Variation in normal mood state influences sensitivity to dynamic changes in emotional expression

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Abstract

Normal social functioning depends on the ability to efficiently and accurately detect when someone's facial expression changes to convey positive or negative emotion. While observer mood state has been shown to influence emotion recognition, how variations in normal mood might influence sensitivity to the dynamic emergence of expressions has not yet been addressed. To investigate this, we modified an existing face morphing paradigm in which a central face gradually changes from neutral to expressive (angry, sad, happy, surprised). Our sample comprised healthy young adults and current mood state was measured using the PANAS-X. Participants pressed a key as soon as they (1) noticed a physical change in expression ('perceptual sensitivity' – novel task element), and (2) could clearly conceptualise which expression was emerging ('conceptual sensitivity'). A final unspeeded response required participants to explicitly label the expression as a measure of recognition accuracy. We measured the percent morph (expression intensity) at which a perceptual and conceptual change was detected, where greater intensity equates to poorer sensitivity. Increased positive mood reduced perceptual and conceptual sensitivity to angry and sad expressions only (a mood incongruency effect). Of particular interest, increased negative mood decreased conceptual sensitivity for all expressions, but had limited impact on perceptual sensitivity. Thus, heightened negative mood is particularly detrimental for effectively decoding someone else's mood change. This may reflect greater introspection and consumption of attentional resources directed towards the negative self, leaving fewer resources to process emotional signals conveyed by others. This could have important consequences for human social interaction.

250 words

Keywords: Mood, Emotion, Sensitivity, Expression Change, Face morph task

Introduction

The ability to rapidly detect and accurately decode nonverbal facial cues to emotion is crucial for normal social functioning (Blair, 2003). Our own mood state can influence how we process emotional expressions conveyed by others. Among healthy individuals, a mood congruency effect (Bower, 1981) is found in which expressions are more accurately labelled (Schmid & Schmid Mast, 2010), rated as more intense (Bouhuys, Bloem, and Groothuis, 1995), or perceived to persist longer (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001; Niedenthal, Halberstadt, Margolin & Innes-Ker, 2000) when the same or similar mood state is shared by the observer. More generally, there is evidence that different mood states can alter perceptual processing of information. According to Affect-as-Information theory (Schwarz & Clore, 1983, 2003), individuals in a negative mood adopt a local information processing style (i.e. focus on specific features), while a positive mood leads to the adoption of a global information processing style (e.g., Gasper & Clore, 2002; Schmid, Schmid Mast, Bombari, Mast, & Lobmaier, 2011). Notably, a global processing style has been shown to be important for emotion recognition (e.g., Prkachin, 2003; Schmid et al., 2011).

The vast majority of studies that have investigated the link between mood and emotion processing used static face images. However, during social interaction individuals are exposed to frequently changing facial expressions and use this dynamic information to monitor intentions and emotional reactions of others. Niedenthal and colleagues (2000, 2001) used a dynamic expression changing task to examine sensitivity to the disappearance of emotions, but what may be particularly pertinent is the ability to detect the *emergence* of positive and negative expressions. Becker et al. (2012) used a face morph task in which faces changed from neutral to happy or angry. They found that healthy participants were faster to correctly state that a happy versus angry expression was emerging, suggesting that rapid detection of prosocial signals is important during social interaction. Using a similar dynamic task, Joormann and Gotlib (2006) showed that individuals with depression required higher levels of expression intensity in order to correctly identify happiness than healthy controls, while individuals with social phobia required less expression intensity to identify anger than the other groups (see also LeMoult, Joormann, Sherdell, Wright, & Gotlib, 2009). These findings indicate that depression reduces sensitivity to positive emotion and social phobia heightens sensitivity to threat. In a study of anti-social individuals, Schönenberg, Louis, Mayer, and Jusyte (2013) found that violent offenders were less sensitive to the emergence of fear and surprise than controls, while detection of the onset of anger, happiness, sadness, and disgust were equivalent between groups. Thus, clinical mood and social disorders influence sensitivity to dynamic changes in expression in emotion-specific ways.

