Sad people are more accurate at expression identification with a smaller own-ethnicity bias than happy people

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Abstract

Sad individuals perform more accurately at face identity recognition (Hills, Werno, & Lewis, 2011), possibly because they scan more of the face during encoding. During expression identification tasks, sad individuals do not fixate on the eyes as much as happier individuals (Wu, Pu, Allen, & Pauli, 2012). Fixating on features other than the eyes leads to a reduced own-ethnicity bias (Hills & Lewis, 2006). This background indicates that sad individuals would not view the eyes as much as happy individuals and this would result in improved expression recognition and a reduced own-ethnicity bias. This prediction was tested using an expression identification task, with eye tracking. We demonstrate that sad-induced participants show enhanced expression recognition and a reduced own-ethnicity bias than happy-induced participants due to scanning more facial features. We conclude that mood affects eye movements and face encoding by causing a wider sampling strategy and deeper encoding of facial features diagnostic for expression identification.

Keywords

Mood induction; happiness; sadness; depression; face recognition; eye tracking; own-ethnicity bias

Sad people are more accurate at expression identification and show a smaller own-ethnicity bias than happy people

Sad individuals are more accurate at old/new face identity recognition tasks (Hills, Werno, & Lewis, 2011). Hills et al. hypothesised that this was because they were processing the faces more deeply than happy or neutral individuals. If this hypothesis is correct, then sad individuals would show other areas of enhanced performance in face processing such as emotional expression identification. While there are distinct neurological (Haxby, Hoffman, & Gobbini, 2000) and processing differences (Bruce & Young, 1986) between face identity recognition and expression identification[1], early visual processing is theoretically similar. In the influential Bruce and Young (1986) model of face recognition, both require an early stage of structural processing before being processed in parallel (Young & Bruce, 2011). This suggests that, if sad individuals show enhanced face recognition abilities, they may also show enhanced expression identification abilities, though this model does not explain why there might be processing differences due to mood. Enhanced expression identification could also be revealed through sad individuals requiring less intensity (signal) of the expression in order to detect the expression and provide a response. These hypotheses were tested in the current experiment.

While we might indicate that sad individuals would show enhanced expression identification, there is evidence that depressed individuals show poorer expression identification relative to healthy controls (Carton, Kessler & Pape, 1999; Cooley & Nowicki, 1989; Persad & Polivy, 1993), though these findings are somewhat inconsistent (Ridout, Astell, Reid, Glen & O'Carroll, 2003). The effects observed in clinical depression are not always replicated in non-clinical sadness (e.g., Niedenthal, Halberstadt, & Innes-Ker, 1999) and depression may not equate to extreme sadness. Therefore, the question of whether sad individuals would be more accurate at expression identification than happy individuals is an open one. In order to explain why sad individuals would be better at expression recognition we can explore how mood affects the encoding of faces.

Mood affects attention. Individuals show attentional biases toward emotionally-relevant information (Koster, De Raedt, Goeleven, Franck, & Crombez, 2005). Sad individuals detect and respond to sad expressions faster than other expressions (Koster et al., 2005). Niedenthal, Halberstadt, Margolin, and Innes-Ker (2000) have found mood-congruent biases in how easy expressions are to detect. In their tasks, their participants had to state when a facial expression changed from emotional to neutral in a movie. Sad individuals saw sadness for longer than happy

[1] Throughout this paper, we consistently use the term 'face identity recognition' to refer to the recognition of facial identity and the term 'expression identification' to refer to the process of naming the expression on a face.

individuals[2]. This indicates that sad people required less expression in order to see the expression, a hallmark of perceptual fluency. In expression identification tasks, there appears to be mood-congruent biases (Gotlib, Kasch, Traill, Joormann, Arnow, & Johnson, 2004; Rinck & Becker, 2005): Sad people tend to identify sad expressions more accurately than other expressions (but see, Mogg, Millar & Bradley, 2000; Zuroff & Colussy, 1986).

In a more direct test of face encoding, Hills and Lewis (2011) demonstrated that sad individuals detect changes to the nose and head shape more accurately than happy and neutral individuals. In eye-tracking studies, Wu, Pu, Allen, and Pauli (2012) have shown that dysphoric individuals fixate less on the eyes and more on the nose than happier individuals in expression identification tasks. Similar results were found in a face identity recognition task (Hills, Marquardt, Young, & Goodenough, 2017). Typically, the eyes are the most diagnostic feature of faces for the recognition of identity in White faces (Gold, Sekuler, & Bennett, 2004; Vinette, Gosselin, & Schyns, 2004) as evidenced by event-related potentials that selectively respond to the eyes (Eimer, 1998) and eye-tracking data showing that the eyes attract more and longer fixations and greater scanning than any other feature (Althoff & Cohen, 1999; Henderson, Falk, Minut, Dyer, & Mahadevan, 2001; Walker-Smith, Gale, & Findlay, 1977) except in sad individuals (Hills et al., 2017; Wu et al., 2012).This highlights the importance of the eyes for identity recognition. Expressions are revealed through more features than just the eyes (e.g., Gosselin & Schyns, 2001; Schyns, Bonnar, & Gosselin, 2002; Smith, Cottrell, Gosselin, & Schyns, 2005). Indeed, the mouth is an important feature for expression identification (Calvo, Fernández-Martín, & Nummenmaa, 2014), but is largely undiagnostic in identity recognition. Therefore, sad individuals might be expected to be better at detecting and identifying expressions because they scan more facial features than happy or neutral individuals. The theory is that mood affects how faces are encoded, leading to sad individuals scanning more features of a face. Therefore, sad individuals scan features that better reveal expressions leading them to be more accurate at expression identification.

In the preceding paragraph, we mentioned that the eyes are critical for the recognition of White faces. This is not true for Black faces (e.g., Ellis, Deregowski, & Shepherd, 1975). The nose has more diagnostic value in differentiating between Black faces (Shepherd & Deregowski, 1981). This is further borne out by eye tracking research comparing White and East Asian and Black individuals. East Asian and Black individuals tend to fixate on the nose more than White individuals (Blais, Jack, Sheepers, Fiset, & Caldara, 2008; Caldara, Zhou, & Miellet, 2010; Hills & Pake, 2013; Miellet, Vizioli,

[2] However, when sad participants are allowed to mimic the facial expressions on display they detect changes in expressions quicker than participants not allowed to mimic (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001).

