Searching for Emotion or Race: Task Irrelevant Facial Cues have Asymmetrical Effects

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Abstract

Facial cues of threat such as anger and other race membership are detected preferentially in visual search tasks. However, it remains unclear whether these facial cues interact in visual search. If both cues equally facilitate search, a symmetrical interaction would be predicted; anger cues should facilitate detection of other race faces and cues of other race membership should facilitate detection of anger. Past research investigating this race by emotional expression interaction in categorisation tasks revealed an asymmetrical interaction. This suggests that cues of other race membership may facilitate the detection of angry faces but not vice versa. Utilising the same stimuli and procedures across two search tasks, participants were asked to search for targets defined by either race or emotional expression. Contrary to the results revealed in the categorisation paradigm, cues of anger facilitated detection of other race faces whereas differences in race did not differentially influence detection of emotion targets.

Keywords: Other race faces, emotional expression, visual search, anger superiority effect.

The human face is a rich source of information that has a profound effect on the manner in which we behave in a social situation. Should we approach or withdraw? Should we prepare for a pleasant conversation or to run? These decisions are made quickly and are frequently based only on the information displayed on another person's face. But which aspects of a face feed into these decisions and if there is more than one aspect that is considered, how is the information aggregated? The purpose of the present study was to investigate the influence of two facial characteristics: emotional expression and race in visual search. Processing of both race and emotional expression cues has been widely investigated, but the investigation of the combined effects of race and emotional expression on the manner in which we process faces has received less attention (Hutchings & Haddock, 2008). This seems surprising given that a number of findings have emerged to suggest parallels in the processing of angry or fearful and other race faces.

In isolation, both cues of emotional expression and race can signal threat. Studies measuring implicit evaluation using tasks such as affective priming have shown that angry or fearful as well as other race faces are evaluated negatively in comparison to happy or own race faces (Fazio & Olson, 2003; Lipp, Price & Tellegen, 2009). This negative evaluation is also evident in brain imaging studies that have documented increased blood flow in the amygdala in response to angry (Whalen et al., 1998) and other race faces (Cunningham et al., 2004). Preferential fear-learning as indexed by enhanced resistance to extinction has been shown for angry and fearful faces (Öhman, 1986) and for other race faces (Olsson, Ebert, Banaji, & Phelps, 2005).

Cues of threat have also been found to bias attentional processes. In visual search, a task where participants search through an array of faces to detect a target, more efficient detection of threatening stimuli has been found. Both angry and fearful facial expressions (Lipp et al., 2009) as well as other race faces (Levin, 2000) are detected faster that neutral or pleasant expressions and own race faces (but

see Becker, Anderson, Mortensen, Neufeld, & Neel, 2011 [emotional expression] and Lipp, Terry et al., 2009 [race] for a qualification).

Although the effects of race and emotional expression cues have been assessed in isolation, it remains unclear how performance may be influenced when multiple facial cues of threat are presented in visual search. Past studies on the effect of race and emotional expression cues tend to only investigate their combined effect rather than shedding light on the nature of the interaction between the cues within a particular task. However, these studies do demonstrate across a range of tasks that emotional expressions can influence the processing of race cues (Hugenberg & Bodenhausen, 2004) and race cues can affect the processing of emotional expression (Craig, Mallan, & Lipp, 2012; Hugenberg, 2005; Hugenberg & Bodenhausen, 2003).

Ackermann et al. (2006) demonstrated that the other race effect, the more accurate recognition of own race than other race faces, is moderated by emotional expression. Caucasian participants presented with both black and white faces displaying either neutral or angry expressions demonstrated greater accuracy recognizing other race faces when the faces expressed anger. In a similar vein, participants high in implicit prejudice were more likely to categorise racially ambiguous faces as African rather than Caucasian when they displayed anger but not when they displayed happiness (Hugenberg & Bodenhausen, 2004) and the categorization of ambiguous race angry faces as black also led participants to report the expression as more intense than if the faces were categorised as white (Hutchings & Haddock, 2008). These studies present converging evidence to suggest that emotional expression cues influence the processing of race cues in recognition and categorisation.

Other evidence demonstrates that race cues can influence the processing of emotional expressions. Participants high in implicit prejudice detected the offset of anger later for black than white faces when watching videos of these faces morphing from a clearly hostile expression to a neutral expression (Hugenberg & Bodenhause, 2003). Similarly, in an emotion categorisation tasks,

white participants categorized Caucasian faces faster when they were happy than when they were angry whereas black faces were categorized faster when they were angry (Hugenberg, 2005).

The few attempts to determine the nature of the interaction between race and emotional expression within the same task have produced mixed results. Karnadewi and Lipp (2011) used the Garner categorisation paradigm and found an asymmetrical interaction between race and emotional expression. Participants categorised faces on one dimension, i.e., race or emotional expression, under conditions where the second dimension was held constant, e.g. participants categorised only Caucasian faces on emotional expression, or under conditions where the second dimension was allowed to vary, e.g., participants categorised Caucasian and African faces on emotional expression. Variations in face race influenced the categorisation of emotional expressions but variations in emotional expression did not influence the categorisation of race. Conversely, Kubota and Ito (2007) investigated event related potential in a categorisation paradigm and failed to find any influence of race cues on emotional expression categorisation or vice versa.

Visual search also offers the opportunity to assess the interaction between task irrelevant facial cues, such as race, and task relevant facial cues, such as emotional expressions and vice versa. Across two separate tasks, participants searched through arrays of faces of own and other races expressing happiness and anger to detect targets defined either by race or by emotional expression. As the current state of knowledge regarding the interaction of race and emotional expression remains underdeveloped, strong predictions cannot be made, however, the current literature allows us to propose alternative hypotheses.