What is unknown at present is how natural variations in mood state among the healthy population influence sensitivity to the emergence of facial expressions. This is important because humans do not function in a neutral vacuum, thus interactions with others may be coloured by our own mood. In the current study we utilised the animated face morph task used by Joormann and Gotlib (2006) and Schönenberg et al. (2013) in which faces gradually changed from neutral to expressive. Our sample comprised healthy young adults whose normal, current mood state was measured using the PANAS-X (Positive and Negative Affect Schedule – Expanded; Watson & Clark, 1994). Furthermore, we adapted the paradigm in order to examine two forms of change sensitivity: (1) *perceptual sensitivity* to lower level physical changes in expression; (2) Higher level *conceptual sensitivity* where the nature and meaning of the expression change is fully understood. We reasoned that perceptual sensitivity would be driven by the processing of local details, whereas conceptual sensitivity would be best served by global processing.

Mood-Congruency theory would predict that perceptual and conceptual sensitivity to expression change would be enhanced if participants' mood shared the valence of the emerging facial expression. Affect-as-Information theory would predict two things. First, individuals in a negative mood may be particularly sensitive to low-level changes in physical detail, and thus require less expression intensity to accurately detect a perceptual change. Second, individuals in a positive mood may be particularly sensitive to global changes in expression, and thus require less expression intensity to accurately understand the broader conceptual change. Our pattern of results fits neither theory adequately, and instead provides the novel and interesting finding that higher intensity mood states can reduce perceptual and conceptual sensitivity to the emergence of a variety of expressions.

METHODS

Participants

Forty seven healthy adult participants (23 male, 24 female; mean age 23 years) from the University of Aberdeen took part voluntarily or for monetary reimbursement. One dataset was excluded due to incorrect use of the response keys. All participants reported no previous history of any clinical mood disorders. The study was approved by the School of Psychology Ethics Committee.

Materials and Stimuli

All tasks were conducted on a Dell Optiplex 780, 1024 x 1280 resolution, using Eprime 2.0, and participants were seated approximately 30 cm away from the screen. For the animated morph task, digitized colour photographs (421x500 pixels) of three male models with hair present (numbers 23, 25, 71) illustrating seven affective states (fear, disgust, angry, sad, surprised, happy, neutral) were selected from the Radboud Faces database (Langner et al., 2010), as per Schönenberg et al. (2013). The neutral expression was morphed into each of the six emotional expressions in 2% increments for every model, using FantaMorph software (Abrosoft, China). Thus there were 51 intensity level images in each sequence ranging from 0% neutral to 100% expressive. Each of the 18 different morph sequences was repeated five times throughout the main task. Because morph sequences were repeated, it was important to reduce potential learning effects and thus vary the appearance of each morph sequence so that the timing of expression change was not fixed (see Schönenberg et al., 2013). To do this, 10 individual images within each sequence were randomly duplicated to create a sequence comprising 61 images. Current mood state was measured using a computerised version of the 60-item PANAS-X (Watson & Clark, 1994). Participants rated 30 positive and 30 negative emotion words to describe how they felt at that moment, on a scale of 1 (not at all) to 5 (extremely). Scores for each item were summed, thus yielding a possible score of between 30 (low intensity) and 150 (high intensity) for each mood valence.

Design and Procedure

First, participants completed the PANAS-X (Watson & Clark, 1994). The animated morph task began with 30 practice trials (15 fear, 15 disgust; randomised), followed by the main experimental session which comprised 15 trials per expression (angry, sad, happy, surprised). Emotional expression and face model were pseudo-randomised in a within-subjects design. As per Schönenberg et al. (2013), morph images in each sequence were presented for 500 ms each in the centre of the screen, starting with the 100% neutral face that progressed to the 100% emotional counterpart. In our adapted paradigm, participants were first required to press a key as soon as they detected a physical change in expression (perceptual sensitivity – a new addition to this paradigm). The morph sequence continued and participants were instructed to press another key as soon as they were certain which emotion was emerging (conceptual sensitivity, as in the traditional paradigm). On making this conceptual response, the morph sequence terminated and participants pressed a labelled key to name the emotion (fear/disgust for practice; angry/sad/happy/surprised for main task). This final emotion labelling response was not speeded and was used to compute emotion recognition accuracy scores.