He, Zhou, & Caldara, 2012). Valentine and Endo (1992) suggest that people focus on the most diagnostic features for distinguishing between the most frequently encountered faces. Therefore, part of the reason why people are less accurate at recognising faces of and identifying expressions in faces of other-ethnicities (known as the own-ethnicity bias, Meissner & Brigham, 2001) is that they are not viewing the most diagnostic features (Hills & Lewis, 2006). Since sad individuals view more features of the face, including those that are relatively more diagnostic in the discrimination between other-ethnicity faces, they will show a smaller own-ethnicity bias.

Accuracy of expression identification is not the only way to assess whether sad individuals are superior at expression identification relative to happy individuals. Another method is to assess the required strength of expression needed to perceive the expression (perceptual fluency). It is well established that expressions are detected as distinct categories when individuals are presented with morphed expressions (ranging from neutral to an expression or from expression to expression; Calder, Young, Perrett, Etcoff, & Rowland, 1996; Etcoff & Magee, 1992). When individuals are presented with a morphed image of a particular strength of expression, they are likely to identify the expression easily. However, when the expression passes below a certain cut-off, individuals no longer report seeing the expression in the face. This is one of the hallmarks of categorical perception of expressions (Young et al., 1996). Individuals can readily identify and categorise the six basic emotions (anger, disgust, fear, happiness, sadness, surprise) when presented with morphed images between the expression and neutral faces (Young, Rowland, Calder, Etcoff, Seth, & Perrett, 1997). Young et al. found that morphs that contained roughly 50% of an expression were categorised with the emotion label, whereas morphs containing less than 50% of the expression were categorised as neutral. The morphing technique, therefore allows us to establish how much expression is needed to categorise an expression as such (and therefore providing an index of perceptual fluency). Therefore, in this task, we used morphs from neutral to 100% expression to see if mood affected how much expression was required to detect and identify it. Given the findings from Niedenthal et al. (2000, 2002) we expect that mood will have an effect on how much expression is needed to accurately identify it. The use of morphed expressions, allows for an exploration of whether accuracy differences due to individual mood is due to perceptual fluency (i.e., requiring less expression to detect an expression) or overall accuracy.

We also used this experiment to assess whether other perceived-to-be negative emotions act in the same way as sadness. The effect sad mood has on face perception may be due to a generalised effect that negative emotion might have on face perception. Other negative emotions might cause individuals to process faces in a similar manner to sadness. One such possibility is anger. Anger appears to cause an over-reliance on heuristic processing in social judgements (Bodenhausen, Sheppard, & Kramer, 1994; Tiedens, 2001; Tiedens & Linton, 2001, but see Young, Tiedens, Jung, & Tsai, 2011). However, anger has also been linked to higher performance on cognitive tasks (Sluyter, Keijser, Boomsma, van Doornen, van den Oord & Snieder, 2000, see also Janowsky, Oviatt & Orwoll, 2004). Anger may therefore increase face recognition performance in a similar way to sadness. Similar to sadness, anger causes individuals to observe mood-congruent expressions more quickly than mood-incongruent expressions (Hall, 2006).

In the context of this background research, we predict that sad participants would be more accurate (in overall accuracy and increased perceptual fluency indexed through lower percentage of an expression needed to see the expression) at an expression identification task than happy and angry participants. They would also show a smaller own-ethnicity bias effect than happy and angry participants. Sad participants' eye movements would be characterised by an exploration of more facial features than happy participants. These hypotheses were tested in a typical expression identification task employing eye movements.

Method

Participants

Sixty (42 female) ethnically-White undergraduate students from Anglia Ruskin University aged between 18 and 50 years of age participated in this experiment as a partial fulfilment of a course requirement. All participants self-reported that they had normal or corrected vision. Participants were randomly allocated to an experimental condition with the condition that there was an equal number of participants in each condition. The Faculty of Science and Technology Research Ethics Panel at Anglia Ruskin University granted ethical approval for this study.

Materials

We used 40 (20 White and 20 Black or Asian) face identities from the well-validated NimStim database (Tottenham, Borscheid, Ellertsen, Markus, & Nelson, 2002). The images were cropped to have the same white background and all clothes masked. Faces were of males and females in frontal pose with no extraneous features (such as jewelry, glasses, or beards). The images were constrained to 506 pixels wide by 764 pixels high and were presented in greyscale and high resolution (106 dpi).

In order to create faces of different levels of expression, we morphed together the most extreme image of each expression with the neutral image of the same face identity, using Morph Age Express 4.1.3 (Creaceed). We created five images of each face containing different amounts of the expression (0%, 20%, 40%, 60%, 80%, and 100%). We did this for each of the 40 identities. Therefore, there were 200 face images. Six non-overlapping areas of interest (AOIs) were mapped out on to each individual image independently (see Goldinger, He, & Papesh, 2009, see Figure 1). These mapped out areas were not visible to participants. The areas were based on theoretically important regions of the face.

Stimuli were displayed on a white background in the centre of a 17" (1280 x 1024 pixels) LCD colour monitor. The stimuli were presented and identification responses were recorded using E-Prime Professional Version 2. Eye movements were recorded using a Tobii 1750 eye-tracker (Falls Church, VA), with embedded infrared cameras with a sampling rate of 50Hz. A fixation was defined as the eyes remaining in the same 30 pixel area for at least 100 ms or returning to the same region within 100 ms (see Goldinger, et al., 2009). Participants' heads were positioned using a standard chinrest 65 cm from the monitor.

Figure 1 about here

To induce mood, the autobiographical memory task was used (Hesse & Spies, 1994). Participants were instructed to:

> *"Write down [the happiest/saddest/most anger inducing] moment of your life"*

or, in the neutral condition:

> *Write down your journey to University today[3]."*

Participants were encouraged to be as accurate and as emotive as possible. Participants were also reassured that the information was completely anonymous. Participants had 5 minutes to write their memories down on a plain piece of paper with no identifying information. This was destroyed at the end of the experiment.

Design

We employed a 4 x 3 x 2 x 5 mixed-subjects design, with the between-subjects factor of participant mood (happy, sad, angry, or neutral), and the within-subjects factors of facial expression (happy, sad, or angry), facial ethnicity (Black and White), and emotion intensity. The eye-tracking analysis also included the within-subjects factor of AOI and had 6 levels. Accuracy of expression identification was recorded, in addition to eye movement measures of duration of fixation to each AOI. Due to the

[3] The neutral manipulation ensured that the neutral induction was as similar as possible to the mood induced conditions as it involved writing for the same length of time.

