethnicity (M = -.55, SD = .75) than own-ethnicity faces (M = 1.03, SD = .64). In addition, the condition x face-ethnicity interaction was significant, $F(1, 49) = 4.68$, $p = .035$, $\eta_p^2 = .087$. Control participants demonstrated a more pronounced bias to respond affirmatively to other-ethnicity (M = -.68, SD = .71) vs. own-ethnicity (M = 1.16, SD = .72) faces than did anxious participants (other-ethnicity M = -.42, SD = .78; own-ethnicity M = .91, SD = .56).

The response bias main-effect was underpinned by an increase in the false-alarm rate, where participants had a higher false alarm rate for other-ethnicity faces (M = .41, SD = .20) than for own-ethnicity faces (M = .19, SD = .13), $t(50) = 8.25$, $p < .001$, d = 2.33. However, there was no significant difference in hit rates between other-ethnicity (M = .66, SD = .17) and own-ethnicity (M =.61, SD = .23) faces, $t(50) = 1.38$, $p = .17$, d = 0.39.

In sum, the analyses of the log-linear d' scores indicate that OEB was observed for both anxious and control participants, driven by more affirmative responding and a higher false-alarm rate for other-ethnicity faces. Not only did anxiety not moderate the magnitude of the OEB, anxious participants showed a reduced own- vs. other-ethnicity response bias as compared with controls. Importantly, however, anxious participants were poorer at face recognition than control participants. Still, this experiment is limited in that participants were anxious during both the encoding and retrieval of faces. Whether anxiety creates deficits in face recognition via encoding or retrieval processes (or both) was investigated further in Experiment 2.

Experiment 2

The purpose of Experiment 2 was to determine whether anxiety interferes with face retrieval in the OEB task. There were two differences between Experiments 1 and 2. First, anxiety was induced after, rather than before, the face-learning phase. This allowed us to deduce whether the findings in Experiment 1 were likely due to anxiety-related deficits in encoding or in retrieval. Second, a different anxiety induction was employed (because of differing ethical protocols at the universities where the studies were conducted).

Method

Participants

One-hundred and ten Caucasian (females n = 81, males n = 29), undergraduate psychology students from the University of Western Australia and Murdoch University participated in exchange for partial course credit. Of these, 57 were randomly allocated to the anxiety condition and 53 were allocated to the control condition. Participants were aged between 18 to 51 years (M = 21.49, SD = 7.99).

Apparatus and Procedure

In Experiment 2, the apparatus and procedure were the same as for Experiment 1 except that all participants completed a surprise anagram task between the learning and recognition phases, in which they were instructed to unscramble words under time constraints. Unbeknownst to participants, only half of the anagrams could be solved. Control participants were told that the task was difficult and not to worry if their performance was poor. Participants in the anxiety-induction condition, however, were told that university students generally do well at the task and that if they did not perform well, they would be required to complete additional anagrams whilst being videoed.

Furthermore, participants in the anxiety-induction group were told that the footage would be shown to other students as an example of poor anagram-solving performance. This method of inducing anxiety has been used successfully in previous research (e.g., Curtis & Locke, 2005, 2007).

Results and Discussion

Data Preparation. As in Experiment 1, log-linear d' and *c* scores were calculated as an index of recognition accuracy and response bias respectively. As in Experiment 1, data were screened to ensure that statistical assumptions were met and no assumption breaches were observed.

Manipulation Checks. Participants were significantly more state anxious in the anxiety-induction condition (M = 40.64, SD = 9.74) than in the control condition (M = 36.57, SD = 10.46); $t(108) = 2.10$, $p = .03$, $d = .40$. Trait anxiety scores did not differ significantly between anxious and control participants; $t(104) = .03$, $p = .97$, $d = .007$[4].

Face Recognition. Log-linear d' scores were analyzed with a 2 (condition: anxiety vs. control) x 2 (face ethnicity: own-ethnicity vs. other-ethnicity) mixed ANOVA. A main effect of ethnicity was observed, $F(1,108) = 18.03$, $p < .001$, $\eta_p^2 = .14$, indicating that participants were better at recognizing own-ethnicity (M = 1.27, SD = .66) compared to other-ethnicity (M = .90, SD = .54) faces. Thus, the OEB was observed. Unlike Experiment 1, the main effect of condition was not significant, $F(1, 108) = .03$, $p = .84$, $\eta_p^2 < .001$. Participants demonstrated similar performance in the control (M = 1.09, SD = .57) and anxiety (M = 1.08, SD = .59) conditions (see Figure 2). Moreover, the condition x ethnicity interaction was not significant, $F(1, 108) = 1.13$, $p = .28$, $\eta_p^2 = .01$.