Data Analysis

Mean emotional intensity values (% morph) at the point of key press for both perceptual and conceptual responses on correct recognition trials only were used to compute a sensitivity index value, where larger values indicate lower sensitivity. The influence of participant mood was directly assessed by computing Pearson correlations between mood scores and sensitivity scores for each expression.[1] In our sample, negative mood scores ranged from 33 to 102 (M = 48.41; median = 45.50; SD = 13.72), and positive mood scores ranged from 35 to 122 (M = 77.62; median = 76.00; SD = 15.51).

RESULTS

Recognition Accuracy

A repeated-measures ANOVA revealed a significant main effect of emotion ($F(3, 135) = 14.66$, $p < .001$, $\eta_p^2 = .25$). Pairwise comparisons with Bonferroni corrected p-values showed that participants were significantly poorer in labelling angry expressions (M = 88.85, SE = 2.04) compared to happy (M = 98.57, SE = 0.44; $p < .001$), sad (M = 97.39, SE = 0.83; $p = .003$), and surprise (M = 97.70, SE = 0.69; $p = .001$). All other comparisons were non-significant (all *p*s = 1.00). Poorer labelling of anger versus other emotions among the healthy population has been reported previously (Joormann & Gotlib, 2006) so this finding is a healthy replication and not unique or unexpected. Mood did not significantly influence recognition accuracy (see Table 1 for mood/accuracy correlations).

Sensitivity to Expression Change

Perceptual Sensitivity. Mean perceptual sensitivity values were: angry (M = 25.37, SE = 1.48), sad (M = 24.14, SE = 1.28), happy (M = 16.76, SE = 0.71), surprised, (M = 16.64,

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[1] We also assessed the mood of a subsample of 13 participants both before and after the practice session, in order to check whether viewing fear and disgust faces during practice inadvertently altered mood before the main task began. We found no reliable support for this ($p = .50$ and $p = .18$ for positive and negative mood score differences pre- versus post-practice).

SE = 0.92). All correlations between negative mood and perceptual sensitivity scores were non-significant (see Table 1). However, increased positive mood significantly decreased perceptual sensitivity to a change in both angry ($r(44) = .33$, $p = .027$) and sad ($r(44) = .39$, $p = .007$) expressions (Figures 1a and 1b respectively). Correlations between positive mood and sensitivity to happy or surprised expressions were non-significant (Table 1).

Conceptual Sensitivity. Mean conceptual sensitivity values were: angry (M = 37.71, SE = 1.51), sad (M = 34.12, SE = 1.13), happy (M = 22.96, SE = 0.77), surprised (M = 25.98, SE = 0.84). Increased negative mood significantly decreased conceptual sensitivity to a change in both angry ($r(44) = .39$, $p = .008$) and sad ($r(44) = .47$, $p = .001$) expressions (Figures 1c and 1d respectively). There were also weaker correlations between increased negative mood and reduced sensitivity to changes in happy ($r(44) = .28$, $p = .060$; Figure 1e) and surprised ($r(44) = .28$, $p = .060$; Figure 1f) expressions. Thus, heightened negative mood decreased the ability to accurately conceptualise the emergence of all expressions to some degree. In contrast, increased positive mood significantly reduced conceptual sensitivity to a change in angry ($r(44) = .35$, $p = .018$) and sad ($r(44) = .42$, $p = .004$) expressions (Figures 1g and 1h respectively), but had little impact on sensitivity to happy or surprised expressions (Table 1).

Table 1 about here

Figure 1 about here

We also note that perceptual and conceptual changes took longer to detect in negative than positive expressions (happy vs. angry/sad and surprised vs. angry/sad, all Bonferroni corrected *p*s < .001). Given the notion that threat signals should be particularly salient, it is perhaps surprising that we find lower sensitivity to negative versus positive expressions. However, our findings replicate the happy advantage consistently found among healthy adults in the traditional version of our task (Becker et al., 2012; Joormann & Gotlib, 2006;

Schönenberg et al., 2013). Becker et al. (2012) suggest that the emergence of a happy expression may be more readily detected due to expansion properties of happy facial features (neutral to angry involves contraction). The same could apply to surprise here. However, our expressions changed more slowly than those in Becker et al's (2012) study, and perceptual sensitivity to surprise was similar to happy (p = .805), so this interpretation is provided with caution. On a more conceptual level, Becker and Srinivasan (2014) propose that prosocial communication is essential for human development and evolution, and that happy expressions are salient for this reason. Supporting this, conceptual sensitivity was significantly higher for happy than surprised expressions (p = .001), suggesting that happy signals are rapidly decoded at a deeper, more meaningful level.