If cues of threat equally facilitate search then a symmetrical interaction should emerge in a search task where both race and emotion cues are present. Cues of other race membership should facilitate detection of angry faces and the presence of anger should facilitate detection of other race faces. Alternatively, if one threat cues is processed preferentially, as in the Garner paradigm

(Karnadewi & Lipp, 2011), we predict an asymmetrical interaction. Cues of race should facilitate the detection of threatening angry faces whereas cues of emotional expression should have no effect on the detection of other race faces.

Method

Participants

Thirty-four Caucasian undergraduate students (27 females, M = 19.00), provided informed consent and volunteered participation. Participants received course credit or AUS$10 to compensate for their efforts.

Apparatus

Participants were seated at a distance of 70 cm in front of a 17-inch (43cm) CRT monitor which was used to display the experimental tasks. The task was implemented using custom written software and run under DOS to ensure accurate millisecond timing. Participants' responses were registered with a two-button button box operated with their left and right index fingers. The buttons were labelled 'Same' and 'Different' and response mapping was counterbalanced across participants.

Thirty-six photographs of nine African American and nine Caucasian males each displaying happy or angry facial expressions served as stimulus materials. The photos were sourced from the NimStim face database (Tottenham et al., 2009; angry and happy, mouth closed versions of posers 20, 21, 22, 32, 34, 38, 39, 40, 41, and 43) and the Montreal Set of Facial Displays of Emotion (Beaupré & Hess, 2003; angry and happy versions of posers 20, 21, 22, 23, 30, 31, 32, 33). Pictures from the MSFDE were edited to reduce the impact of the toothy smile displayed by the encoders on the happy pictures. All faces were resized, set on a grey scale, dropped in a grey background of 260 x 195 pixels (7.52° x 5.97° of visual angle if presented centrally), and matched for brightness and contrast. Pictures were presented in matrices of nine (3x3) pictures subtending 22.42° x 17.90° of visual angle.

Procedure

Participants completed two search tasks in counterbalanced order. They viewed arrays of nine faces presented on the computer screen. In one task, participants indicated whether all nine faces had the same emotional expression or whether there was a different expression present (e.g. an angry face in a background of happy faces). In the second task, participants detected targets differing from the background faces in race (e.g. an African face in a background of Caucasian faces). Participants were asked to respond as quickly as possible but to avoid mistakes.

The general task parameters were similar to those used in previous research on preferential attention to emotional faces (Lipp et al., 2009). Each task comprised the same set of 288 trials organized in two blocks of 144 trials and presented in two different random sequences. In each block of 144 trials, 36 trials each comprised eight background faces of the same race and expression, African happy, African angry, Caucasian happy, or Caucasian angry. The ninth face was either the same as the backgrounds (e.g., all African happy), or differed in expression (e.g. African angry among African happy), in race (e.g. Caucasian happy among African happy), or in expression and race (e.g. Caucasian angry among African happy). This meant that in each block participants saw all possible combinations of the three factors Background (African happy, African angry, Caucasian happy, Caucasian angry) x Target (African happy, African angry, Caucasian happy, Caucasian angry) x 9 Target positions.

A single trial consisted of the presentation of a white fixation cross, subtending 1.53° x 1.53° of visual angle, in the middle of a black screen for 1000ms. The fixation cross was replaced by a 3x3 matrix of nine pictures displayed for 6000ms or until the participant made a response. Trials were separated by an inter-trial interval of 1000ms during which the screen was black. Participants completed a practice task before the two main tasks. Preliminary analyses including Task-order as a factor found participants faster in the task completed second, but no interaction involving the factor sequence, largest $F(1,32) = 2.82$, $p = .103$, $\eta_p^2 = .081$.

Participants were asked to search for targets differing in emotional expression in one task and to search for targets differing in race in the second. Thus, presentation of a happy Caucasian face among happy African faces was a target trial ('Different' response) in the race task, but a Non-target trial ('Same' response) in the emotional expression task. Conversely, presentation of an angry African face among happy African faces was a target trial ('Different' response) in the emotional expression task, but a Non-target trial in the race task ('Same' response; see Table 1 for a summary). To avoid confusion we will refer to stimuli that differ from the backgrounds on the dimension that required pressing the button labelled 'Different' as targets (e.g., happy Caucasian face among angry Caucasian faces in the emotional expression task), and to stimuli that differ from the backgrounds, but require pressing the button labelled 'Same' as deviants (e.g. happy Caucasian face among angry Caucasian faces in the race task).

Given this method, results cannot simply be stimulus driven as the same sets of stimuli were used in both tasks. Results must be due to the interaction of race and emotional expression within the specific demands of each task.

Scoring, response definition and statistical analysis

Incorrect button presses or failures to respond within the maximum time allowed were excluded from analysis. In addition, responses faster than 100ms and responses three standard deviations faster or slower than a participants' average response time were not incorporated into analyses. Less than 1% of the data were excluded based on this criterion. Analyses were based on mean response times for each condition averaged across target positions. Error rates were higher for target trials (Emotional expression task: Mean = 25.82 %, SD = 17.29; Race task: 13.56 %, SD = 9.62) than for Non-target trials (Emotional expression task: Mean = 6.58 %, SD = 7.32; Race task: 6.27 %, SD = 7.18) and indicate that both tasks were not trivial. Preliminary analysis of errors revealed no evidence for a speed

accuracy trade-off. The current report is limited to reaction time data however detailed information as to the analysis of error percentages is available on request from the first author.