AOIs occupying vastly different amounts of the screen, we conducted an analysis on area-normalised AOIs (calculated by dividing the proportion of fixations or durations by the proportion of the screen the AOI occupied, see Bindemann, Scheepers, & Burton, 2009; Fletcher-Watson, Findlay, Leekam, & Benson, 2008). The pattern of results from a non-normalised analysis was identical to that presented here.

Procedure

After providing informed consent, participants' mood was induced using the autobiographical memory task. Following mood induction, participants' eyes were calibrated to the eye tracker using the built-in calibration, which involved participants' following, with their eyes, a moving blue ball around a white background to nine pseudo-random locations on the screen. We then asked participants to report how they were feeling as a manipulation check: All participants reported their feelings using synonyms that matched that of the manipulation (e.g., "a bit glum" indicated sadness). Participants' hands were then placed over the relevant keys over the keyboard and instructed to keep movement to a minimum during the task.

Following the set-up, the experimental task began. Participants were presented with the 200 trials containing each face image. These were presented sequentially in a random order. Participants were instructed to identify the expression that the face image displayed by responding with the appropriate key on the keyboard: These were clearly labelled ("h" for happy; "s" for sad; "a" for angry; and "n" for neutral). There was a blank inter-stimulus interval of 150 ms between each face. Each face was on screen for 1500 ms. The task lasted a total of 5 mins 30 s and there were no breaks. After the final face was presented, participants were thanked, offered the positive mood induction, and then debriefed.

Results

We present these results according to our initial hypotheses. Therefore, we first tested whether mood affected expression identification accuracy. Expression identification accuracy for the different facial expressions are presented in Figure 2. These data were subjected to a 4 x 3 x 5 x 2 mixed-subjects ANOVA with the factors participant mood, facial expression, expression intensity, and facial ethnicity. This analysis revealed a significant main effect of participant mood, $F(3, 56) = 6.12$, $MSE = 0.15$, $p = .001$, $\eta_p^2 = .25$. Consistent with our hypothesis (therefore, one-tailed tests), sad participants were more accurate at expression identification than happy ($p = .003$, Cohen's $d = 0.65$), neutral ($p = .042$, Cohen's $d = 0.47$), and angry ($p = .001$, Cohen's $d = 0.72$) participants. No other pairwise comparisons were significant (smallest $p = .701$, largest Cohen's $d < 0.25$).

Secondly, we tested our hypothesis that mood would affect the own-ethnicity bias. We found a significant own-ethnicity bias in our White participants, $F(1, 56) = 89.65$, $MSE = 0.04$, $p < .001$, $\eta_p^2 = .62$, in which own-ethnicity expressions were better identified than other-ethnicity ones. Crucially, this factor interacted with participant mood, $F(3, 56) = 11.90$, $MSE = 0.04$, $p < .001$, $\eta_p^2 = .39$. Šidák-corrected pairwise comparisons revealed that the own-ethnicity bias was significant for angry, happy, and neutral participants (all *p*s < .05, Cohen's *d* > 0.62), but was not significant for sad participants (*p* > .99, Cohen's *d* = 0.04), consistent with our second hypothesis.

As expected, we found that expression identification accuracy depended on intensity of the expression, $F(12, 224) = 1104.99$, $MSE = 0.03$, $p < .001$, $\eta_p^2 = .95$, with more intense expressions being more accurately identified than less intense ones, revealed by a significant linear trend, $F = 4375.38$, $p < .001$, $\eta_p^2 = .99$. This effect interacted with participant mood, $F(4, 224) = 4.98$, $MSE = 0.03$, $p < .001$, $\eta_p^2 = .21$, such that sad participants needed less intense expressions, on average, to identify expressions than other participants (though no simple effects were significant). This indicates that sad participants demonstrated enhanced perceptual fluency.

The effect of level also interacted with the category of expression, $F(8, 448) = 9.03$, $MSE = 0.02$, $p < .001$, $\eta_p^2 = .14$, such that sad and happy faces were categorised with less intense expressions than angry expressions (but no simple effects were significant). This level by expression interaction also interacted with participant mood, $F(8, 448) = 2.40$, $MSE = 0.02$, $p < .001$, $\eta_p^2 = .11$. A series of tests were run comparing the identification accuracy for each expression for each level across participants with different moods. The pattern revealed that sad faces were categorised with less intense expressions for sad participants than for happy and angry participants and happy expressions were categorised with less intensity required for happy and neutral participants than sad and angry participants, though no simple effects were significant.

Figure 2 about here

Subsequently, we tested whether mood affected fixation pattern. The area-normalised total fixation duration to each AOI data are summarised in Figure 3. Figure 3 collapses across face ethnicity as previous research indicates that there should be no eye movement differences across faces of different ethnicities, Blais et al., 2008, Caldara et al., 2010, Hills & Pake, 2013, and indeed none were found in this study: $F(5, 280) = 2.02$, $MSE = 48.92$, $p = .129$, $\eta_p^2 = .04$. Figure 3 also collapsed across expression intensity (as previous research indicates that participants will employ the same stable eye movement strategies across all repeated trials, Mehoudar, Arizpe, Baker, Yovel, 2014, and indeed no significant effects were found for this variable, $F(8, 448) = 1.85$, $MSE = 62.01$, $p = .100$, $\eta_p^2 = .03$.

These data were subjected to a 4 x 3 x 2 x 5 x 6 mixed-subjects ANOVA with the factors: participant mood, expression, facial ethnicity, expression intensity, and AOI.

While, we found the standard hierarchy of features (Haig, 1986a, b), $F(5, 280) = 206.18$, $MSE = 2197.06$, $p < .001$, $\eta_p^2 = .79$[4] in which the eyes were the most scanned feature, all *p*s < .05, Cohen's *d*s > 0.58 (replicating e.g., Althoff & Cohen, 1999), we found that this effect interacted with participant mood, $F(15, 280) = 6.88$, $MSE = 430.82$, $p < .001$, $\eta_p^2 = .27$. This result directly confirms our hypothesis that mood would affect fixation pattern. Šidák-corrected pairwise comparisons demonstrated that the eyes were scanned more by happy and neutral participants than sad participants (all *p*s < .01, Cohen's *d*s > 0.21). The nose and mouth were scanned more by sad participants than angry, happy, and neutral participants (all *p*s < .05, Cohen's *d*s > 0.19). The chin, cheeks, and ears AOI was scanned more by sad participants than happy and neutral participants (all *p*s < .05, Cohen's *d*s > 0.35).

