Visual search for emotional expressions: Effect of stimulus set on anger and happiness superiority

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Abstract

Prior reports of preferential detection of emotional expressions in visual search have yielded inconsistent results, even for face stimuli that avoid obvious expression-related perceptual confounds. The current study investigated inconsistent reports of anger and happiness superiority effects using face stimuli drawn from the same database. Experiment 1 excluded procedural differences as a potential factor, replicating a happiness superiority effect in a procedure that previously yielded an anger superiority effect. Experiments 2a and 2b confirmed that image colour or poser gender did not account for prior inconsistent findings. Experiments 3a and 3b identified stimulus set as the critical variable, revealing happiness or anger superiority effects for two partially overlapping sets of face stimuli. The current results highlight the critical role of stimulus selection for the observation of happiness or anger superiority effects in visual search even for face stimuli that avoid obvious expression related perceptual confounds and are drawn from a single database.

Keywords: emotional expression; visual search; anger superiority effect; happiness superiority effect.

Past research on the preferential processing of facial expressions of emotion in visual search has yielded a rather varied pattern of results (for a review, see D.V. Becker, Anderson, Mortensen, Neufeld, & Neel, 2011). Consistent with the notion that threatening stimuli may receive processing priority, the first study to assess the processing of emotional expressions in visual search reported an anger superiority effect (Hansen & Hansen, 1988). Angry target faces were found faster than happy target faces, and appeared to 'pop-out', within crowds of neutral or emotional distractor expressions. This 'pop-out' effect was later shown to be the result of a black spot at the base of one of the angry faces used (Hampton, Purcell, Bersine, Hansen, & Hansen, 1989), and further research suggested that once a number of low-level visual confounds were controlled for, happy faces were actually detected fastest (Purcell, Stewart, & Skov, 1996). Subsequent research has either provided support for the anger superiority effect (e.g., Frischen, Eastwood, & Smilek, 2008; Horstmann & Bauland, 2006; Lipp, Price, & Tellegen, 2009a) or for the opposite outcome, a happiness superiority effect (Juth, Lundqvist, Karlsson & Öhman, 2005; D.V. Becker, et al. 2011; Calvo & Nummenmaa, 2008).

Reflecting this inconsistent pattern of results, multiple explanations have been offered for both anger and happiness superiority. Arguments have been made that these patterns are driven by differences in the emotional meaning of the faces, as a result of the evolutionary advantage in the ability to quickly detect emotional expressions. This argument has been made for both faster detection of anger (Hansen & Hansen, 1988) and faster detection of happiness (D.V Becker et al., 2011). Other attempts to explain these effects and to reconcile the disparate findings point to the effects of low-level perceptual features. This work expands on reports demonstrating that the original anger superiority effect report by Hansen and Hansen (1988) was actually driven by a non-emotion related perceptual confound (Hampton et al., 1989; Purcell et al., 1996, see also D.V. Becker et al., 2011; S.I. Becker, Horstmann, & Remmington, 2011; Savage, Lipp, Craig, S.I. Becker, & Horstmann, 2013).

Even after controlling for non-emotion related confounds, determining the influence of low-level perceptual artefacts on visual search for emotional expressions is made problematic by the difficulty inherent in controlling for emotional expression-related perceptual confounds. Expression-related confounds are features intrinsic to the emotional expression, such as bared teeth or furrowed eyebrows, that can guide visual search. Whether expression-related confounds drive search performance due to their emotional meaning or their perceptual salience is difficult to determine because removing or changing them to reduce their influence as low-level perceptual confounds, may also change the emotional meaning of the expressions used. The role of these confounds was illustrated by Savage et al. (2013) who reported an anger superiority effect in tasks using faces from the NimStim database (Tottenham et al., 2009), and a happiness superiority effect using faces from the Pictures of Facial Affect database (Ekman & Friesen, 1976). It was suggested that this pattern reflected consistent differences in emotion portrayal, such that the effect of expression-related confounds varied systematically across databases (for a similar argument see Lundqvist, Juth & Öhman, 2014). This may reflect cross database differences in the similarity between target (emotional) and non-target (neutral) faces as target/distractor similarity has been shown to influence search performance (Duncan & Humphreys, 1989).

Reports of happiness superiority effects are often attributed to the prominent display of teeth in open-mouthed smiles of happy faces. Although this may account for the results of studies using open-mouth expressions, it does not explain the results of Horstmann, Lipp, and S. I. Becker (2012) who found a happiness superiority effect using both open- and closed-mouth expressions drawn from the NimStim database. These results are interesting not only because the search advantage for closed-mouth happy faces cannot be attributed to teeth displays, but also because a happiness superiority effect was found with faces from the NimStim database, the same database used by Savage et al. (2013) in their demonstration of an anger superiority effect for closed and open mouthed faces. This suggests that different patterns of results can also be obtained using faces selected from a single database.

The discrepant finding for open-mouthed faces may be explained readily when looking at the stimuli used in the two studies. The NimStim database provides images of 25 males and 18 females displaying a range of emotions with both open- and closed-mouth versions, resulting in 672 images to choose from. Displays of happiness are offered in three variants, closed-mouth, open-mouth, and exuberantly happy. From these, Savage et al. (2013) and Horstmann et al. (2012) selected different versions for use as happy 'open-mouth' faces. Horstmann et al. (2012) used the exuberantly happy faces whereas Savage et al. (2013) used the open-mouth versions. Using both versions of happiness, Savage et al. reported that relative to search for open-mouthed angry faces, open-mouthed happy faces were found slower yielding an anger superiority effect, and exuberantly happy faces are found faster, yielding a happiness superiority effect. Thus, the use of different expressions of happiness may explain the discrepant results observed with open-mouthed faces. However, there is currently no plausible explanation for the different results reported for closed-mouth expressions for which Horstmann et al. report faster and more efficient detection of happy faces and Savage et al. report faster and more efficient detection of angry faces.

The studies conducted by Horstmann et al. (2012) and Savage et al. (2013) differ in a range of procedural characteristics like the gender mix of the posers, the colour of the images and the search procedures used, which employed different stimulus displays, stimulus display times, presentation of feedback, and trial compositions. Horstmann et al. presented displays comprising 1x2, 2x2, and 3x3 picture grids that were centered on the screen to implement set sizes of two, four, and nine faces respectively. Savage et al., however, used a single 3x3 grid to determine the face positions for each set size, such that sets of two and four faces were presented around the edges of the grid, with every position filled for the nine-face arrays . The Horstmann et al. tasks contained more trials (120 trials x 4 tasks) than the Savage et al. tasks (96 trials x 3 tasks). Horstmann et al. and Savage et al. displays remained on the screen until participants made a response, however in the Horstmann et al. tasks the maximum display time was 30s, with feedback provided to the participant after each trial. The Savage et al. displays remained on the screen for only up to 3s, with no feedback provided.

Experiment 1 was designed to assess whether the differences in search procedure used can account for the discrepant findings. Thus, the closed-mouth stimuli used by Horstmann et al. (2012) were presented in the search procedure used by Savage et al. (2013) to replicate Horstmann et al.'s happiness superiority effect within the procedure used by Savage et al. This was done firstly to replicate the happiness superiority effect with stimuli that do not contain teeth displays in our laboratory, and secondly, to determine whether the inconsistent results of Horstmann et al. and Savage et al. may be due to procedural differences unrelated to the face stimuli.

Experiment 1

Experiment 1 attempted to replicate the happiness superiority effect reported by Horstmann et al. (2012) using their stimuli in the search methodology used by Savage et al. (2013). Given that the task design used by Savage et al. utilised up to nine different background identities and eight potential target identities, only nine of the ten posers used by Horstmann et al. were chosen and only eight served as targets. These faces were then presented in the search procedure of Savage et al.

Method

Participants

Thirty-nine students (12 male, *M* = 19.28 years, range = 17 - 35 years) from the University of Queensland participated in return for course credit.

Apparatus and stimuli

Participants were tested in a multiple computer lab with six computers. Tasks were presented on seventeen-inch CRT monitors, with a resolution of 1024 x 768 pixels and a refresh rate of 85 Hz. The stimuli were presented and response times recorded using DMDX (Forster & Forster, 2003).