Heightened anxiety did not impair face recognition, nor did it moderate the own-ethnicity bias.

Response Bias. To determine if participants differed in their response tendency towards own- and other-ethnicity faces a 2 (condition: anxiety vs. control) x 2 (face ethnicity: own-ethnicity vs. other-ethnicity) mixed ANOVA was performed on log-linear *c* scores. The main effect of ethnicity was significant, $F(1, 108) = 36.50$, $p < .001$, $\eta_p^2 = .25$, participants were more likely to respond affirmatively to other-ethnicity ($M = -.30$, $SD = .59$) than own-ethnicity faces ($M = .24$, $SD = .68$). The condition x ethnicity interaction was not significant, $F(1, 108) = .58$, $p = .45$, $\eta_p^2 = .005$.

(Insert Figure 2 about here)

As in Experiment 1, the face-ethnicity difference in *c* was reflected in a higher false-alarm rate for other-ethnicity ($M = .34$, $SD = .17$) compared to own-ethnicity ($M = .16$, $SD = .13$) faces, $t(109) = 9.07$, $p < .001$, $d = 1.21$. Unlike Experiment 1, hit rates were also significantly higher for other-ethnicity ($M = .68$, $SD = .16$) compared to own-ethnicity ($M = .59$, $SD = .20$) faces, $t(109) = 3.53$, $p = .001$, $d = .49$. Nevertheless, it appears that the OEB was driven by the higher false-alarm rate for other-ethnicity faces, which had an effect size more than double that of the hit-rate difference. No other significant effects were observed (all other *p*s > .34, η_p^2s < .008).

In sum, the key finding of Experiment 2 was that anxiety induced after face encoding did not impair face recognition or moderate the OEB.

General Discussion

The current research investigated the possible impact of anxiety on cross-ethnicity face recognition. We expected that increased anxiety would: (1) moderate the extent of the OEB and/or (2) impair recognition for all faces regardless of ethnicity. Anxiety impaired recognition for all faces regardless of ethnicity only when participants were anxious during both encoding and retrieval (Experiment 1), but not when they were anxious only during retrieval (Experiment 2). In contrast, anxiety did not moderate the extent of the OEB. These findings suggest that anxiety interferes with face encoding but not with later retrieval processes, which is consistent with previous suggestions that anxiety may impair face recognition by compromising encoding (Deffenbacher et al., 2004; Morgan et al., 2004).

Overall, the current results are generally consistent with studies showing that anxiety reduces memory accuracy in person-perception (e.g., Mueller et al., 1979; Valentine & Mesout, 2009). Nonetheless, our experiments provide several unique contributions to the face-memory literature that have been ambiguous in previous studies. First, experimentally-induced anxiety did not moderate the OEB, despite previous correlational evidence of a potential anxiety—OEB relationship (Johnson & Fredrickson, 2005). Second, neither of the previous studies of anxiety and the OEB (i.e., Johnson & Fredrickson, 2005; Horry & Wright, 2009) clearly investigated the role of encoding vs retrieval, thus, our attempt to distinguish between these processes is novel. Third, we have found that anxiety impairs face recognition regardless of the ethnicity of the faces viewed, which was not demonstrated in previous studies.

Our findings do not fit with the idea that anxiety increases the OEB by increasing stereotyping, as argued by Brigham (2008). Nor did we find evidence that potential anxiety-related stereotyping improved person memory for out-group members, which may decrease the OEB. Instead our results are consistent with recent studies which have suggested that anxiety does not increase the use of stereotypes in social judgments (e.g., Curtis, 2013; Curtis & Locke, 2005, 2007). However, given the apparent readiness with which people tend to categorize out-group members and activate relevant stereotypes (Macrae et al, 1994; Mason, Cloutier & Macrae, 2006), it seems likely that ethnic categories and associated stereotypes are already highly activated during typical OEB tasks. As noted by Young et al. (2012), typical OEB tasks probably contain categorization and stereotype-activation ceiling effects. It is possible that such ceiling effects may prevent detection of any anxiety-related moderation of the OEB. However, we would note that the response bias data in Experiment 1 suggests, in fact, that anxiety reduced the response bias pattern usually associated with the OEB. This finding supports the conclusion that anxiety led to inaccuracy via poorer encoding and subsequent poorer recognition rather than because anxiety contributed to a response bias that inflated false alarms.