Happy faces were also looked at more than sad faces, revealed through the main effect of expression, $F(2, 112) = 16.74$, $MSE = 60.60$, $p < .001$, $\eta_p^2 = .23$. This effect also interacted with participant mood, $F(6, 112) = 3.09$, $MSE = 60.60$, $p = .008$, $\eta_p^2 = .14$. The pattern of this interaction was mood-congruent (i.e., happy participants looked at happy faces more than sad faces and sad participants looked at sad faces more than happy faces). However, no significant simple effects (comparing expression identification accuracy across expressions for each participant mood) were significant. The effect of expression also interacted with feature, $F(10, 560) = 4.97$, $MSE = 237.39$, $p = .001$, $\eta_p^2 = .08$. We compared the amount of scanning to each feature across each expression. None of these comparisons were significant, though there was a tendency for happy mouths to be looked at more than sad and angry mouths (consistent with Calvo et al., 2014).

Figure 3 about here

The eye-tracking results indicate that sad participants viewed more of the facial features than other participants and the behavioural results indicate that sad participants were more accurate at the expression identification task. In order to confirm that the eye movements led to the improved performance, we conducted a third analysis in which we measured the expression identification accuracy contingent of the eye movement pattern. In order to do this, we coded the eye-movement according to the proportion of fixations on the eyes versus the other facial features. We entered this into a 4 x 3 x 2 x 5 mixed-subjects ANCOVA with the factors: participant mood, the expression of the

[4] For all main effects and interactions involving the variable feature, Mauchley's test of sphericity was significant, therefore we applied the Greenhouse Geisser correction to the degrees of freedom. Here we report the uncorrected degrees of freedom and the corrected significance level.

face, the ethnicity of the face, and level of expression intensity. Proportion of eye contact was entered as the covariate (this was not mean-centred). If the enhanced expression identification in sad mood is due to increased scanning of other facial features, then the effect of participant mood in this ANCOVA will no longer be significant (as it was in the behavioural analysis above).

The ANCOVA revealed that the main effect of participant mood was no longer significant, $F(3, 55) = 0.55$, $MSE = 22.17$, $p = .652$, $\eta_p^2 = .03$. Instead, the effect of the covariate was significant, $F(1, 55) = 25.75$, $MSE = 22.17$, $p < .001$, $\eta_p^2 = .32$. Similarly, the main effect of ethnicity was no longer significant following inclusion of the covariate, $F(1, 55) = 0.03$, $MSE = 0.92$, $p = .864$, $\eta_p^2 < .01$. The interaction between face ethnicity and participant mood was no longer significant, $F(3, 55) = 2.26$, $MSE = 0.92$, $p = .092$, $\eta_p^2 = .09$. Instead, the interaction between face ethnicity and the covariate was significant, $F(1, 55) = 130361$, $MSE = 0.92$, $p < .001$, $\eta_p^2 = .96$. This analysis confirmed that the effect of sad participants' higher accuracy for expression identification was due to focusing more of other facial features rather than solely on the eyes.

The ANCOVA revealed that the main effect of level of intensity remained significant, $F(4, 220) = 976.25$, $MSE = 175.47$, $p < .001$, $\eta_p^2 = .95$. Similarly, the interaction between participant mood and level of intensity of the expression also remained significant following inclusion of the covariate, $F(12, 220) = 3.91$, $MSE = 175.47$, $p < .001$, $\eta_p^2 = .18$. These results indicate that the perceptual fluency of sad participants is not related to eye movements. This is consistent with the eye tracking results indicating that there were not eye movement differences across different levels of intensity of expression.

Discussion

In this study, we found that sad participants were more accurate at expression identification than happy, angry, and neutral participants. Sad participants showed greater perceptual fluency as they were able to identify expressions with less intensity of expression than other participants replicating Niedenthal, et al. (2000). Sad participants were able to identify sad expressions with less intensity than other participants (happy participants showed the same trend for happy expressions) indicating a mood-congruent encoding process. Sad participants also showed a smaller own-ethnicity bias than all other participant groups. Sad participants scanned the nose, forehead, chin, cheeks, and ears more than the happy and neutral participants (consistent with Wu et al., 2012). We confirmed that this scanning pattern resulted in the improved expression identification performance.

These results extend previous findings highlighting the improved face identity recognition performance in sad participants (Hills et al., 2013; 2017) by demonstrating that sad mood leads to improvements in expression identification. Our analyses confirmed that this increase in accuracy is due to sad participants exploring more of the face than happy participants. This additional exploration of faces leads to more features being scanned. Direct scanning of features is required for accurate face encoding (Laidlaw & Kingstone, 2017). This, therefore, provides direct evidence that sad individuals are encoding faces more deeply. The reason why sad individuals might be exploring more of the face may result from the fact that sad people are less likely to make eye contact (Natale, 1977). According to Bless, Mackie, and Schwarz (1992), sad individuals are motivated to be accurate. The purpose of this motivation is to repair their mood by succeeding at a given task. In order for sad individuals to maintain their accuracy in the present task, they need to actively code facial features other than the eyes. This increased coding of other features means that they will be coding facial features that are diagnostic for expression identification. Within face processing, this suggests that mood affects the perceptual encoding stage in Bruce and Young's (1986) model. Mood alters how information is sampled from the visual world.

Due to sad individuals exploring more of the face than happy individuals, they are encoding facial features that are typically more diagnostic of other-ethnicity faces (i.e., the nose is a more diagnostic feature to distinguish between Black faces). Scanning the more diagnostic features leads to improved face processing accuracy (see e.g., Hills & Pake, 2013). An alternative explanation for the reduction in the own-ethnicity bias is that sad individuals might be more motivated to be accurate than happy individuals, however, motivation to be more accurate typically does not lead to a reduction in the own-ethnicity bias (see e.g., Hugenberg, Millar, & Claypool, 2007). Therefore, we interpret the results as sad mood affects scanning behaviour. Scanning behaviour leads to our White participants sampling features that are typically more diagnostic for Black faces, thereby reducing the own-ethnicity bias. This theory is the same as the one described above for the improvement in overall expression identification accuracy.