Stimuli were obtained from the NimStim database (Tottenham et al., 2009) and comprised 25 images, including 9 neutral faces, 8 happy faces, and 8 angry faces. Four female posers (1, 2, 3, and 7) and four male posers (20, 21, 22, and 24) contributed angry (AN_C) and happy (HA_C) closed-mouth expressions as target faces, and neutral expressions (NE_C) as non-target background faces. Male poser 23 contributed only a neutral expression to make up the ninth background face needed for non-target trials. These posers were chosen from the 10 originally used by Horstmann et al. (2012). The faces were edited to be 187 x 240 pixels in size and were presented in colour. Faces were displayed on the screen in a 3 x 3 grid. The nine possible positions in the grid were filled with two, four or nine faces and positions not occupied by a face remained white (luminance = 109 cd/m^2).

A number of perceptual characteristics were determined for the stimulus sets used in Experiment 1 and all subsequent experiments. This was done to determine whether any differences in search pattern could be explained by similar differences in low-level visual features. Average RGB (for colour images) and greyscale values (for greyscale images) were calculated, along with corresponding CIE coordinates (u′v′), The average luminance and Michelson contrasts (CM) were also calculated for each of the face sets. These values were obtained for angry, happy, and neutral faces across all experiments and are reported in Table 1.

Procedure

Participants completed two tasks and instructions were presented onscreen at the beginning of each task. Participants were instructed to search for angry faces in one task or happy faces in the other, and to respond on the computer keyboard by pressing either the 'present' (right shift key) or 'absent' (left shift key) keys.

Presented within each task were 48 target trials, containing an emotional face (happy or angry) among neutral background faces, and 48 non-target trials, containing all neutral faces. Array sizes of two, four and nine were used, such that each set size was presented on a third of the 96 trials that made up the task. The pseudorandom trial sequence was constrained in such a way that no more than three consecutive trials contained a target or were of the same set size. Each trial started with a black fixation cross, presented for 500ms in the centre of the screen and followed by the search display presented for 3,000ms or until a response was made. The intertrial interval was 1,000ms. The same target/non-target trial sequences were used across the two tasks and the order of the tasks was counterbalanced.

Scoring, response definition and statistical analysis

For Experiment 1 and all subsequent experiments, errors were defined as incorrect responses or failure to respond within 3,000ms of the onset of the search grid. Response times ±3 *SD*s from an individual's mean, and any response time less than 100ms were considered outliers and subsequently classified as errors (accounting for .33% of total data in Experiment 1). F-values are reported from the univariate ANOVA table, as are Greenhouse-Geisser corrected p-values. For any term involving within-subject factors with more than two levels, Greenhouse-Geisser epsilons are reported. Greenhouse-Geisser mean square error values and degrees of freedom were used to calculate two-tailed t-tests to follow-up significant main effects and interactions (Howell, 2008). Follow-up tests were Bonferroni adjusted to maintain an α level of .05. Search efficiency was assessed by calculating search slopes for each individual within Excel by fitting a linear function to the mean individual response times for the three set size conditions. Analysis of error data provided no evidence of speed-accuracy trade-off in Experiment 1 or any of the subsequent experiments.

Results

Response times

Happy target faces were found faster and more efficiently than angry target faces at all set sizes (see upper panel of Figure 1). This happiness advantage was also apparent on non-target trials, with faster response times in the absence of a happy face than an angry face (Figure 2, lower panel). A 2 (target presence: present, absent) x 2 (target emotion: angry, happy) x 3 (set size: two, four, nine) within-subjects ANOVA was conducted, revealing main effects of target presence, $F(1,38)$ =

37.57, $p < .001$, $\eta p^2 = .50$, target emotion, $F(1,38) = 388.85$, $p < .001$, $\eta p^2 = .91$, and set size, $F(2,76) = 500.27$, $p < .001$, $\eta p^2 = .94$, $\varepsilon = .61$. Target presence x set size, $F(2,76) = 5.97$, $p = .012$, $\eta p^2 = .14$, $\varepsilon = .66$, and target emotion x set size, $F(2,76) = 205.98$, $p < .001$, $\eta p^2 = .84$, $\varepsilon = .72$, interactions were significant. Participants were faster to respond on target present trials than target absent trials at all set sizes, *t*s > 3.45, *p*s < .001. This difference was larger at set size nine than set size two, $t(76) = 3.90$, $p < .001$, with no differences between set sizes four and two, $t(76) = 2.60$, $p = .012$ ($p_{crit} = .008$), or nine and four, $t(76) = 1.30$, $p = .200$. Participants responded faster to target and non-target trials in the happy task than the angry task at all set sizes, *t*s > 3.63, *ps* < .001. This difference was larger at set size nine than at set sizes two, $t(76) = 24.07$, $p < .001$, and four, $t(76) = 15.48$, $p < .001$, and larger at set size four than two, $t(76) = 8.59$, $p < .001$. No other significant effects emerged, other *F*s < .98, *p*s < .328.

Insert Figure 1 about here

Search slopes

An analysis of the search slopes across the angry and happy target conditions revealed that search was more efficient for happy faces than for angry faces and more efficient on target present than target absent trials (see Table 2). Correspondingly, a 2 (target presence) x 2 (target emotion) within-subjects ANOVA of the search slopes revealed main effects of target presence, $F(1,38) = 261.286$, $p < .001$, $\eta p^2 = .87$, and target emotion, $F(1,38) = 5.77$, $p = .021$, $\eta p^2 = .13$, but no interaction, $F(1,38) = .00$, $p = .995$, $\eta p^2 = .00$

Insert Table 2 about here

Errors

A 2 (target presence) x 2 (target emotion) x 3 (set size) within-subjects ANOVA was conducted on the errors, revealing main effects of target presence, $F(1,38) = 9.67$, $p = .004$, $\eta p^2 = .20$, and target emotion, $F(1,38) = 77.46$, $p < .001$, $\eta p^2 = .67$. Participants made more errors on target present trials than target absent trials and more errors during the angry than the happy task. Moreover, the set size effect was significant, $F(2,76) = 64.56$, $p < .001$, $\eta p^2 = .63$, $\varepsilon = .80$, reflecting more errors for the largest set size, nine faces vs. two faces, $t(76) = 9.17$, $p < .001$, and four faces, $t(76) = 8.32$, $p < .001$, whereas errors did not differ between the two smaller set sizes, $t(76) = .85$, $p = .399$. Finally, the target presence x target emotion interaction was significant, $F(2,76) = 11.40$, $p = .002$, $\eta p^2 = .23$. More errors were made on angry target trials than happy target trials, $t(76) = 8.53$, $p < .001$, and on non-target trials when searching for angry targets than happy targets, $t(76) = 4.63$, $p < .001$. This difference was larger for target trials than non-target trials, $t(76) = 3.90$, $p < .001$. The target emotion x set size interaction approached significance, $F(2,76) = 2.97$, $p = .057$, $\eta p^2 = .07$, $\varepsilon = .78$ (other *F*s < 2.21, *p*s > .117).

Discussion

Experiment 1 replicated the happiness superiority effect reported in Experiment 1 of Horstmann et al. (2012) using a search procedure similar to that used by Savage et al. (2013). Search for happy faces was faster and more efficient than search for angry faces. Although search was faster and more efficient on target trials than non-target trials, there was no difference in the emotion detection pattern based on target presence or absence. None of the average visual statistics that were calculated appeared to differ in a way that may explain search performance. Replicating the happiness superiority effect reported by Horstmann et al. in the procedure that yielded an anger superiority effect in Savage et al. suggests that differences between the procedures of Horstmann et al. and Savage et al. were not critical for causing the discrepant results. Instead, the inconsistent patterns may reflect on differences between the stimuli used by Horstmann et al. and Savage et al., such as image colour or gender of the posers.