It is well known that anxiety can deleteriously affect cognition (see Eysenck, Derakshan, Santos & Calvo, 2007). Anxious people process information less efficiently than relatively-calm people. A commonly-held explanation for this is that anxiety leads to worry over future misfortune that disrupts information processing, particularly encoding (Eysenck et al., 2007). Such worries divert people from whatever processing task they are engaged in, impairing the quality of processing and thus leading to performance deficits.

In Experiment 1, anxiety-related face-recognition deficits may have arisen during encoding because participants were distracted by thoughts of the speech that they were expecting to give after the experiment. By this explanation, anxious participants would have exerted less effort in the learning phase of the face-recognition task because they were consciously preoccupied with thoughts of the speech and the threat of later embarrassment. Cognitive distraction as an explanation for the impact of anxiety in Experiment 1 is consistent with explanations in the literature for the impact of anxiety on eyewitness accuracy (Deffenbacher et al., 2004; Steblay, 1992).

A potential future research direction would be to compare the impact of experimentally-induced anxiety with other cognitive distraction in an OEB task. For example, comparing anxious and control participants with distracted participants, e.g., people instructed to think about an up-coming, but not anxiety-producing, activity. This would provide a test of whether the impact of anxiety that we observed is accounted for by the cognitive distraction caused by worrying thoughts.

Eysenck et al. (2007) suggest that the detrimental impact of anxiety on cognition may be overcome by increased effort. Another potential future research direction is to examine whether instructions that promote a processing goal of increased effort during face encoding reduces the anxiety-related face-recognition deficit we observed. We note that more effortful processing has been shown to reduce the impact of anxiety on face-recognition accuracy (e.g., Mueller et al., 1979), but this has not been investigated in an OEB task.

Limitations

One limitation that should be acknowledged is the use of different anxiety inductions between Experiments 1 and 2, which was necessitated by differing ethical protocols among the universities where the experiments were conducted. We do not, however, believe that this biased the results. Both anxiety inductions elicit core components of anxiety such as autonomic arousal and worry over an aversive future event. Additionally, in both experiments the participants reported, during debriefing, that they were convinced that the manipulations were real. Given the similarities between the anxiety inductions, and participants' similar levels of anxiety across experiments, we argue that the anxiety inductions used in Experiments 1 and 2 produced comparable effects. Nevertheless, as the manipulations were not identical, this difference in methodology cannot be entirely excluded as a cause of the difference between the findings in Experiments 1 and 2.

Another limitation is that we only tested Caucasian participants. Without counter-balancing participant-ethnicity and face-ethnicity we cannot be completely certain that results were unaffected by a priori recognizability differences in the own- and other-ethnicity face-sets. However, this does not undermine the finding that anxiety at encoding impairs face recognition, but it may mean that recognizability differences across the face-sets may somehow have impaired our ability to detect anxiety-related OEB changes.

Taken together, the results of Experiments 1 and 2 suggest that anxiety impairs face encoding. However, this conclusion is based on the absence of an effect of anxiety in Experiment 2. It may be possible that the absence of an effect is a consequence of limited statistical power. To allay this concern, we must note that the sample in Experiment 2 (where anxiety had no effect) was more than double the size of the sample in Experiment

1 (where an effect was detected). Nevertheless, future studies should seek further evidence that anxiety impairs face encoding in the OEB paradigm.

Conclusion

Across two experiments, we found that anxiety reduced face-recognition accuracy for both own-ethnicity and other-ethnicity faces when anxiety was present during both encoding and retrieval, but not when induced only during retrieval. The question of whether anxiety influences the OEB has obvious practical relevance in the context of eyewitness identification. Surprisingly, no previous study had experimentally examined whether anxiety influences the OEB or whether encoding or retrieval are responsible for any anxiety—OEB relationship. Because of this, the present paper makes an important contribution to the OEB and anxiety literature.