Not only was overall identification accuracy improved by sad mood, but so was perceptual fluency. Sad participants required less intense expressions in order to identify them. This result did not depend on the eye movements. In other words, the enhanced perceptual fluency for sad participants was due to a separate mechanism to that of identifying the fully expressed expression. We can interpret this finding in a similar way to Niedenthal et al. (2001). They suggest that mimicry is an important factor in the perception of expressions. This might be especially true for expressions that are more subtle than full expressions. Alternatively, it may be that the sad participants were simply more motivated in the task than happy participants (Bless et al., 1992) and this effect was only apparent when the task was more difficult (i.e., when the expression identification was harder).

Therefore, they may be multiple mechanisms behind enhanced performance in sad individuals higher expression identification performance than neutral and happy individuals.

We have also shown that the effects of sadness on face perception appear limited to sadness rather than general negative mood, though further negative moods would need to be tested to confirm this. Anger induction did not cause participants to scan more of the face nor reduce the own-ethnicity bias. Angry participants were not more accurate than neutral participants. Rather than anger leading to enhanced cognitive performance (Janowsky et al., 2002), our results are more consistent with the notion that anger lead to shallower processing and poorer performance (Bodenhausen et al., 1994; Tiedens, 2001; Tiedens & Linton, 2001). In fact, in this experiment, angry participants behaved in a similar manner to neutral participants, with the exception of a marginal reduction in scanning of the eyes. These results demonstrate that there is something relatively unique about the way sad mood affects face processing and is not due to generalised negative mood. In addition to these central results, we found that happy faces were looked at more than sad faces consistent with a multitude of research highlighting the social importance of happy faces (Becker, Anderson, Mortensen, Neufeld, & Neel, 2011) and their advantage in recognition memory tests (Calvo & Lundqvist, 2008; Palermo & Coltheart, 2004)

The present results are slightly inconsistent with those presented by Johnson and Friedrickson (2007) who found that happy moods reduced the own-ethnicity bias relative to neutral and fearful individuals. Johnson and Friedrickson hypothesised that happy individuals have a more inclusive thought process (Friedrickson, 2001) which enhances holistic processing for other-ethnicity faces (but they indicate would have no effect on the recognition of own-ethnicity faces). A more plausible explanation is that the more inclusive thought process that happy individuals have leads to more inclusive social categorisation (Dovidio, Gaertner, Isen, & Lowrance, 1995; Isen, Niedenthal, & Cantor, 1992) which would lead to enhanced accuracy (Hugenberg et al., 2007). This mechanism is different to what drives sad individuals' increased accuracy for own- and other-ethnicity faces: that sad individuals scan more of the face. A second difference between the present study and Johnson and Friedrickson (2007) is that we were testing the own-ethnicity bias in expression identification rather than identity recognition. While these involve the same early perceptual processing stages (Bruce & Young, 1986), they are based on different systems later in processing. Different brain regions are assumed to process emotion and identity (e.g., Haxby et al., 2002). Therefore, there is no reason to expect that the mechanisms will be the same.

Our results indicate that mood affects the way information is encoded. By altering eye movements, mood affects the input of information into the cognitive system. These results highlight that some of the later cognitive effects of mood may actually reflect the way information is encoded into the cognitive system. Sad mood affects eye movement strategies, such that sad individuals scan more features of a face and this deeper encoding leads to improved accuracy and a reduced own-ethnicity bias in an expression identification task.

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Figure captions.

Figure 1. An example stimulus with the AOIs mapped onto it: 1. Eyes; 2. nose; 3. mouth; 4. forehead; 5. chin and cheeks; and 6. the rest of the screen. AOIs were not visible to the participants. The AOIs were non-overlapping: for example the forehead region did not include the eyes.

Figure 2. Mean expression categorisation accuracy for own- and other-ethnicity faces of different levels of expression intensity split by participant mood for each facial expression. Error bars show standard error.

Figure 3. Area-normalised time spent fixating in each AOI for angry, happy, and sad faces, split by participant mood. Error bars represent standard error.