Finally, to assess whether there were any speed-accuracy trade-offs, correlations were computed between conceptual sensitivity values (i.e., the point at which they understood which expression had emerged – this response terminated the sequence) and recognition accuracy scores (response made immediately after). There was a significant *negative* correlation between accuracy and sensitivity for angry faces (r (44) = -.520, p< .001) indicating that waiting for more expression information to appear was related to poorer, not better, accuracy. No other correlations reached significance (all ps > .12), thus there is no evidence for any speed-accuracy trade-off.

DISCUSSION

To summarise, we find modest support for mood congruency theory and no support for Affect-As-Information theory. Our results show evidence of a partial mood *in*congruency effect in which increased positive mood reduced perceptual and conceptual sensitivity to the emergence of angry and sad expressions only. However, increased negative mood did not similarly reduce sensitivity to the emergence of positive expressions only.

Our key finding was that while heightened negative mood had little impact on perceptual sensitivity for any expression, it served to reduce conceptual sensitivity (the point at which participants were sure what expression had emerged) to all expressions to varying degrees: strongly for negative and modestly for positive expressions. This may be best interpreted according to theories of attentional resource allocation. It is widely accepted that we have a limited capacity attentional resource (Kahneman, 1973), and thus have to distribute our resources as efficiently as possible according to both internal and external demands. Ellis and Ashbrook's (1988) *resource allocation model* posits that the amount of resource that can be allocated to external tasks is regulated by a person's emotional state. Increasingly intense moods are thought to increase irrelevant thoughts which then compete for resources required to undertake other relevant cognitive activities. While this model refers more specifically to memory, it is conceivable that the ability to more generally monitor external events is similarly influenced by mood, especially when external observations are social and emotional in nature. Our study suggests that while heightened states of both positive and negative moods may consume larger portions of resource, being in a negative mood state may be particularly resource intensive, with greater introspection and self-directed attention leading to reduced capacity for processing a wider variety of socio-emotional signals transmitted by others. Greater introspection and less regard for others is maladaptive: reduced sensitivity to threat signals can impair communication and could endanger one's emotional and physical welfare, while reduced sensitivity to others' expressions of sadness or despair is not conducive to empathic relations. Decreased sensitivity to a smile is disadvantageous for prosocial communication and connection with others, while impaired ability to detect and decode surprise – a form of readiness for action (Kringelbach & Phillips, 2014) - could delay reciprocal behaviour.

In conclusion, our findings draw attention to how sensitivity to others' emotions can be influenced by normal variations in our current mood state. The results help advance theories of mood and emotion processing, and deepen our understanding of normal social human interaction.

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Figure and Table Captions

Figure 1. These scatterplots show correlations between: Positive Mood and Perceptual Sensitivity to the emergence of Angry (a) and Sad (b) expressions; Negative Mood and Conceptual Sensitivity to the emergence of Angry (c), Sad (d), Happy (e), and Surprised (f) expressions; Positive Mood and Conceptual Sensitivity to the emergence of Angry (g) and Sad (h) expressions. Perceptual sensitivity was defined as the % morph (expression intensity) at which a physical change in expression was detected. Conceptual sensitivity was defined as the % morph (expression intensity) at which participants were confident which expression had emerged. All figures show a positive correlation where increased mood intensity served to reduce sensitivity.

Table 1. Correlation coefficients (Pearson's *r*) between Mood scores and Perceptual/Conceptual Sensitivity values, and between Mood scores and Recognition Accuracy scores. Correlation is significant at $p < .01$ (**); correlation is significant at $p < .05$ (*). Values in italics denote a marginally significant correlation $p < .09$.