Results

As can be seen in Figure 1, an asymmetrical interaction between race and emotional expression emerged[1]. There was no differential effect of target race on emotional expression detection. Emotion targets that also deviated in race were detected faster regardless of race or emotional expression. However, emotional expression differentially affected the detection of targets defined by race; Anger uniformly facilitated the detection of African faces but not Caucasian faces.

Emotional expression task

Response times from the Emotional expression task were subjected to separate 2 x 2 x 2 (Background Emotional expression [happy, angry] x Background Race [African American, Caucasian] x Target/Deviant Race [African American, Caucasian]) factorial ANOVAs for Target and Non-target trials.

As shown in the upper panel of Figure 1, the task irrelevant cue of target race affected the detection of emotional targets uniformly. Emotional targets that differed in race from the background were found faster regardless of target race or emotional expression. Moreover, participants seemed overall slower to find targets among Caucasian angry backgrounds. The analysis confirmed this yielding a main effect for Background Race, $F(1,33) = 4.69$, $p = .038$, $\eta_p^2 = .124$, as well as Background Emotional expression x Background Race, $F(1,33) = 24.80$, $p < .001$, $\eta_p^2 = .429$, and Background Race x Target Race interactions, $F(1,33) = 16.52$, $p < .001$, $\eta_p^2 = .334$. The Background Emotional expression x Background Race interaction reflects that participants were slower to find emotional targets among angry Caucasian backgrounds, than among any other, all $t(33) > 3.74$, $p <$

[1] To rule out the possibility that these findings are due to type I error, a study investigating the interaction of race and emotion using a between groups design was also conducted. The asymmetrical interaction reported here was replicated – for a detailed report see supplementary materials.

.001. The Background Race x Target Race interaction indicates faster detection of emotion targets that also differed in race regardless of target emotional expression, both $t(33) > 2.50$, $p < .05$.

In Non-target trials, participants were slower to search through angry Caucasian backgrounds than any others. Presence of a race deviant seemed to slow search if the deviant was African American, but not if it was Caucasian. The analysis confirmed these impressions yielding a main effect for Background Emotional expression, $F(1,33) = 51.56$, $p < .001$, $\eta_p^2 = .610$, as well as Background Emotional expression x Background Race, $F(1,33) = 25.17$, $p < .001$, $\eta_p^2 = .433$, and Background Race x Deviant Race interactions, $F(1,33) = 11.28$, $p = .002$, $\eta_p^2 = .255$. The Background Emotional expression x Background Race interaction reflects on slower search through angry Caucasian backgrounds than through angry African American backgrounds, $t(33) = 4.75$, $p < .001$, which in turn were searched slower than happy African American or Caucasian backgrounds, both $t(33) > 3.94$, $p < .001$. Presence of an African American deviant among Caucasian backgrounds, $t(33) = 3.33$, $p = .002$, but not of a Caucasian deviant among African American backgrounds, $t < 1.42$, $p = .150$, slowed search through Non- target matrices.

Race task

Response times from the Race task were subjected to separate 2 x 2 x 2 (Background Race [African American, Caucasian] x Background Emotional expression [happy, angry] x Target/Deviant Emotional expression [happy, angry]) factorial ANOVAs for Target and Non-target trials. Figure 1, lower panel, summarises the response times from the Target trials.

Whereas the effect of face race in the Emotional expression task was uniform for African American and Caucasian faces, the effects of emotional expression differed across different race and emotional expression backgrounds. Angry African targets were found faster than happy African targets regardless of background expression whereas angry Caucasian targets were found faster than happy Caucasian targets among happy African backgrounds, but not among angry African backgrounds. This

pattern was confirmed by main effects for Background Race, $F(1,33) = 22.32$, $p < .001$, $\eta_p^2 = .404$, and Target Emotional expression, $F(1,33) = 11.67$, $p = .002$, $\eta_p^2 = .261$, as well as a Background Race x Background Emotional expression x Target Emotional expression interaction, $F(1,33) = 14.35$, $p = .001$, $\eta_p^2 = .303$. The three way interaction reflects that participants were faster to find angry than happy African targets among Caucasian backgrounds regardless of emotional expression; and faster to find the angry Caucasian than the happy Caucasian target only among happy African backgrounds, all $t(33) > 2.86$, $p < .007$.

In Non-target trials, participants were slower to search backgrounds of Caucasian than of African faces, $F(1,33) = 11.14$, $p = .002$, $\eta p^2 = .252$, and slower to search backgrounds of angry than of happy faces, $F(1,33) = 6.17$, $p = .018$, $\eta p^2 = .158$. The presence of an emotional expression deviant did not affect the search times.

Discussion

The aim of the current investigation was to determine the nature of the interaction between two threat cues, other race membership (Levin, 2000) and expressions of anger (Lipp et al., 2009), in the context of visual search. If these threat cues mutually facilitate threat detection, then cues of other race membership should facilitate the detection of anger and cues of anger should facilitate the detection of other race faces. The current results are inconsistent with this prediction of a symmetrical interaction, but yielded evidence for an asymmetrical interaction. In the emotional expression task, targets that differed in race as well as emotional expression were found faster than targets that differed in emotional expression only. This search advantage was uniform across all combinations of race and emotional expression indicating that there was no selective advantage for detecting angry other race targets relative to any others. The race task on the other hand provided evidence for a selective influence of emotional expression on race target detection. Participants were faster to find angry African faces than happy African faces regardless of the emotional expression displayed by the

Caucasian background faces. A similar effect was evident for angry Caucasian faces among happy African faces, but not among angry African faces. Thus, relative to happy African faces, angry African faces are detected preferentially among happy and angry Caucasian faces whereas, relative to happy Caucasian faces, angry Caucasian faces are detected preferentially only among happy African faces.