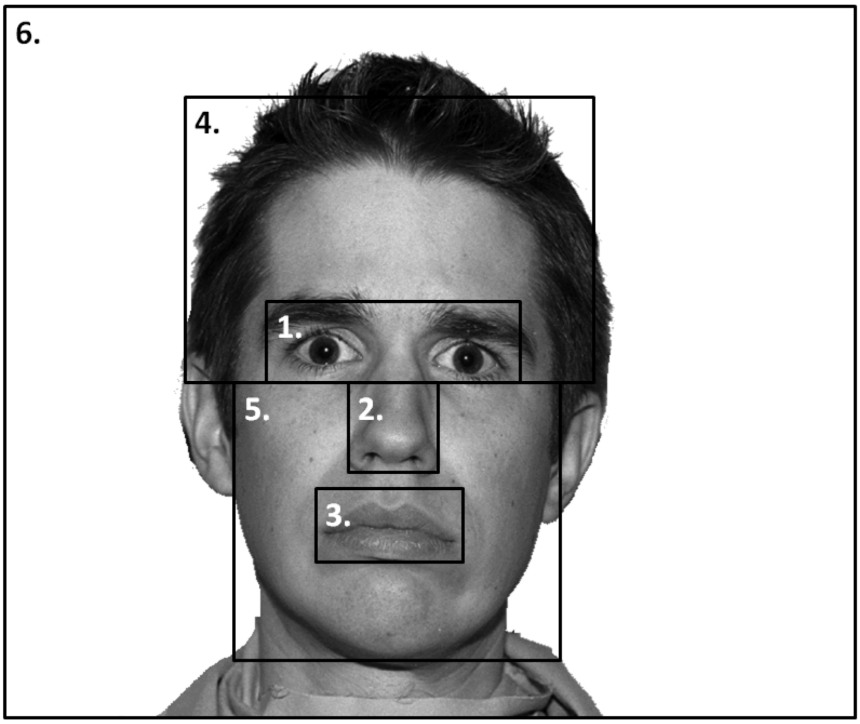
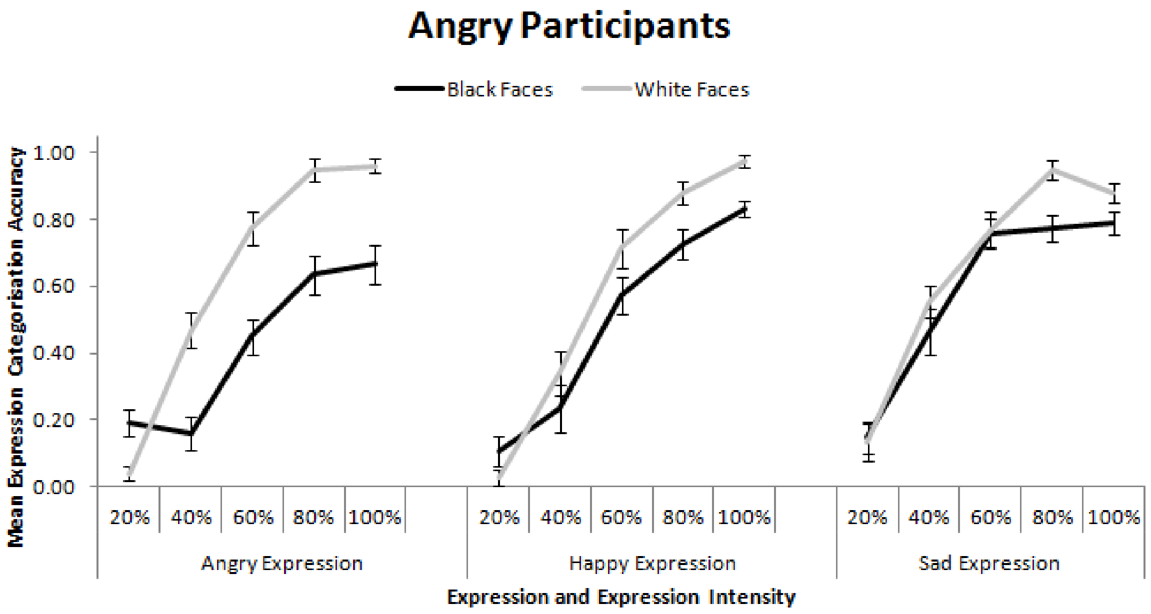
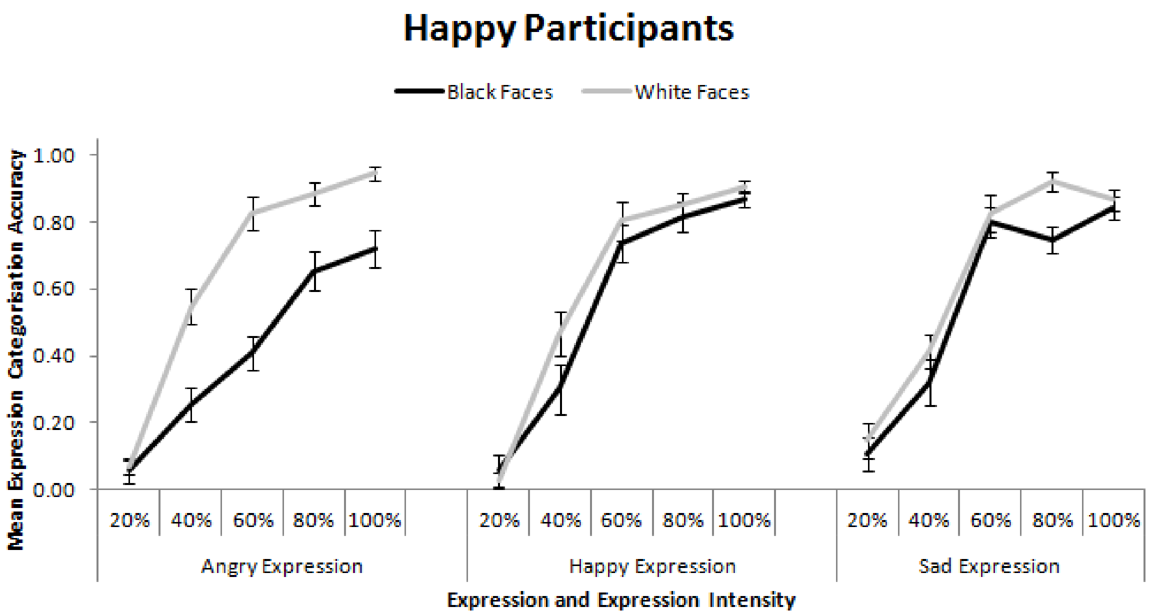
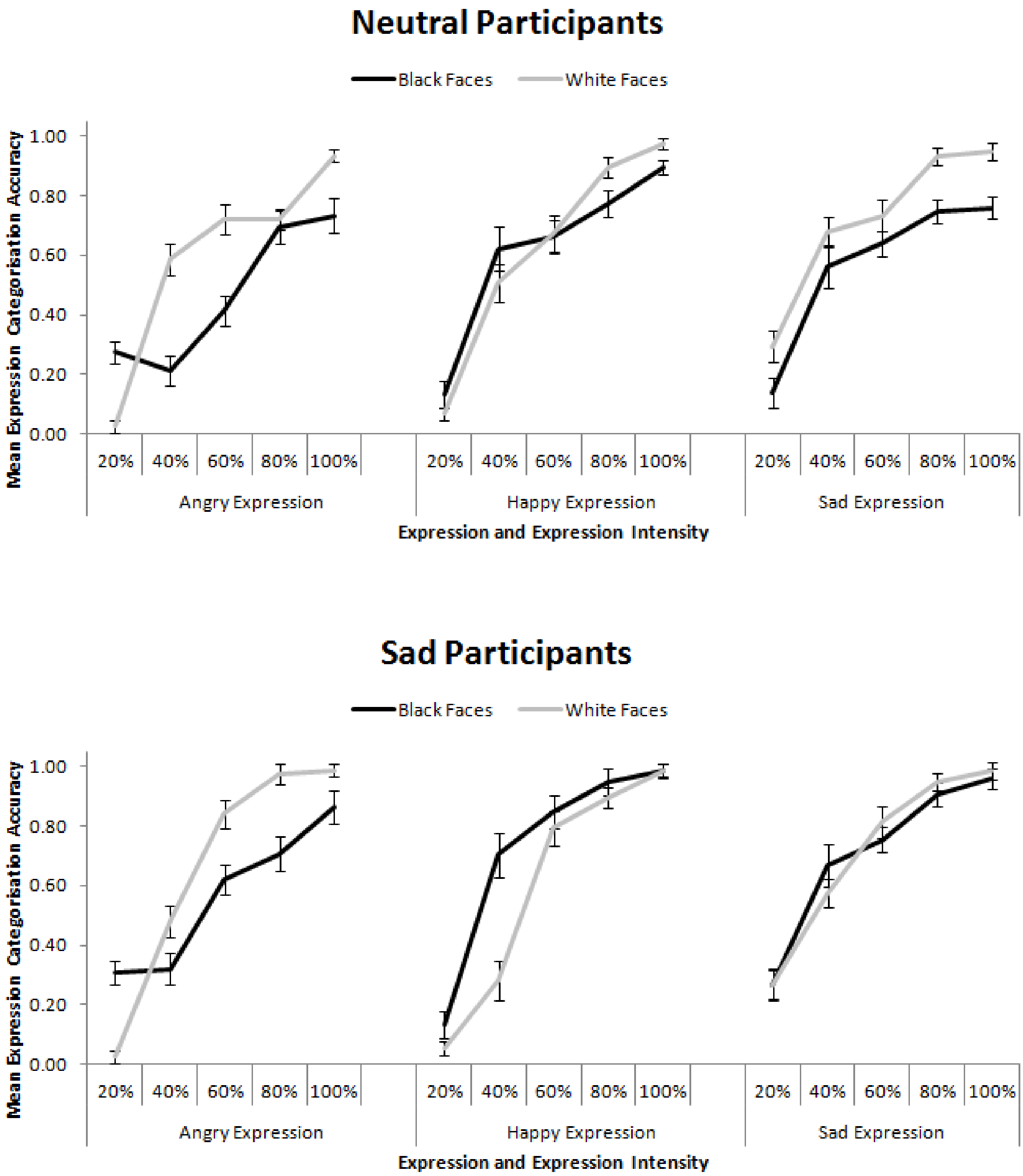