Image colour provides extra information, whether related or unrelated to emotion, that participants may be able to use to distinguish targets from non-targets. Previous evidence suggests that attention can be allocated according to the relative colour of targets and distractors (S. I. Becker, Folk, & Remington, 2013). When searching for a coloured target, search is slowed to a greater extent by similarly coloured distractors than by differently coloured distractors (Ansorge & Horstmann, 2007). Consistent with the target-distractor similarity argument advanced by Duncan and Humphreys (1989), if the difference in colouring of angry or happy faces relative to neutral is greater for one emotion, search performance may be facilitated for that emotion. Using greyscale images eliminates the possibility that participants will use colour-based differences to solve the search task instead of relying on the emotional content of the expression.

Experiment 2a investigated the possibility of stimulus colour accounting for differences in anger and happiness superiority effect. Experiment 2a involved a replication of Experiment 1 using greyscaled versions of the same images. Given that the greyscale images used by Savage et al. resulted in an anger superiority effect, a similar pattern was predicted here.

Experiment 2a

Method

Participants

Thirty-four students from the University of Queensland participated in return for course credit. Thirty-three participants provided complete data sets, 8 participants were male (M = 21.71 years, range = 17 - 35 years).

Apparatus, stimuli and procedure

The apparatus, procedure and experimental stimuli were identical to those of Experiment 1, except that faces were edited so that they were greyscaled. Scoring and response definition were the same as Experiment 1, with outliers accounting for .25% of total data in Experiment 2a.

Results

Response times

Figure 2 suggests that happy target faces were again found faster than angry target faces (upper panel) and that on non-target trials participants were faster in the search for happy faces than the search for angry faces (lower panel). This was supported by the results of a 2 (target presence: present, absent) x 2 (target emotion: angry, happy) x 3 (set size: two, four, nine) within-subjects ANOVA. Main effects of target presence, $F(1,32) = 12.86$, $p = .001$, $\eta p^2 = .29$, such that search was faster on target present trials than target absent trials, target emotion, $F(1,32) = 232.23$, $p < .001$,

ηp^2 = .88, and set size, $F(2,64) = 336.60$, $p < .001$, $\eta p^2 = .91$, $\varepsilon = .57$, were evident, as well as the target emotion x set size interaction, $F(2,64) = 134.711$, $p < .001$, $\eta p^2 = .81$, $\varepsilon = .70$. Participant were faster to determine the presence or absence of emotional targets during the search for happy faces than the search for angry faces at set sizes four, $t(64) = 8.44$, $p < .001$, and nine, $t(64) = 10.50$, $p < .001$, but not two, $t(64) = 2.29$, $p = .027$. The target presence x set size interaction approached significance, $F(2,64) = 2.89$, $p = .082$, $\eta p^2 = .08$, $\varepsilon = .71$ (other *F*s< .77, *p*s > .447).

Insert Figure 2 about here

Search slopes

A 2 (target presence) x 2 (target emotion) within-subjects ANOVA of the search slopes revealed a significant main effect of target presence, $F(1,32) = 163.45$, $p < .001$, $\eta p^2 = .84$, such that search was more efficient on target present than target absent trials. A marginally significant main effect of target emotion was also evident, $F(1,32) = 3.61$, $p = .066$, $\eta p^2 = .10$, reflecting more efficient search for happy faces than angry faces (see Table 2). There was no interaction, $F(1,32) = .00$, $p = .966$, $\eta p^2 = .00$.

Errors

A 2 (target presence) x 2 (target emotion) x 3 (set size) within-subjects ANOVA was also used to analyse the errors. Main effects of target presence, $F(1,32) = 23.17$, $p < .001$, $\eta p^2 = .42$, target emotion, $F(1,32) = 65.47$, $p < .001$, $\eta p^2 = .67$, and set size, $F(2,64) = 61.22$, $p < .001$, $\eta p^2 = .66$, $\varepsilon = .85$, were evident. The target presence x target emotion, $F(1,32) = 23.50$, $p < .001$, $\eta p^2 = .42$, and target presence x target emotion x set size interactions, $F(2,64) = 3.46$, $p = .044$, $\eta p^2 = .10$, $\varepsilon = .88$, were both significant. Participants made more errors when searching for angry targets than happy targets on target present and target absent trials at all set sizes (*t*s > 3.95, *p*s < .001). The difference between errors during search for angry and happy faces was larger for target present trials than target absent trials at set sizes two, $t(33) = 5.42$, $p < .001$, and four, $t(33) = 7.17$, $p < .001$, but not nine, $t(33) = 2.30$, $p = .028$ ($p_{crit} = .003$). More errors were also made on target present than target absent trials when searching for angry faces (*t*s > 3.58, *p*s < .001), but there was no difference when searching for happy faces (*t*s < 1.29, *p*s > .206). No other significant effects emerged, *F*s < 1.40, *p*s > .253.

Discussion

The results of Experiments 2a suggest that stimulus colour cannot account for the different patterns of results reported by Horstmann et al. (2012) and Savage et al. (2013). Faster detection of happy faces than angry faces emerged using greyscale images in Experiment 2a. Again, there was no evidence that the average greyscale, CIE, luminance, or contrast values could provide an explanation for this finding (see Table 1). The happiness superiority effect evident in Experiment 2a was not as clear as in Experiment 1, with no significant response time difference between angry and happy target detection at the smallest set size, and only a marginally significant difference in the slopes. The happiness superiority effect evident in Experiment 1 using colour images was clearer than in Experiment 2a using greyscale images, suggesting that the use of colour images may facilitate the detection of emotion targets. It does not, however, explain the discrepancy between anger and happiness superiority effects.

Evidence in the categorization literature suggests that categorization of emotional expressions depends on the gender of the face. Hugenberg and Sczeny (2006) report a significantly larger happy categorization advantage for female faces than for male faces. It is suggested that these differences are due to more positive implicit evaluations of females than males facilitating the categorization of happy expressions on female faces relative to male faces. It is therefore possible that a happiness superiority effect emerged in Horstmann et al. (2012) because both male and female faces were presented together. This may be because firstly, a happiness superiority effect for female faces may be masking an anger superiority effect for the male faces, or secondly, that the inclusion of female faces may influence the processing of emotion expressed on male faces (Lipp, Craig, & Dat, 2015).

Experiment 2b investigated the influence of poser gender by running separate tasks using only male or female faces. This allows for the investigation of possible differences in search advantages between male and female faces. Horstmann et al. presented both males and females in the same task, whereas Savage et al. used only males. As such, we predicted that an anger superiority effect would be observed in the search through the male faces and a happiness superiority effect would be observed in the search through female faces.

Experiment 2b

Participants

Twenty-four students (7 male, *M* = 19.81 years, range = 17 - 28 years) from the University of Queensland participated in return for course credit.

Apparatus, stimuli and procedure

The general procedure was similar to that of Experiment 1. Participants completed four search tasks, two of which comprised only male faces and two of which comprised only female faces. For each gender participants completed two tasks in which they were instructed to search for either angry or happy faces.

The five posers for each gender (females 1, 2, 3, 7, and 8; males 20, 21, 22, 23, and 24), used in Horstmann et al. (2012) were used here, with the addition of another four posers for each gender (females 5, 6, 9, and 10; males 25, 28, 34, and 37) to make up the nine posers needed for each task. All posers contributed angry, happy, and neutral expressions except posers 10 and 34 who contributed only neutral expressions as backgrounds. Images were presented in colour, as per the original Horstmann et al. experiment. Scoring and response definition were the same as in Experiment 1, with outliers accounting for .30% of total data in Experiment 2b.