This difference in visual search cannot be attributed to effects of low level perceptual features as the same stimuli and stimulus configurations were used in both tasks. Thus, differences in target detection reflect on the processing of the dimension, race or expression, that defines the targets in a particular task. It should be noted that the effect of anger on African faces can be seen as manifesting in two ways – facilitation of target detection regardless of backgrounds or preventing faster detection of angry Caucasian faces when used as backgrounds. We chose to emphasize the former view as there was no evidence for slower search through angry African background faces on Non-target trials.

Although the current results are contrary to what would be predicted extrapolating from studies of the race by emotion interaction in face categorisation (Karnadewi & Lipp, 2011), the finding that emotional expressions can affect the processing of race cues is not unique within the current the literature. Caucasian participants high in implicit prejudice were faster to label faces morphing between Caucasian and African as African when they are displaying anger (Hugenberg & Bodenhausen, 2004; Hutchings & Haddock, 2008). Angry expressions appear to facilitate the perception of other race cues by shifting the decision threshold as to when a face is labelled as belonging to the racial out-group. However, finding different race-expression interactions in search and categorisation paradigms remains intriguing. This may reflect as much on our currently limited understanding of the factors that determine performance in categorisation tasks (see Craig et al., 2012) as well as on the fact that performance in visual search is not only a function of the target stimuli used, but also of the backgrounds and their interaction. Moreover, the assumption of a mapping between faster categorisation and faster target detection may be overly simplistic. The search literature currently

provides evidence for both, happiness and anger superiority effects (Becker et al., 2011; Savage et al., 2013) whereas the happy face advantage is well documented in categorisation (Leppänen & Hietanen, 2003). These inconsistencies may be seen as problematic in that they provide for an inconsistent literature. On the other hand, they provide an opportunity to further our understanding of the manner in which emotional expressions or invariant cues like race cues are processed as they can offer a starting point for process level based analysis. Thus we propose that the current approach which holds stimuli and task constant, but varies which aspect of the stimuli is task relevant be extended to other task domains – and thus different psychological processes.

The current finding of an effect of emotional expression cues on the processing of race in absence of the inverse pattern is unique. It should be noted that such asymmetries are not uncommon in the literature on visual search (Treisman & Souther, 1985). A recent account assessed search asymmetries in the context of prototypicality effects pointing to the finding that a prototype is more difficult to detect among deviants than a deviant among prototypes (Kayaert, Op de Beeck, & Wagemans, 2011)[2]. It is interesting to speculate about whether this account can be applied in the present context, by proposing that a race prototype may include an emotional expression whereas race does not form part of an emotion prototype. However, in the absence of a broader data base, this seems to be beyond the scope of the current report.

The current search results suggest that race cues do not provide for differential guidance of spatial attention in the search for emotional targets. Having a Caucasian face among African faces or vice versa aids target detection in a manner that is uniform across races. Moreover, the effect of a race deviant on the detection of an emotional target was less than 200ms, a saving that seems rather small given the overall rather slow target detection times in the emotional expression task. This seems to suggest that participants were well able to focus on the search for different emotional expressions and

[2] We would like to thank the anonymous reviewer who pointed this out to us.

that attention was not captured by the other race singleton in the display (Theeuwes & Burger, 1998). Search for targets defined by race was overall faster and generated fewer errors than search for targets defined by emotional expression suggesting that the race task was easier than the emotional expression task. This is consistent with the notion that race cues are more uniform across individuals and easily detected (Montepare & Opeyo, 2002) than are emotional expression cues, in particular for the closed mouthed facial expressions used here. It seems difficult to see, however, how a difference in task difficulty can account for the current results. As suggested by the response times, the race task was not trivial and there was no floor effect as the emotional expressions aided target detection, in particular for African target faces.

In summary, using the same stimulus materials and varying only the task instructions, the current study provides evidence for an asymmetrical interaction in the processing of emotional expression and race cues. Anger facilitated the detection of other, but not of same race target faces across all background conditions. Race cues, on the other hand did not have a differential effect on the detection of targets defined by emotional expressions. This pattern of results is not consistent with the notion that the combination of two threat cues, other race and anger, will lead to preferential processing.

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Table

Table 1: *Breakdown of Target and Non-target trials in the Emotional expression (EE) and Race (R) tasks as a function of face stimuli presented as background and as target/deviant stimuli.*

	Target/Deviant			
Background	African happy	African angry	Caucasian happy	Caucasian angry
African happy	EE & R: No target	EE: Target R: No target	EE: No target R: Target	EE & R: Target
African angry	EE: Target R: No target	EE & R: No target	EE & R: Target	EE: No target R: Target
Caucasian happy	EE: No target R: Target	EE & R: Target	EE & R: No target	EE: Target R: No target
Caucasian angry	EE & R: Target	EE: No target R: Target	EE: Target R: No target	EE & R: No target