Figure 1.

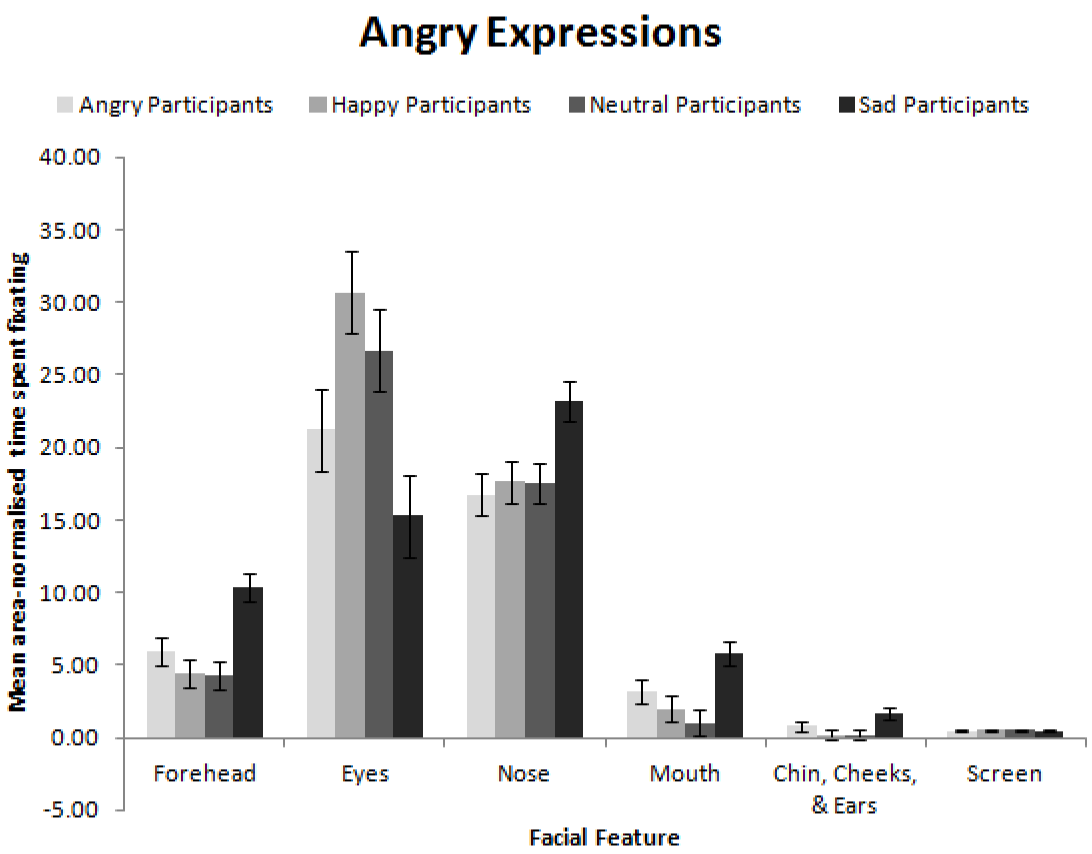

Angry Participants
Black Faces
White Faces
Mean Expression Categorisation Accuracy
1.00
0.80
0.60
0.40
0.20
0.00
20%
40%
60%
80%
100%
Angry Expression
Happy Expression
Sad Expression
Expression and Expression Intensity


Happy Participants
Black Faces
White Faces
Mean Expression Categorisation Accuracy
1.00
0.80
0.60
0.40
0.20
0.00
20%
40%
60%
80%
100%
Angry Expression
Happy Expression
Sad Expression
Expression and Expression Intensity