Results

Response times

Figure 3 shows the mean target (upper panels) and non-target (lower panels) trial response times for the male and female face tasks. Participants were faster to respond when searching for happy female faces than angry female faces, but there was no difference during the tasks using male faces. A 2 (target presence: present, absent) x 2 (target emotion: angry, happy) x 2 (poser gender:

male, female) x 3 (set size: two, four, nine) within-subjects ANOVA was conducted, revealing main effects of target presence, $F(1,23) = 318.06$, $p < .001$, $\eta p^2 = .93$, of target emotion, $F(1,23) = 15.54$, $p = .001$, $\eta p^2 = .40$, and set size, $F(2,46) = 444.17$, $p < .001$, $\eta p^2 = .95$, ε = .57, Target presence x set size, $F(2,46) = 126.26$, $p < .001$, $\eta p^2 = .85$, ε = .69, target emotion x set size, $F(2,46) = 7.65$, $p = .004$, $\eta p^2 = .25$, ε = .72, and gender x emotion, $F(1,23) = 4.58$, $p = .043$, $\eta p^2 = .17$, interactions were all significant. Participants were faster to determine the presence than the absence of targets at set sizes four, $t(46) = 9.28$, $p < .001$, and nine, $t(46) = 20.75$, $p < .001$, but there was no difference at set size two, $t(46) = 2.26$, $p = .031$ ($p_{crit} = .017$). Participants found happy targets faster than angry targets at set size four, $t(46) = 6.30$, $p < .001$, and nine, $t(46) = 6.68$, $p < .001$, but not two, $t(46) = 2.43$, $p = .021$ ($p_{crit} = .017$). Participants were faster when searching for happy female faces than angry female faces, $t(23) = 4.12$, $p < .001$, but there was no difference for male faces, $t(23) = 1.65$, $p = .113$. No other significant effects emerged, *F*s < 2.92, *p*s > .101

Insert Figure 3 about here

Search slopes

A 2 (target presence) x 2 (poser gender) x 2 (target emotion) ANOVA was used to analyse the search slopes, revealing main effects of target presence, $F(1,23) = 149.63$, $p < .001$, $\eta p^2 =.87$, and target emotion, $F(1,23) = 5.68$, $p = .026$, $\eta p^2 =.20$. Search through target present trials was more efficient than search through target absent trials and search for happy faces was more efficient than search for angry faces (see Table 2). All other *F*s < 1.41, *p*s > .247.

Errors

A 2 (target presence) x 2 (target emotion) x 2 (poser gender) x 3 (set size) within-subjects ANOVA of the errors revealed main effects of target presence, $F(1,23) = 54.22$, $p < .001$, $\eta p^2 = .70$, target emotion, $F(1,23) = 29.03$, $p < .001$, $\eta p^2 = .56$, and set size, $F(2,46) = 77.65$, $p < .001$, $\eta p^2 = .77$, ε = .92. A target presence x poser gender interaction was evident, $F(1,23) = 10.64$, $p = .003$, $\eta p^2 = .32$, participants missed male target faces more often than female target faces, $t(23) = 2.91$, $p = .008$, but there was no difference between male and female target absent trials, $t(23) = .86$, $p =$

.399. The next largest interactions was the target presence x target emotion interaction, $F(1,23) = 10.64$, $p = .091$, $\eta p^2 = .12$, this reflected more errors on angry target present trials than on happy target present trials, $t(23) = 3.63$, $p = .001$, but no difference between angry and happy target absent trials, , $t(23) = 1.59$, $p = .126$. No other significant effects emerged, *F*s < 2.67, *p*s > .104.

Discussion

The results of Experiments 2b suggest that poser gender does not fully account for the different patterns of results reported by Horstmann et al. (2012) and Savage et al. (2013). A happiness superiority effect was apparent for female faces, but not male faces. RGB, CIE, luminance, and contrast values did not differ consistently in a way that could explain this pattern (see Table 1). Although there was no significant difference for male faces in Experiment 2b, the means trend in the direction of a happiness superiority effect, with a 66ms difference between happy and angry faces, clearly not indicative of an anger superiority effect. This is inconsistent with various other studies using male faces from the NimStim database, which tend to report a search advantage for angry male faces (Savage et al., 2013; Savage & Lipp, in press, Williams et al., 2005, Williams & Mattingley, 2006). Given that no search advantage for angry faces was evident with male faces, these findings suggest that the use of female faces in Experiment 1 and in Horstmann et al. did not mask an anger superiority effect for male faces. Analysis of task order effects revealed that regardless of the order that tasks were completed in (female first or male first) the pattern remained the same, suggesting that the viewing of female faces did not alter search performance for male faces. Therefore, although the use of female faces may augment the overall happiness superiority effect reported by Horstmann et al., the lack of an anger superiority effect using only male faces remains unexplained.

Experiment 3 aimed to further investigate the differences between the two studies and to delineate what determines the differences in results. Two sets of tasks were created, one used the same posers as Savage et al. whereas the other used the posers from the male task in Experiment 2b (adapted from Horstmann et al.). Only male posers were included, as Savage et al. had used male posers only. It should be noted that five of the target posers in each task were the same (posers 20, 22, 24, 25, and 37) and that the two tasks differed only in the three remaining target posers (Experiment 3a: posers 21, 23, and 28; Experiment 3b: posers 30, 32 and 34) and two non-target posers (Experiment 3a: posers 23 and 28; Experiment 3b: posers 30 and 32). It was expected that the task using the same posers as Savage et al. would result in an anger superiority effect, whereas the task using the male posers from Horstmann et al. would result in a happiness superiority effect.

Experiment 3

Method

Participants

Forty-two students from the University of Queensland participated in return for course credit. Results for Experiment 3a and 3b were analysed separately. Forty-one participants provided complete data sets for Experiment 3a (16 males, *M* = 18.92 years, range = 17 - 24 years). Forty participants provided complete data sets for Experiment 3b (15 males, *M* = 18.95 years, range = 17 - 24 years).

Apparatus, stimuli and procedure

The general procedure was the same as for the previous experiments. Participants in Experiment 3 completed four tasks. Experiment 3a comprised two tasks, fixed target searches for angry and for happy faces, using the male posers from Experiment 2b, based on the stimuli used in Horstmann et al. (2012), presented in greyscale.

Experiment 3b also involved two tasks, using the male posers used by Savage et al. (2013). The stimuli used in Experiment 3b, as a replication of Savage et al., included posers 20, 22, 24, 25, 30, 32, 34, and 37, who contributed neutral (CA_C), happy (HA_C) and angry (AN_C) expressions. Poser 21 contributed only a neutral expression. Stimuli for both sets of tasks were edited to be greyscale and 187 x 240 pixels in size. Scoring, response definition, and analyses were the same as Experiment 1. Outliers accounted for .24% of total data in Experiment 3a and .30% in Experiment 3b.

Experiment 3a Results

Response times

The posers that were used by Horstmann et al. yielded a happiness superiority effect, as was also observed in the original study (see Figure 4, upper right panel). A 2 (target presence: present, absent) x 2 (target emotion: angry, happy) x 3 (set size: two, four, nine) ANOVA revealed main effects of target presence, $F(1,40) = 210.92$, $p < .001$, $\eta p^2 = .84$, and set size, $F(2,80) = 491.79$, $p < .001$, $\eta p^2 = .93$, $\varepsilon = .63$, and a marginally significant effect of target emotion, $F(1,40) = 4.00$, $p = .053$, $\eta p^2 = .09$. There was a significant target presence x set size interaction, $F(2,80) = 162.34$, $p < .001$, $\eta p^2 = .80$, $\varepsilon = .85$, search on target present trials was faster than on target absent trials at all set sizes (*t*s > 3.53, *p*s < .001). This difference was larger at set sizes nine than four, $t(80) = 15.89$, $p < .001$, and two, $t(80) = 22.77$, $p < .001$, and larger at set sizes four than two, $t(80) = 6.88$, $p < .001$. The emotion x set size interaction approached significance, $F(2,80) = 2.81$, $p = .077$, $\eta p^2 = .07$, $\varepsilon = .84$, and reflected faster detection of happy than angry faces at set sizes two, $t(80) = 2.94$, $p = .005$, and four, $t(80) = 4.31$, $p < .001$, but not set size nine, $t(80) = .99$, $p = .326$. No other significant effects emerged, *F*s < .375, *p*s >.665.

Insert Figure 4 about here

Search slopes

A 2 (target presence) x 2 (target emotion) ANOVA was used to analyse the search slopes (see Table 2 for means), revealing a main effect of target presence, $F(1,40) = 231.80$, $p < .001$, $\eta p^2 = .85$ (other *F*s < 2.29, *p*s > .138).