Figure

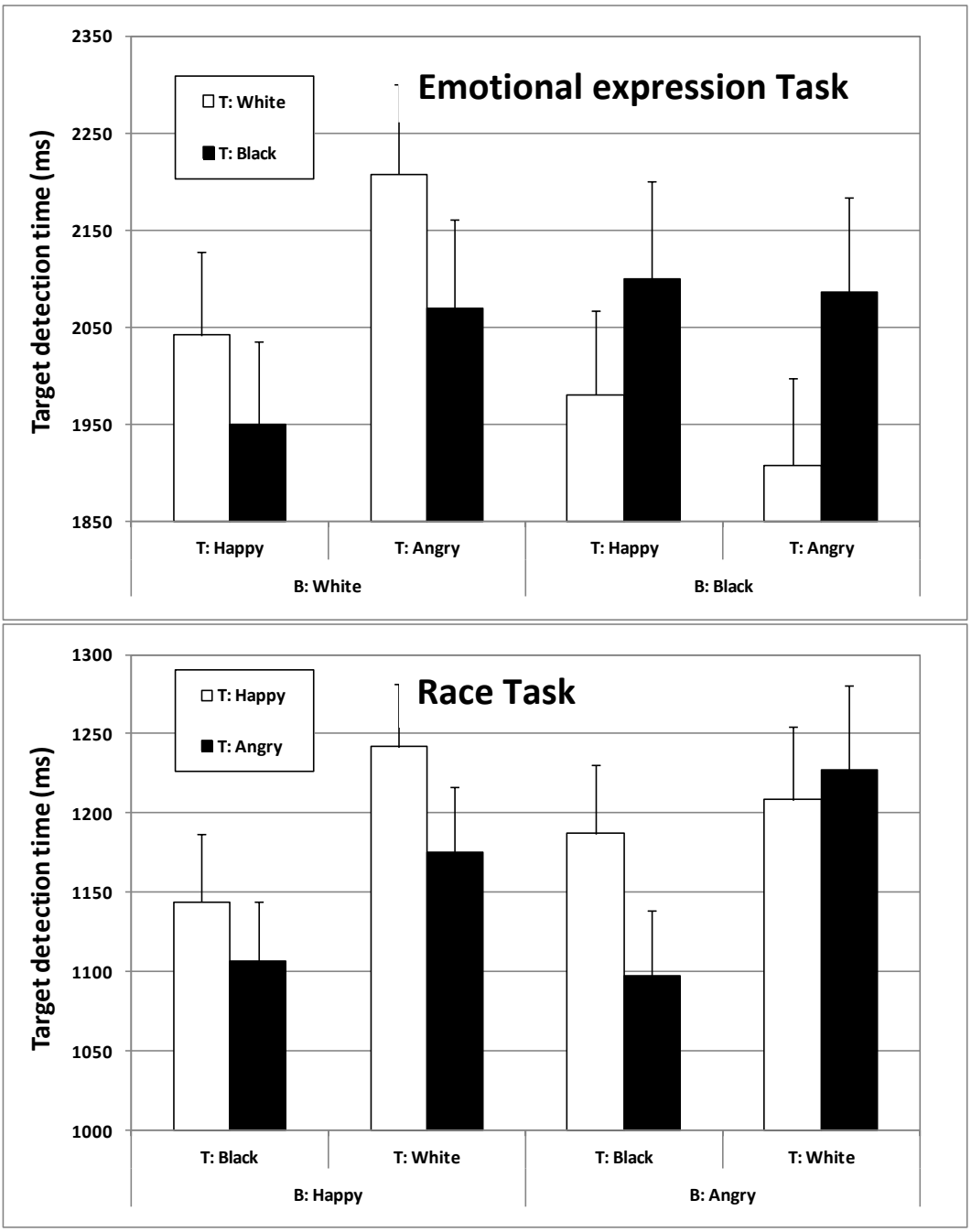

Figure 1: Target detection time on target trials in the Emotional expression (upper panel) and Race tasks (lower panel). There was no differential effect of target race in the Emotional expression task with all emotional targets that differed in race as well found faster than same race targets. There was a differential effect of target expression in the Race task, with angry Caucasian targets found faster than happy Caucasian targets only among happy African faces whereas angry African targets were found faster than happy African targets among happy and angry Caucasian background faces (error bars indicate standard errors of the mean).

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Supplementary materials

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Supplementary Experiment 1: Searching for emotional expression targets

Experiment 1 was designed to assess the effect of poser race on the detection of angry or happy target faces among neutral backgrounds, and of neutral target faces among angry or happy backgrounds. Race, Caucasian vs. African American, was treated as a latent variable that was varied between tasks. Based on previous research (Lipp, Price, & Tellegen, 2009; Öhman, Lundqvist, & Esteves, 2001) it was predicted that emotional targets would be found faster than neutral targets and that on Non-target trials search through emotional backgrounds would be slower than through neutral backgrounds. The latter difference was expected to be larger for African American faces, which also should be found faster when used as emotional targets, in particular when expressing anger.

Method

Participants. Twenty-five Caucasian undergraduate students (15 female, *M*= 20.20 years; range of 17-29 years) volunteered participation and provided informed consent. Participants received course credit or AUS$10 in exchange for participation.

Apparatus and Materials. The apparatus and materials are similar to those described in the manuscript, however, in addition to the 36 photographs used in the original experiment, the neutral expressions of each individual depicted in the original experiment were included. These images were edited in the same manner as in the original experiment. This resulted in 54 photographs, nine each of male African American and Caucasian persons displaying neutral, happy or angry facial expressions.

Procedure. Participants completed four tasks, searching through grids of 4 or 9 faces and indicating whether the expressions displayed were all the same or whether a different expression was present. In two of the tasks, the expressions displayed were neutral or happy whereas they were neutral or angry in the other two tasks. One each of the emotion tasks, neutral/happy and neutral/angry, employed African American faces whereas the second set employed Caucasian faces. Participants were asked to respond as quickly as possible but to avoid mistakes and to fixate on the centre of the screen

whenever the fixation cross was presented.