Table 1

	Perceptual Sensitivity				**Conceptual Sensitivity**				**Recognition Accuracy**			
	Angry	**Sad**	**Hap**	**Surp**	**Angry**	**Sad**	**Hap**	**Surp**	**Angry**	**Sad**	**Hap**	**Surp**
Negative Mood	.25	.21	.05	.03	**.39****	**.47****	***.28***	***.28***	-.06	.03	-.25	-.24
Positive Mood	**.33***	**.39****	.21	.19	**.35***	**.42****	.05	.15	-.23	.12	-.15	-.21

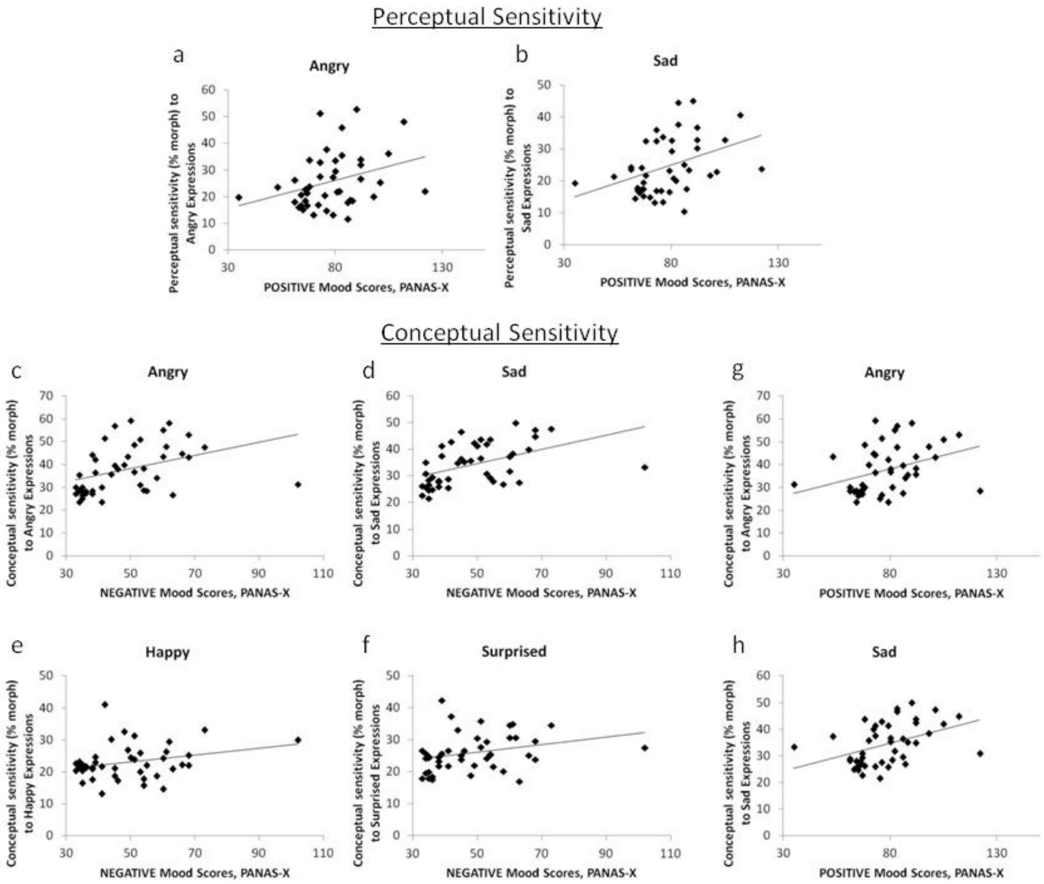
Perceptual Sensitivity
a
Angry
Perceptual sensitivity (% morph) to Angry Expressions
POSITIVE Mood Scores, PANAS-X
b
Sad
Perceptual sensitivity (% morph) to Sad Expressions
POSITIVE Mood Scores, PANAS-X
Conceptual Sensitivity
c
Angry
Conceptual sensitivity (% morph) to Angry Expressions
NEGATIVE Mood Scores, PANAS-X
d
Sad
Conceptual sensitivity (% morph) to Sad Expressions
NEGATIVE Mood Scores, PANAS-X
g
Angry
Conceptual sensitivity (% morph) to Angry Expressions
POSITIVE Mood Scores, PANAS-X
e
Happy
Conceptual sensitivity (% morph) to Happy Expressions
NEGATIVE Mood Scores, PANAS-X
f
Surprised
Conceptual sensitivity (% morph) to Surprised Expressions
NEGATIVE Mood Scores, PANAS-X
h
Sad
Conceptual sensitivity (% morph) to Sad Expressions
POSITIVE Mood Scores, PANAS-X

Figure 1