Errors

A 2 (target presence) x 2 (target emotion) x 3 (set size) within-subjects ANOVA of the errors revealed main effects of target presence, $(1,40) = 27.52$, $p < .001$, $\eta p^2 = .41$, target emotion, $F(1,40) = 21.46$, $p < .001$, $\eta p^2 = .35$, and set size, $F(2,80) = 60.39$, $p < .001$, $\eta p^2 = .60$, $\varepsilon = .69$. More errors were made on target present than target absent trials and more were made during the search for angry faces than happy faces. Participants made more errors at the set size nine than set sizes four, $t(80) = 5.17$, $p < .001$, and two, $t(80) = 5.85$, $p < .001$, but there was no difference between set sizes four and two, $t(80) = .68$, $p = .499$. No interactions were significant, *F*s < 2.291, *p*s > .138

Experiment 3b Results

Response times

The faces from Savage et al. showed the opposite pattern of results, with faster detection of angry target faces than happy target faces (means presented in Figure 4, upper left panel). Similarly, participants searched through non-target arrays faster in search for angry than for happy faces (lower left panel). This was confirmed by a 2 (target presence: present, absent) x 2 (target emotion: angry, happy) x 3 (set size: two, four, nine) ANOVA which revealed main effects of target presence, $F(1,39) = 196.204$, $p < .001$, $\eta p^2 = .83$, target emotion, $F(1,39) = 14.16$, $p = .001$, $\eta p^2 = .27$, and set size, $F(2,78) = 359.70$, $p < .001$, $\eta p^2 = .90$, $\varepsilon = .61$. A target presence x set size interaction emerged, $F(2,78) = 104.46$, $p < .001$, $\eta p^2 = .73$, $\varepsilon = .70$. Participants were faster to respond to target present trials than target absent trials at all set sizes (*t*s > 3.47, *p*s < .001). This difference was larger at set size nine than four, $t(78) = 9.41$, $p < .001$, and two, $t(78) = 17.12$, $p < .001$, and larger at set size four than two, $t(78) = 7.71$, $p < .001$. No other significant interactions emerged, *F*s < 1.31, *p*s > .274

Search slopes

A 2 (target presence) x 2 (target emotion) ANOVA was used to analyse the search slopes (see Table 2 for means), revealing a main effect of target presence, $F(1,39) = 122.57$, $p < .001$, $\eta p^2 = .76$ (other *F*s < .67, *p*s > .417).

Errors

A 2 (target presence) x 2 (target emotion) x 3 (set size) within-subjects ANOVA of the errors revealed main effects of target presence, (1,39) = 12,84, $p < .001$, $\eta p^2 = .25$, target emotion, $F(1,39) = 10.49$, $p = .002$, $\eta p^2 = .21$, and set size, $F(2,78) = 117.99$, $p < .001$, $\eta p^2 = .75$, $\varepsilon = .82$. Target presence x target emotion, (1,39) = 13.10, $p = .001$, $\eta p^2 = .25$, and target emotion x set size,

$F(2,78) = 5.57$, $p = .009$, $\eta p^2 = .13$, $\varepsilon = .83$, interactions emerged. On target absent trials, more errors were made during search for happy faces than search for angry faces, $t(39) = 3.74$, $p < .001$, but there was no difference on target present trials, $t(39) = .54$, $p = .592$. More errors were made during the search for happy faces than the search for angry faces at set size nine, $t(78) = 5.33$, $p < .001$, and four, $t(78) = 2.71$, $p = .009$, but not two, $t(78) = 1.08$, $p = .284$. No other interactions were significant, *F*s < 1.02, *p*s > .353.

Additional analyses

Given that Experiments 3a and 3b only differed in the use of three posers, an additional analysis was conducted on the detection times for these three posers to further support the conclusion that these three posers mediate the differing results. New variables were created by averaging across set sizes for each of the three unique posers in Experiment 3a (posers 21, 23, 28) and 3b (posers 34, 30, 32), and across the three posers for each task. This meant that four means were created, one each for the angry and happy targets in Experiment 3a and Experiment 3b.

A 2 (target emotion: angry, happy) x 2 (Experiment: 3a, 3b) within subjects ANOVA revealed a significant emotion x experiment interaction, $F(1,38) = 10.15$, $p = .003$, $\eta p^2 = .21$. After controlling for multiple comparisons ($p_{crit} = .025$), the emotion effects for each experiment were marginally significant. Happy faces were found faster than angry faces for the three posers used in Experiment 3a, $t(38) = 2.23$, $p = .032$, whereas angry faces were found faster than happy faces for the three posers used in Experiment 3b, $t(38) = 2.27$, $p = .029$. Neither of the main effects of target emotion or experiment were significant, both *F*s < .29, *p*s > .595.

Discussion

Opposing patterns of emotion superiority were found between the two sets of tasks. In Experiment 3a, using posers employed by Horstmann et al. (2012), an advantage for the detection of happy faces emerged. Experiment 3b, using the posers employed by Savage et al. (2013), revealed the opposite pattern, a search advantage for angry faces. These differences, however, were only apparent in search times, not search slopes. Given that anger and happiness detection advantages were observed using faces from the same database, our results suggest that finding anger and happiness detection advantages may not only reflect on the database from which the faces are drawn, as suggested by Savage et al. (2013), but on the specific posers selected from within a particular database. This is supported by additional analyses, which revealed trends towards a happiness superiority effect for the three unique posers in Experiment 3a, and an anger superiority effect for the three unique posers in Experiment 3b. However, the average image statistics calculated across the image sets for both experiments provided no explanation for this pattern (see Table 1).

The arousal hypothesis advanced by Lundqvist, Juth and Öhman (2014) may provide an alternative explanation for our results. Lundqvist et al. (2014) propose that differences in search performance reflect on differences in stimulus arousal with high arousal targets found faster than lower arousal targets. For faces selected from the NimStim face set (Tottenham et al., 2009) the account predicts a search advantage for angry faces because angry faces from the NimStim database elicit higher arousal ratings than the happy faces. This account is not consistent with other evidence, however. Savage et al. (2013) failed to find a correspondence between differences in arousal ratings and search performance using NimStim faces. Although angry and exuberantly happy faces did not differ in rated arousal, $M = 5.06$, $SD = 0.64$, and $M = 5.07$, $SD = 0.52$, respectively, exuberantly happy faces were found faster than angry faces. Nevertheless, in order to assess whether differences in rated arousal may explain the current findings, an additional sample of 27 participants rated the face sets used in Experiment 3a and 3b. Arousal ratings were analysed using two one-way ANOVAs, which revealed main effects of emotion for both face sets (Experiment 3a $F(2,25) = 41.11$, $p < .001$, $\eta p^2 = .77$; Experiment 3b $F(2,25) = 44.31$, $p < .001$, $\eta p^2 = .78$). Higher arousal ratings were evident for angry and happy faces relative to neutral faces (ts > 5.66, ps < .001) for the faces sets used in Experiment 3a (angry $M = 3.77$, $SD = 1.24$; happy $M = 3.78$, $SD = 1.10$; neutral $M = 2.15$, $SD = .77$) and Experiment 3b (angry $M = 3.95$, $SD = 1.38$; happy $M = 3.57$, $SD = 9.67$; neutral $M = 2.14$, $SD = .83$), but there was no difference between arousal ratings for angry and happy faces for either face set (*t*s < 1.49, *p*s > .149). Thus, differences in rated arousal do not seem to account for the current pattern of results.

General Discussion

The study aimed to further investigate reports of anger and happiness superiority using closed mouth faces drawn from a single database. Across the three experiments presented here, both anger and happiness superiority effects emerged reliably depending on the particular subset of face stimuli selected. Using a particular set of eight posers from the NimStim database (Tottenham et al., 2009), resulted in faster detection of happy than angry faces, replicating Horstmann et al. (2012). This search advantage for happy faces was robust and shown with mixed gender displays (Experiment 1 and 2a), male only displays (Experiments 2b and 3a), and female only displays (Experiment 2b), and with faces presented in colour (Experiment 1 and 2b) and greyscale (Experiments 2a and 3a). Replicating Savage et al. (2013), the opposite pattern emerged when three of the eight posers were replaced with different identities, producing faster detection of angry than happy faces in Experiment 3b.