The general task parameters were the same as used in the original experiment. In each task, participants were presented with a sequence of 156 trials organized in three blocks of 52 trials, 16 displaying four picture grids and 36 displaying nine picture grids. The 16 four picture grids comprised 8 Target trials, 2 backgrounds (Expression [Neutral vs. Emotional]) x 4 positions for the target, and 8 Non-target trials. The 36 nine picture grids consisted of 18 Target trials, 2 backgrounds (Expression [Neutral vs. Emotional]) x 9 positions for the target, and 18 Non-target trials. The trials were created by allocating a random permutation of the nine pictures per category (neutral or happy/angry) to each position in the nine picture grid so that all pictures in a single trial were of a different individual. On 4 picture grids, the five non-corner positions were blacked out. On Target trials, target pictures, i.e., a picture of the same person displaying a different emotion, were inserted such that each possible grid position held a target once and that each picture was used as target once within each set of 36 nine picture trials and not more than twice across the three sets of four picture trials. Thus, three of the pictures per category were used as target five times and six were used four times. The trial sequence within each block was randomized with the restriction that no more than three consecutive trials were of the same size, had the same emotional background, or required the same response.

Trials were structures as in the original experiment except that both set sizes of 4 and 9 were used. The nature of the emotional expression, angry or happy, and poser race were varied across tasks. The sequence in which the tasks were completed was counterbalanced across participants. The first task was preceded by a practice task of 10 trials which used schematic faces as stimuli (Lipp, 2006).

Scoring, response definition and statistical analysis. Data were pre-processed as in the original experiment. Search time and error data were subjected to 2 x 2 x 2 x 2 (Race [African American vs. Caucasian] x Expression [neutral, emotional] x Emotion [happy, angry] x Size [2x2, 3x3]) factorial ANOVAs for Target and Non-Target trials separately. Due to incomplete data in one of

the cells, the analyses for Target trials are based on 24 participants and those for Non-target trials on data from 22 participants. Again, no evidence emerged for a speed accuracy trade-off. The results of the error analyses are available upon request from the first author.

Results

The upper panel of Figure 1 summarizes the detection times on the Target trials. As can be seen, participants were slower to search nine-picture than four-picture grids, $F(1,23) = 89.63$, $p < .001$, $\eta_p^2 = .796$, slower in the search for angry than in the search for happy targets, $F(1,23) = 31.11$, $p < .001$, $\eta_p^2 = .575$, and faster to find an emotional target among neutral faces than a neutral target face among emotional faces, $F(1,23) = 20.10$, $p < .001$, $\eta_p^2 = .466$. Moreover, there was an Emotion x Set Size interaction, $F(1,23) = 7.97$, $p = .010$, $\eta_p^2 = .257$, which reflects that although participants were slower to find targets in large than in small grids in tasks involving happy and angry faces, all $t(23) > 13.40$, this difference was larger in the tasks involving angry faces.

The search times on Non-target trials are summarized in the lower panel of Figure 1. The analysis yielded main effects for Expression, $F(1,21) = 41.01$, $p < .001$, $\eta_p^2 = .661$, Emotion, $F(1,21) = 35.44$, $p < .001$, $\eta_p^2 = .628$, and Set Size, $F(1,21) = 75.44$, $p < .001$, $\eta_p^2 = .782$, as well as Expression x Emotion, $F(1,21) = 27.06$, $p < .001$, $\eta_p^2 = .563$, Expression x Size, $F(1,21) = 9.13$, $p = .006$, $\eta_p^2 = .303$, and Race x Emotion x Set Size interactions, $F(1,21) = 4.98$, $p = .037$, $\eta_p^2 = .192$. The Expression x Emotion interaction reflects that participants were faster to search through neutral than through angry backgrounds, $t(21) = 8.11$, but not faster to search through neutral than through happy backgrounds, $t(21) < 1$. The Expression x Size interaction reflects that participants were faster to search through neutral than through emotional backgrounds for both grid sizes, both $t(21) > 5.43$, but the difference was larger for the larger grids. Finally, the three way Race x Emotion x Size interaction indicates faster search through small grids of African American than of Caucasians faces in the Angry Task, $t(21) = 3.98$, but not for any other combination of Emotion and Size, all $t < 1.60$.