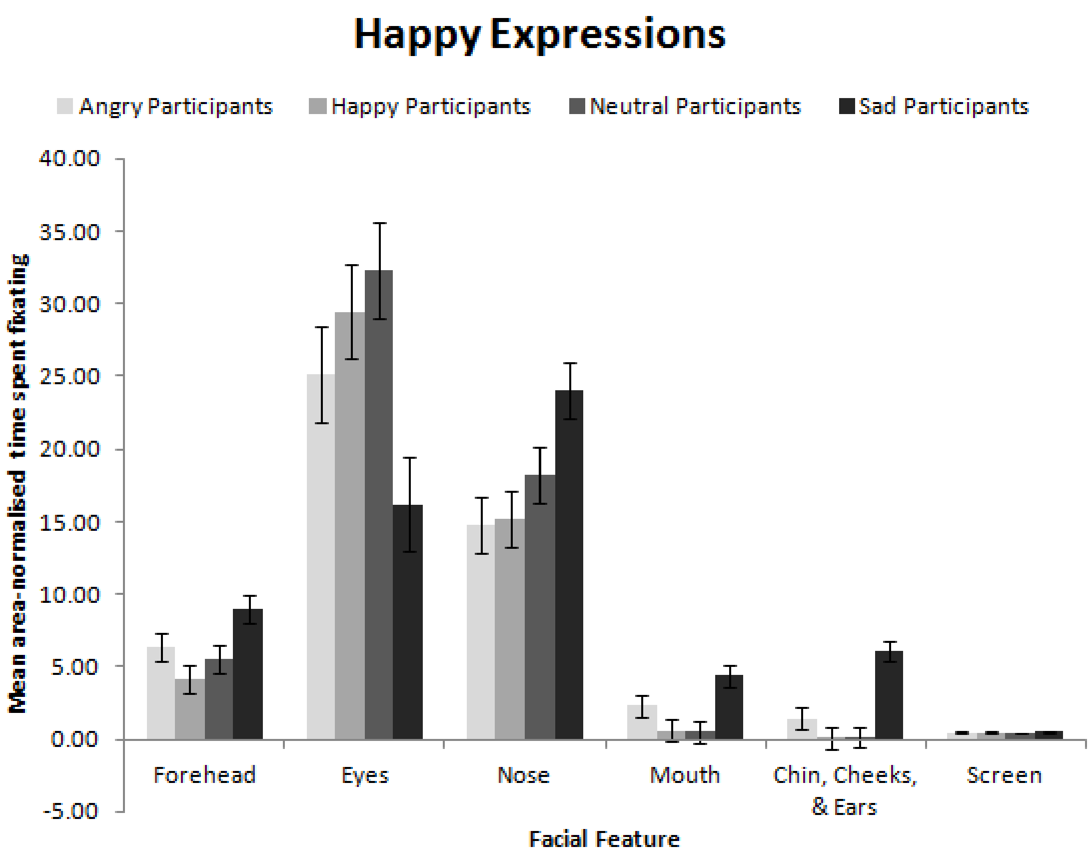


Neutral Participants
Black Faces
White Faces
Mean Expression Categorisation Accuracy
1.00
0.80
0.60
0.40
0.20
0.00
20%
40%
60%
80%
100%
Angry Expression
Happy Expression
Sad Expression
Expression and Expression Intensity
Sad Participants
Black Faces
White Faces
Mean Expression Categorisation Accuracy
1.00
0.80
0.60
0.40
0.20
0.00
20%
40%
60%
80%
100%
Angry Expression
Happy Expression
Sad Expression
Expression and Expression Intensity

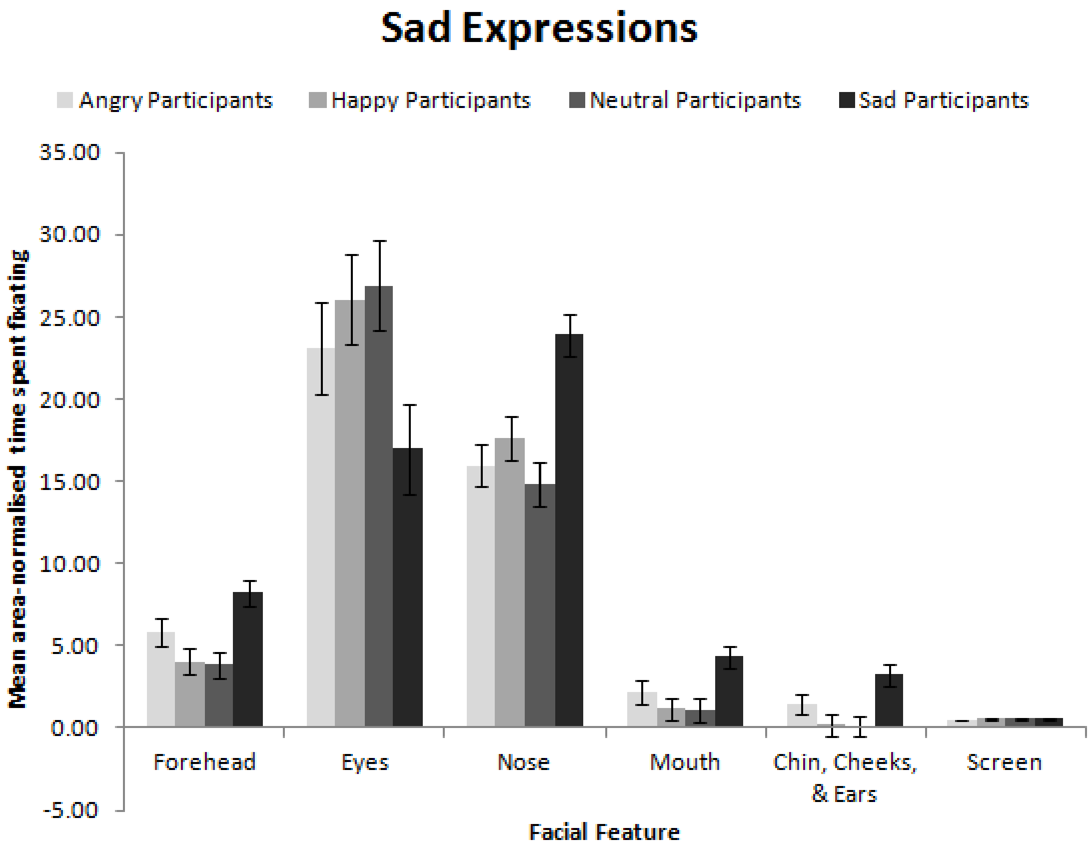
Figure 2.



Angry Expressions
Angry Participants
Happy Participants
Neutral Participants
Sad Participants
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
Mean area-normalised time spent fixating
Forehead
Eyes
Nose
Mouth
Chin, Cheeks, & Ears
Screen
Facial Feature



Happy Expressions
Angry Participants
Happy Participants
Neutral Participants
Sad Participants
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
Mean area-normalised time spent fixating
Forehead
Eyes
Nose
Mouth
Chin, Cheeks, & Ears
Screen
Facial Feature



Sad Expressions
Angry Participants
Happy Participants
Neutral Participants
Sad Participants
Mean area-normalised time spent fixating
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
Forehead
Eyes
Nose
Mouth
Chin, Cheeks, & Ears
Screen
Facial Feature

Figure 3.