Inconsistencies in previous literature make understanding the processes underlying visual search for emotional faces difficult. Differences between the methodologies employed across experiments may explain some inconsistent results, along with differences regarding the measures reported (e.g., response time vs. search efficiency). Previous research has suggested that differences in task set up (e.g., set size, homogenous vs. heterogeneous targets/backgrounds) may influence the way participants search through faces and, as such, the emotion detection pattern that emerges (Lipp, Price, & Tellegen, 2009b). However, the results of Experiment 1 are not consistent with this interpretation indicating a happiness superiority effect in a task setup that yielded an anger superiority effect previously.

The results of Experiment 2b suggest that poser gender does not account for differing reports of anger and happiness superiority effects. There was a difference between search through male vs. female faces in terms of the presence or absence of a significant happiness superiority effect, but there was no suggestion that the use of male faces only would result in an anger superiority effect. These findings support prior evidence that poser gender influences search for emotional expressions (Williams & Mattingley, 2006). Although Williams and Mattingley (2006) report no gender effects in response times, they did find that poser gender moderated search efficiencies, such that set size effects were absent for the detection of angry male target faces, but were evident for the detection of male fearful faces and female angry and fearful faces. In the current study however, no interaction between poser gender and emotion was evident in the search efficiencies. Given strong arguments that search performance may be heavily influenced by the display of teeth (Horstmann et al., 2012), this difference may reflect the used of open-mouthed expressions by Williams and Mattingley, and closed-mouth expressions in the experiments reported here. Lipp et al. (2009a) however, report faster detection of happy female faces than angry female faces, whereas angry male faces were detected faster than happy male faces. This finding also seems likely to reflect of stimulus differences. Upon visual inspection of the stimuli used, the female happy face sports a big toothy grin, making it stand out more from the neutral faces relative to the other emotions. Among the male faces set, the angry face appears the most distinctly different. These findings are however, consistent with stereotypical expectations regarding male and female faces, which may aid detection of emotional deviants. The experiments in Lipp et al. involved the presentation of one poser identity in each task, drawn from the Ekman and Friesen database (1976) and each display comprised an array of nine faces. Previous research in our lab has suggested that in visual search for emotional faces such a task design (e.g., one poser identity, one set size) may encourage participants to rely on featural differences such as the particular shape of the mouth or the eye region to complete the task (Lipp et al., 2009b). Therefore it is possible that these task differences may also influence processing of gender information and the effect it has on search for emotional faces.

Previous reports of happiness superiority in visual search have been attributed to teeth displays in the smiles of happy faces (D. V. Becker et al., 2011). Given the use of closed-mouth faces in the current study, this explanation does not apply here. Although teeth displays have been shown to influence detection of emotional expressions (Horstmann et al., 2012), our findings suggest that displays of teeth cannot provide a complete explanation for the detection advantage for happy faces. Although the current findings could be taken as stronger evidence for an emotional account of faster detection of happy faces, the reversal of this pattern when three different posers were used suggests that these effects may be highly stimulus-specific.

Research has shown that different emotion advantages can be elicited as a function of the database from which faces stimuli are selected (Savage et al., 2013). The results of Experiment 3 further illuminate the role of stimulus choices. Aside from three poser identities, the tasks were identical across Experiments 3a and 3b. As such, the happiness vs. anger superiority observed in Experiments 3a and 3b, indicate that the nature of a particular target plays a more important role in determining search performance than previously thought. This is further supported by additional analyses of target detection on trials in which the six unique faces were presented as targets. On these trials a marginally significant happiness superiority effect was apparent for the three poser identities unique to Experiment 3a, and a marginally significant anger superiority effect was apparent for the three poser identities unique to Experiment 3b. The faces displayed across both experiments did not seem to differ substantially on any of the global measures reported (e.g., average luminance and greyscale values). However, it is possible that any behavioural differences in task performance may be due to smaller, salient parts of an image that have minimal impact on the overall image statistics. For example, a bright patch within a generally dark image may attract attention. The luminance of this image could average out to be the same as a second image with no such attention grabbing features. Similarly, specific facial areas, e.g., wide eyes or teeth displays, may differ between happy and angry expressions. These may facilitate search, but not be reflected in statistics that average across the whole face area. The two faces sets used in Experiments 3a and 3b may therefore differ on some more localized low-level perceptual characteristics that are not reflected in the measures reported. The apparent dependence on stimulus materials suggests that an explanation of the results in terms the effects of emotional expressions may be inadequate, and that these findings could be taken as support for arguments that search performance relies heavily on low-level perceptual features (Purcell et al., 1996; D.V. Becker et al., 2011).

The current findings indicate that search performance depends on the stimuli chosen, however, at this stage it is unclear which factor causes the observed difference across stimulus sets. The current findings suggest that it is unlikely to be due to differences in stimulus colour or poser gender. It is unlikely that search performance is driven solely by simple low-level features or image statistics. Visual inspection of these image statistics suggests similar degrees of variance between targets and backgrounds as amongst the background faces, making it unlikely that these variables account for the current findings. Given that search advantages were evident on both target and non-target trials, and that there were differences in performance on non-target trials between Experiment 3a and Experiment 3b, it is unlikely that differences in search performance are driven solely by target faces. It is more likely that anger and happiness superiority effects are driven by complex interactions between the characteristics of target and background images used in a particular task.

The stimuli and tasks in Experiment 3 were designed such that each poser could be presented as the target in one trial, and the background in another (although never as target and background on the same trial). This renders it unclear whether the different poser identities influence search performance in their role as target faces or as background faces. Differences in search times were evident not only between angry and happy target trials, but also between non-target trials in the search for angry faces and the search for happy faces. Although this difference between the non-target trials during search for angry and happy faces was not significant in Experiment 3a, participants in Experiment 3b searched non-target trials faster in the search for angry faces than for happy faces. The pattern of results on non-target trials differed between Experiments 3a and 3b, suggesting that the particular stimulus sets may influence performance not only when used as emotional target faces, but also when used as the neutral non-target faces. The difference on non-target trials between the angry and happy search tasks in Experiment 3b also indicates that distractor-rejection differs as a function of the searched-for emotional expression and the particular stimulus set employed (e.g., S.I. Becker, et al., 2011). In order to disentangle the effects of target and background faces, different sets of poser identities could be used for target and background images. Maintaining constant backgrounds across differing target sets would control for the influence of background faces and separate the effect of target faces on search performance.

The current study aimed to further investigate reports of anger and happiness superiority effects in visual search for emotional expressions using closed-mouth faces. Given our use of closed-mouth faces, the current findings provide further evidence that reports of happiness superiority in visual search may not be entirely due to teeth displays. Our results also suggest that each of the face stimuli presented in a search task may bias the emotional advantage in favour of either happiness or anger superiority. Careful control of face stimuli used is crucial in the investigation of emotion-related search differences. However, this is complicated by the difficulty in measuring differences in localized low-level perceptual characteristics. The differing emotional search advantages that were mediated through the selection of only three different poser identities suggest that caution should be exercised when attributing detection advantages to the emotionality of face stimuli.

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Figure 1. Search times for angry and happy target (upper panel) and non-target (lower panel) trials at set sizes two, four, and nine faces in Experiment 1. Error bars represent standard errors.

Figure 2. Search times for angry and happy target (upper panel) and non-target (lower panel) trials at set sizes two, four, and nine faces in Experiment 2a. Error bars represent standard errors.

Figure 3. Search times for angry and happy target (upper panels) and non-target (lower panels) trials in the male tasks (left panels) and female tasks (right panels), at set sizes two, four, and nine faces in Experiment 2b. Error bars represent standard errors.

Figure 4. Search times for angry and happy target (upper panels) and non-target (lower panels) trials at set sizes two, four, and nine faces in Experiment 3a (left panels) and Experiment 3b (right panels). Error bars represent standard errors.