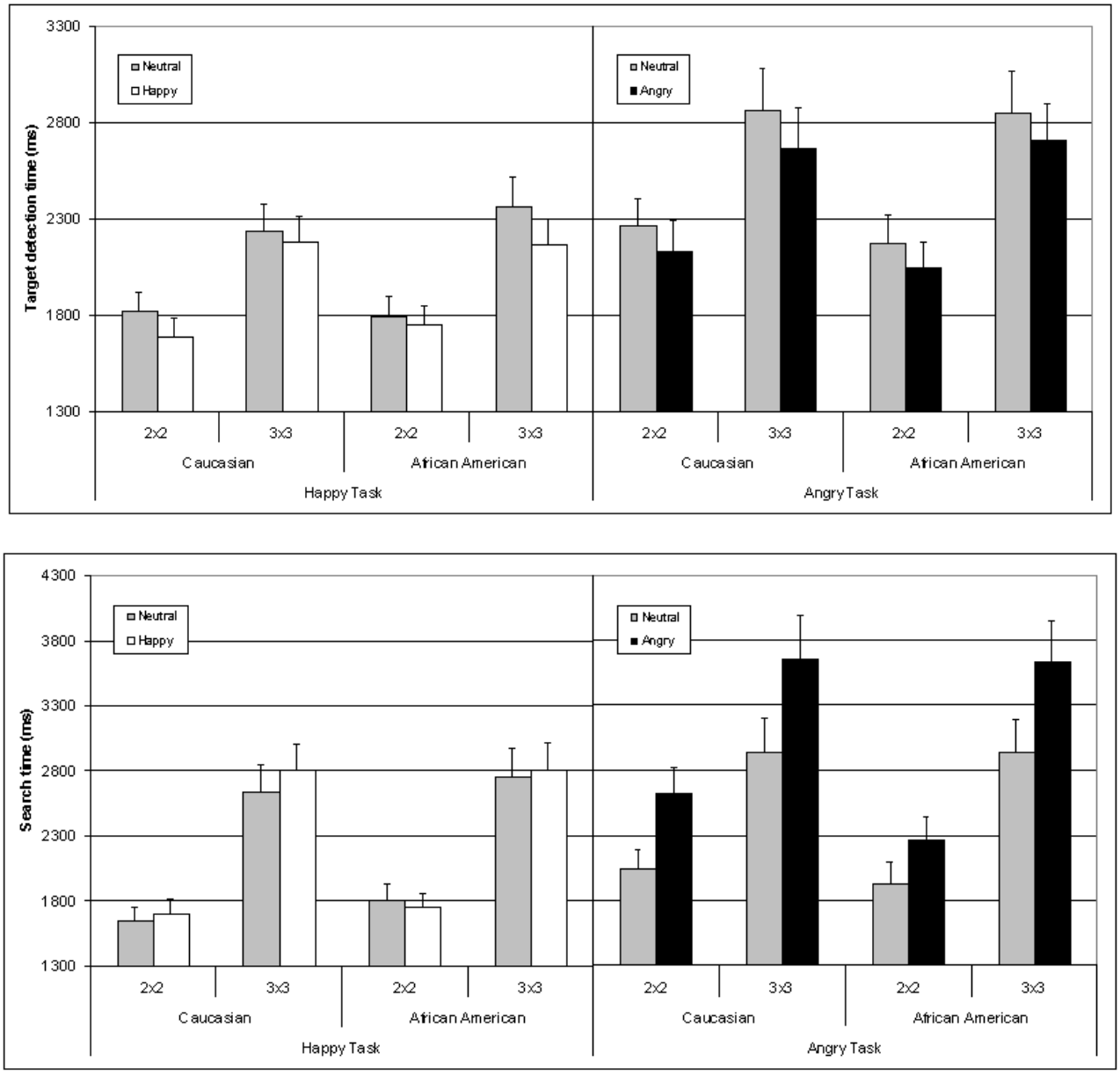

Figure 1: Upper panel: Mean target detection time as a function of poser race and grid size. For the Happy Task, detection times are shown for happy targets among neutral backgrounds and for neutral targets among happy backgrounds; for the Angry Task, detection times are shown for angry targets among neutral backgrounds and for neutral targets among angry backgrounds. The pattern of results was not affected by poser race. Lower panel: Mean search time for Non-target grids as a function of poser race and grid size. For the Happy Task, search times are shown for search through neutral and happy backgrounds; for the Angry Task, search times are shown for search through neutral

and angry backgrounds. Poser race had no differential effect on the search through backgrounds of different expression (error bars are standard errors of the mean).

Discussion

The aim of Supplementary Experiment 1 was to replicate the finding from the original study that task irrelevant race cues do not differentially affect the detection of targets defined by emotional expression in a between task design. As predicted, there was no evidence for differences in the detection of emotional targets between the tasks involving African or Caucasian faces. Emotional targets were uniformly found faster than neutral targets in all four tasks completed regardless of target emotion or poser race.

Supplementary Experiment 2: Searching for race targets

As did the original Experiment, Supplementary Experiment 1 did not provide evidence for an interaction between poser race and emotional expression in visual search for emotional targets. Supplementary Experiment 2 was designed to assess whether a different pattern emerges if participants are asked to search for differences in race among faces displaying different emotional expressions as was the case in the original Experiment. Thus, in Supplementary Experiment 2, emotional expressions, neutral, happy or angry, varied across tasks and served as the latent variable in the search for targets defined by race.

Method

Participants. Twenty-four Caucasian participants (15 females, average = 19.80 years; range 18-34 years) volunteered participation in exchange for course credit or were reimbursed AUS$10 for their participation.

Apparatus, Materials, and Procedure. Supplementary Experiment 2 employed the same stimulus materials and apparatus as did Supplementary Experiment 1. Participants were asked to complete three visual search tasks that required the detection of a person of different race. Emotional

expression, neutral, happy or angry, was varied across tasks. In each task, participants were presented with a sequence of 156 trials comprising three blocks of 16 four picture grids and 36 nine picture grids. The 16 four picture grids comprised 8 Target trials, 2 backgrounds (Race [African American vs. Caucasian]) x 4 positions for the Target, and 8 Non-target trials. The 36 nine picture grids consisted of 18 Target trials, 2 backgrounds (Race [African American vs. Caucasian]) x 9 positions for the target, and 18 Non-target trials. The allocation of pictures within trials, the structure of the trials, and the nature of the practice task were the same as in Supplementary Experiment 1. All participants completed the task with neutral faces first and the sequence of the two emotion tasks was counterbalanced across participants.

Scoring, response definition and statistical analysis. Data screening and reduction were completed as above. Search time and error data were subjected to separate 3 x 2 x 2 (Emotion [neutral, happy, angry] x Race [African American vs. Caucasian] x Size [2x2, 3x3]) factorial ANOVAs for Target and Non-target trials.

Results

The upper panel of Figure 2 displays the detection times for African American and Caucasian target stimuli as a function of displayed emotion and grid size. As can be seen, differences in target detection time seem smaller for the small grids than for the larger ones. Moreover, the search advantage for African American targets seems larger among angry faces, than among neutral or happy faces. The analysis confirmed this yielding main effects for Emotion, $F(2,22) = 5.51$, $p = .011$, $\eta_p^2 = .334$, and Set Size, $F(1,23) = 17.11$, $p < .001$, $\eta_p^2 = .427$, as well as Emotion x Race , $F(2,22) = 3.66$, $p = .042$, $\eta_p^2 = .250$, and Race x Set Size interactions, $F(1,23) = 11.50$, $p = .003$, $\eta_p^2 = .333$. The Race x Size interaction reflects that participants were faster to find African American than Caucasian targets in the larger grids, $t(23) = 4.68$, but not in the small grids, $t(23) = 0.19$, *ns*. The Emotion x Race interaction reflects that participants were faster to find African American than Caucasian targets among angry

faces, $t(22) = 4.80$, but not among happy, $t(22) = 2.08$, *ns*, or neutral faces, $t(22) = 1.28$, *ns*.