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Footnotes

[1] Two independent raters suggested that second images were more difficult to recognise than altered images, making the Caucasians face-stimuli on average more difficult.

[2] Analyses of confidence and response latencies showed some trivial and inconsistent effects in Experiments 1 and 2. As these data were not the subject of hypotheses, and of little theoretical interest, they are not reported here. Interested readers may contact the corresponding author for these data.

[3] Note that the replication of the standard OEB occurred despite Caucasian faces being more difficult than African American faces.

[4] Due to an administrative error, four participants did not complete the trait anxiety measure.

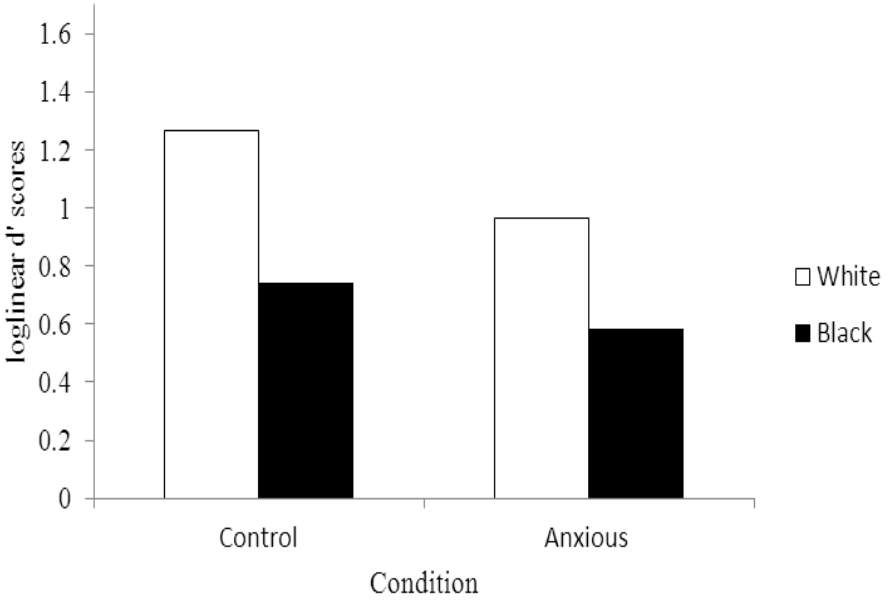

Figure 1. d-prime scores for African American (black) and Caucasian (white) faces from the control and anxiety conditions in Experiment 1.

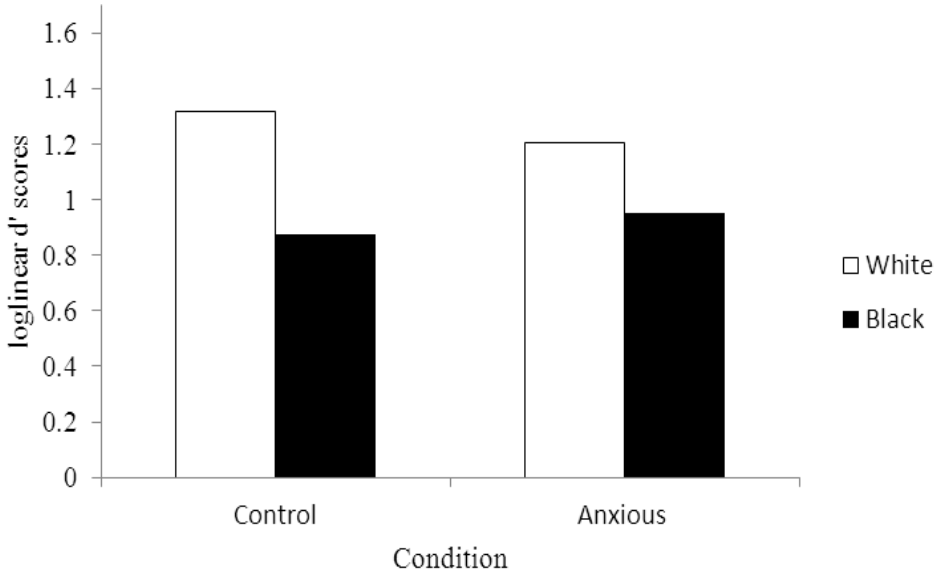

Figure 2. d-prime scores for African American (black) and Caucasian (white) faces from the control and anxiety conditions in Experiment 2.