Table 1

Mean RGB, greyscale, CIE coordinates, luminance and Michelson contrast (CM) values for stimuli used in Experiments 1-3.

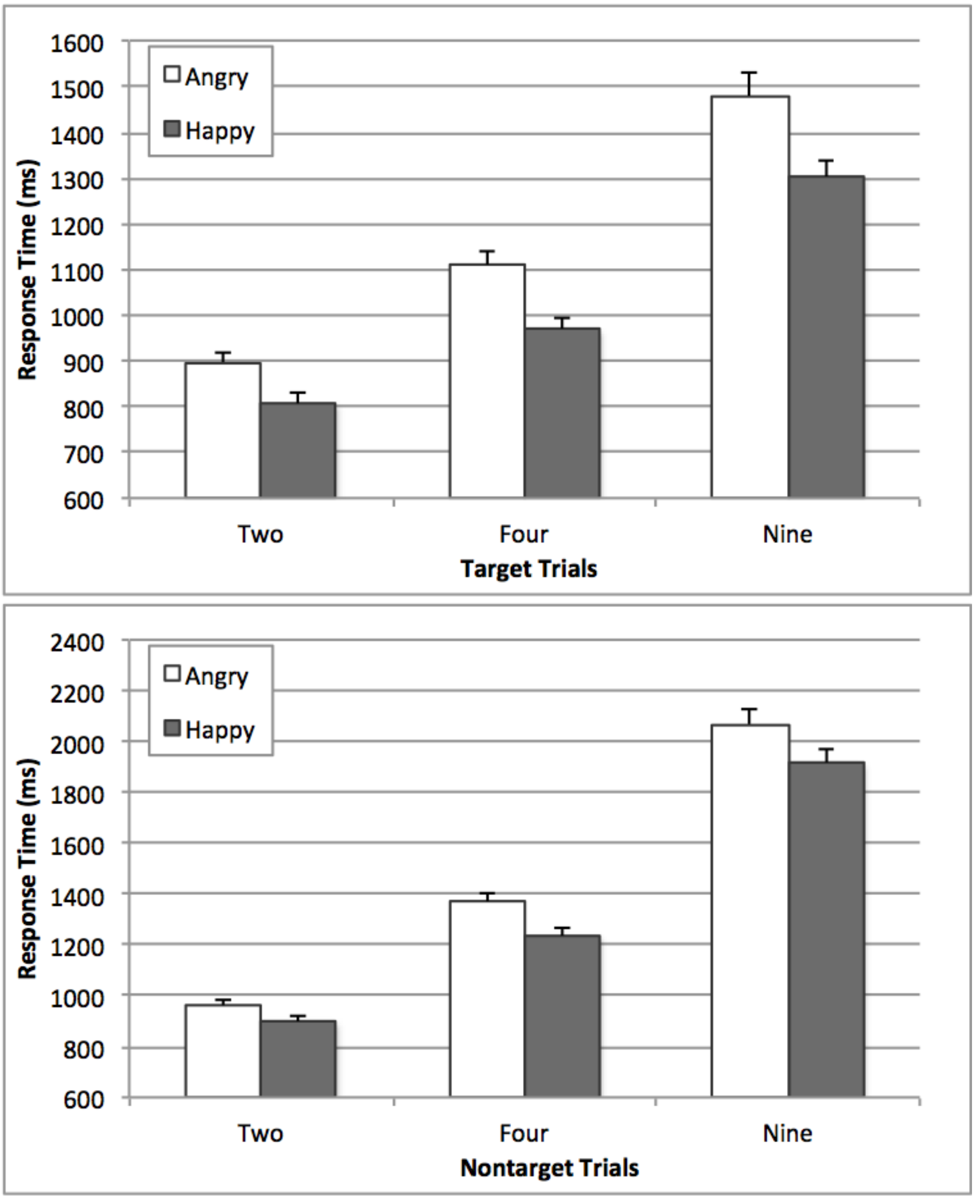
		RGB	Greyscale	u′v′	Luminance (cd/m^2)	CM
Experiment 1	Angry	164,141,134		.177, .489	35.10	1.55
	Happy	162,137,130		.177, .489	35.00	1.55
	Neutral	161,137,130		.176, .489	36.10	1.51
Experiment 2a	Angry		143.09 (81.45)	.165, .480	38.20	1.42
	Happy		143.06 (80.42)	.165, .480	38.20	1.42
	Neutral		148.02 (81.43)	.165, .480	37.40	1.45
Experiment 2b						
Male	Angry	167,145,139		.172, .488	34.60	1.57
	Happy	168,145,139		.176, .489	38.00	1.43
	Neutral	170,148,141		.175, .489	39.00	1.39
Female	Angry	154,134,128		.175, .488	33.60	1.62
	Happy	157,134,128		.177, .489	33.60	1.43
	Neutral	159,139,133		.172, .488	34.50	1.58
Experiment 3 shared models	Angry		147.60 (83.09)	.165, .480	37.90	1.47
	Happy		148.03 (82.66)	.165, .480	37.40	1.45
	Neutral		151.51 (81.15)	.165, .480	39.10	1.39
Experiment 3a	Angry		155.52 (82.29)	.165, .480	40.60	1.34
	Happy		157.22 (81.76)	.165, .480	40.70	1.34
	Neutral		157.68 (81.54)	.165, .480	40.70	1.34
Experiment 3b	Angry		165.12 (81.00)	.165, .480	44.60	1.22
	Happy		157.97 (81.32)	.165, .480	40.70	1.34
	Neutral		163.15 (80.41)	.165, .480	44.50	1.22

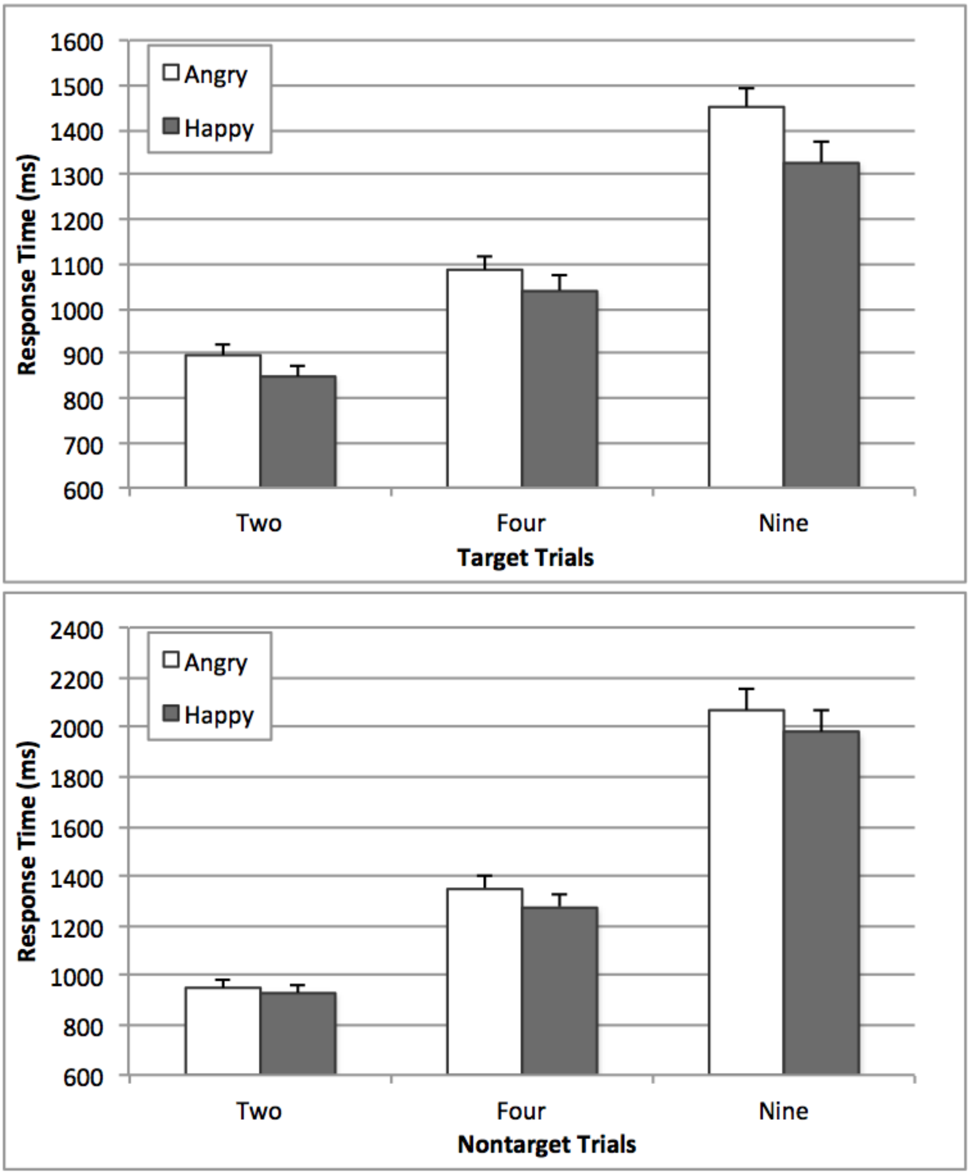
Note. Numbers in parentheses represent average standard deviation for all images in each set.