The lower panel of Figure 2 displays the time required to search Non-target trials. Participants were slower to search larger grids, $F(1,23) = 81.93$, $p < .001$, $\eta_p^2 = .781$, and tended to be faster to search through grids comprising African American faces, $F(1,23) = 3.82$, $p = .063$, $\eta_p^2 = .142$.

Discussion

Results from Supplementary Experiment 2 suggest that poser race and emotional expression interact if participants are asked to search for a target face defined by race. African American targets were found faster than Caucasian targets when expressing anger, but not if the target had a happy or neutral expression. The latter finding, together with the finding of a tendency towards faster search through Non-target grids comprising African American faces, is consistent with the original Experiment. The finding that other race targets are found faster in angry backgrounds suggests that the emotional context can set the occasion for more efficient search for race deviants. This finding deviates from the results of Supplementary Experiment 1 where, inversely, face race did not affect the detection of targets that were defined by emotional expression. Together these Supplementary Experiments confirm the reliability of the results presented in the original study.

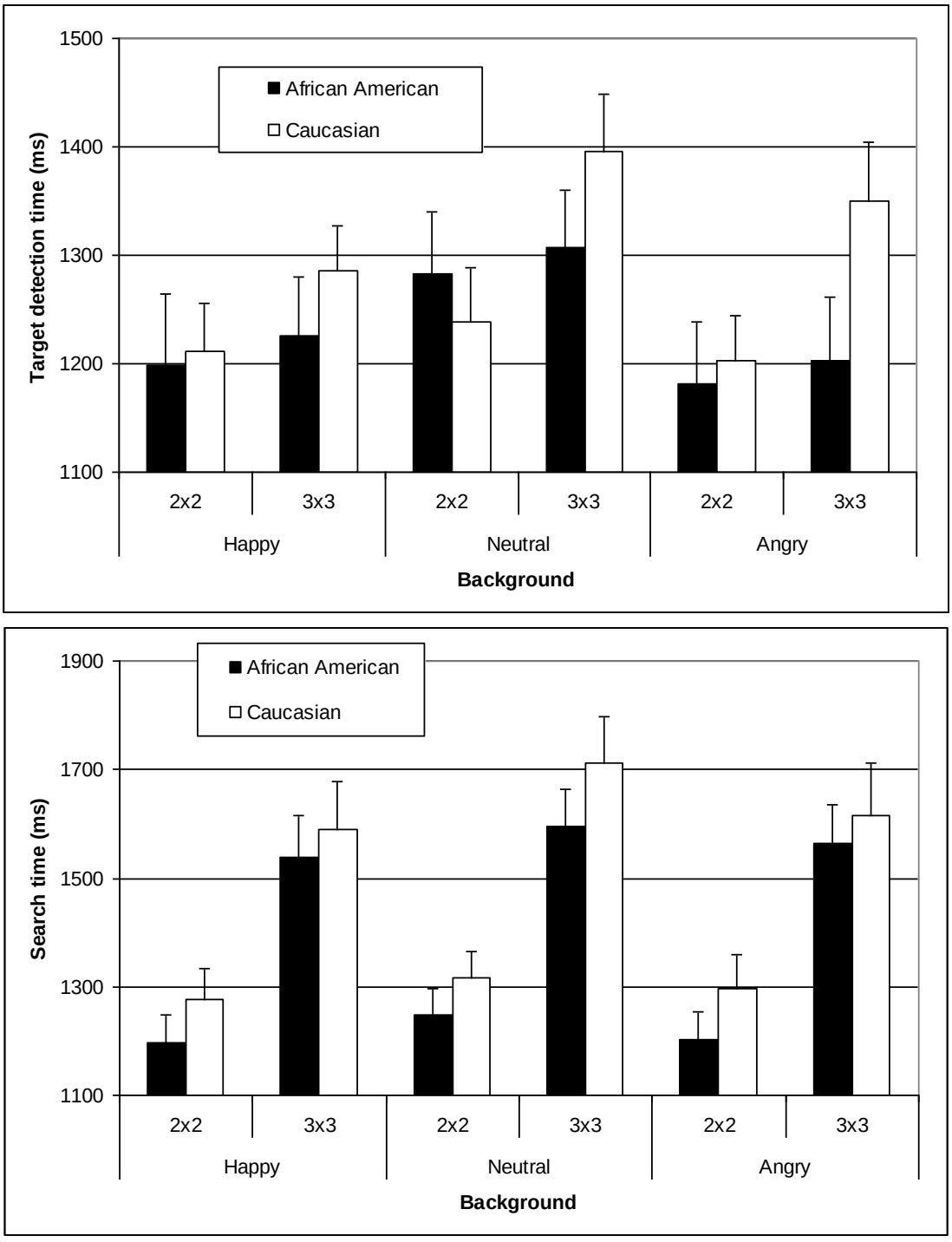

Figure 2: Mean target detection time for African American and Caucasian targets as a function of emotional expression and grid size (upper panel) and mean search time for Non-target trials comprising African American or Caucasian faces as a function of emotional expression and grid size in Supplementary Experiment 2 (lower panel; error bars are standard errors of the mean).

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