Table 2

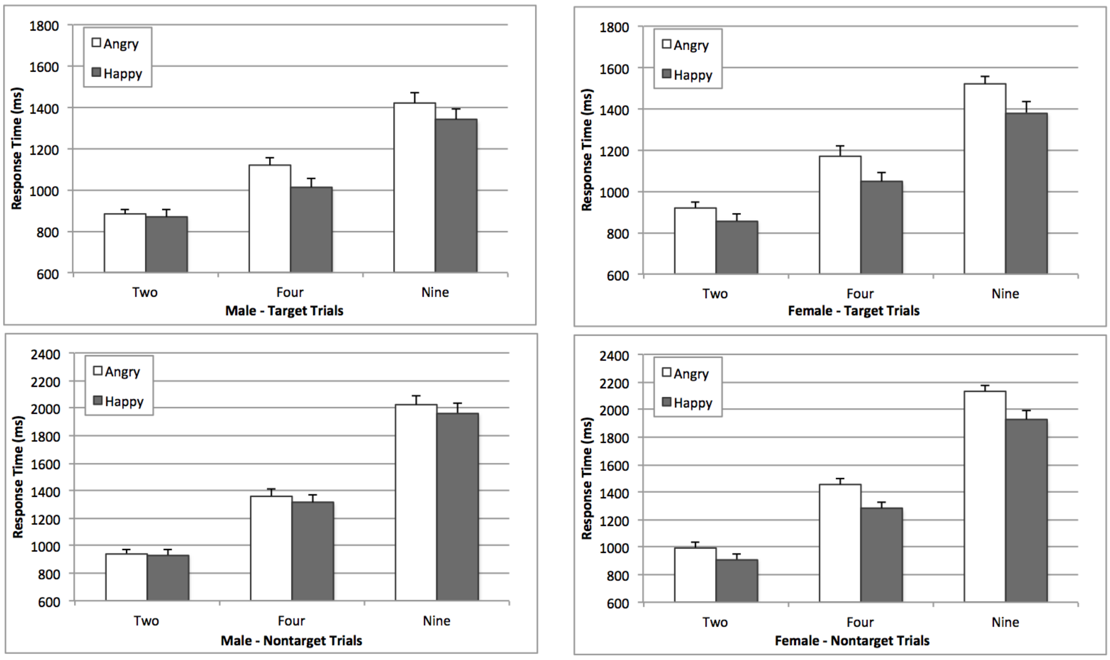
Search slopes for target and non-target trials in the angry and happy search tasks. Standard deviations are reported in brackets.

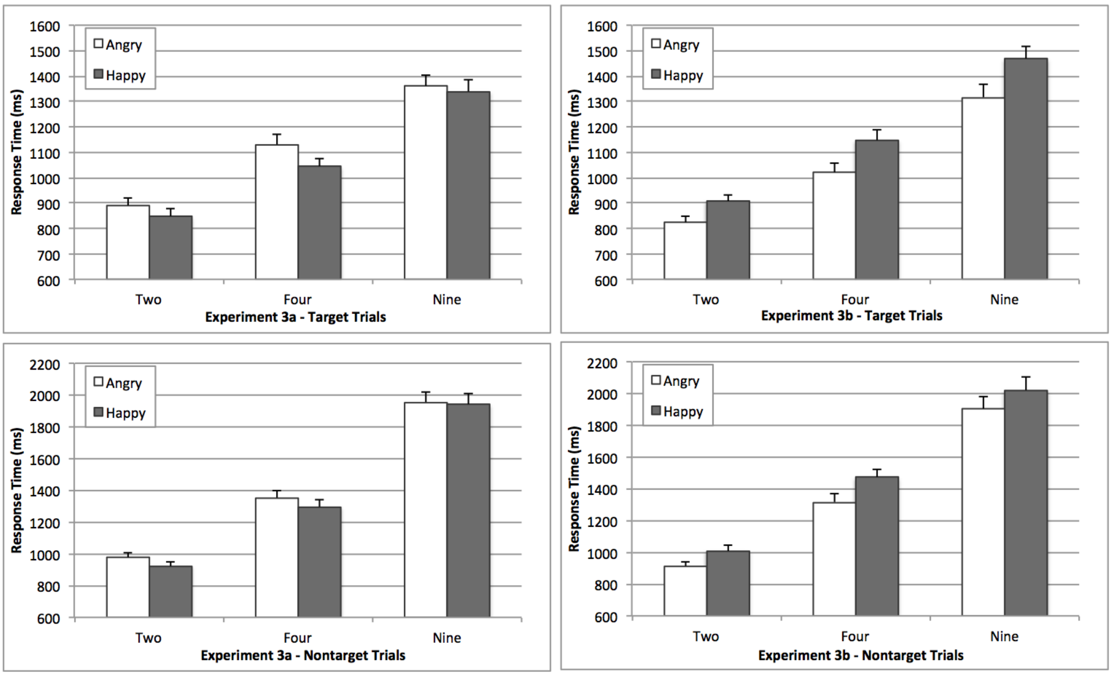
	Target		Non-target	
	Angry	Happy	Angry	Happy
Experiment 1	81.57 (33.69)	70.37 (24.95)	154.71 (40.76)	143.54 (47.93)
Experiment 2a	77.30 (28.91)	67.65 (25.60)	161.69 (51.36)	152.37 (59.08)
Experiment 2b				
Male	73.80 (23.65)	67.04 (18.68)	149.80 (43.58)	143.96 (44.62)
Female	82.66 (20.88)	73.35 (28.34)	156.08 (47.73)	141.73 (46.34)
Experiment 3a	62.69 (26.02)	68.21 (25.21)	136.13 (44.05)	142.41 (44.63)
Experiment 3b	68.48 (28.98)	76.90 (30.21)	136.99 (52.30)	137.98 (62.24)


1600
1500
1400
1300
1200
1100
1000
900
800
700
600
Angry
Happy
Response Time (ms)
Two
Four
Nine
Target Trials
2400
2200
2000
1800
1600
1400
1200
1000
800
600
Angry
Happy
Response Time (ms)
Two
Four
Nine
Nontarget Trials



Angry
Happy
Response Time (ms)
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
Two
Four
Nine
Target Trials
Angry
Happy
Response Time (ms)
2400
2200
2000
1800
1600
1400
1200
1000
800
600
Two
Four
Nine
Nontarget Trials


Angry
Happy
Response Time (ms)
1800
1600
1400
1200
1000
800
600
Two
Four
Nine
Male - Target Trials
Female - Target Trials
2400
2200
2000
Male - Nontarget Trials
Female - Nontarget Trials


Response Time (ms)
Angry
Happy
Two
Four
Nine
Experiment 3a - Target Trials
Experiment 3b - Target Trials
Experiment 3a - Nontarget Trials
Experiment 3b - Nontarget Trials