Running Head: Emotion recognition in disordered eating

The influence of emotional intensity on facial emotion recognition in disordered eating

Nathan Ridout[a]*, Deborah J. Wallis[b], Yasmin Autwal[a] & Jenna Sellis [b]

[a] Cognitive & Affective Neurosciences, School of Life & Health Sciences, Aston University,

Birmingham, UK, B4 7ET.

[b] Loughborough University Centre for Research into Eating Disorders, School of Sport,

Exercise & Health Sciences, Loughborough University, Leicestershire, UK, LE11 3TU.

*Address for correspondence:

Dr Nathan Ridout

Cognitive & Affective Neurosciences,

School of Life and Health Sciences,

Aston University,

Birmingham, UK, B4 7ET.

Tel: +44 (0) 121 204 4162

Fax: +44 (0) 121 204 4090.

Email: n.ridout@aston.ac.uk

Abstract

Significant facial emotion recognition (FER) deficits have been observed in participants exhibiting high levels of eating psychopathology. The current study aimed to determine if the pattern of FER deficits is influenced by intensity of facial emotion and to establish if eating psychopathology is associated with a specific pattern of emotion recognition errors that is independent of other psychopathological or personality factors. Eighty females, forty high and forty low scorers on the Eating Disorders Inventory (EDI) were presented with a series of faces, each featuring one of five emotional expressions at one of four intensities, and were asked to identify the emotion portrayed. Results revealed that, in comparison to low EDI scorers, high scorers correctly recognised significantly fewer expressions, particularly of fear and anger. There was also a trend for this deficit to be more evident for subtle displays of emotion (50% intensity). Deficits in anger recognition were related specifically to scores on the body dissatisfaction subscale of the EDI. Error analyses revealed that, in comparison to low EDI scorers, high scorers made significantly more *fear-as-sadness* and *fear-as-anger* errors. Also, a tendency to label anger expressions as sadness was related to body dissatisfaction. Current findings confirm FER deficits in subclinical eating psychopathology and extend these findings to subtle expressions of emotion. Furthermore, this is the first study to establish that these deficits are related to a specific pattern of recognition errors. Impaired FER could disrupt normal social functioning and might represent a risk factor for the development of more severe psychopathology.

Key words

Introduction

Emotional facial expressions provide vital non-verbal cues about the intentions and motivations of others (Darwin, 1872) and, as such, are a crucial aspect of everyday social functioning. Evidence suggests that individuals who exhibit deficits in facial emotion recognition (FER) tend to experience difficulties in their social functioning. For example, Pan, Chen, Chen and Liu (2009) reported that poor social functioning in a sample of schizophrenic patients was significantly associated with impairments in FER. Consistent with this proposal, Besel and Yuille (2010) demonstrated that participants' FER accuracy predicted the quality of their social skills, as measured by the Empathy Quotient scale (Lawrence et al., 2004).

There is consistent evidence that clinically diagnosed eating disorders, in particular anorexia nervosa (AN) and bulimia nervosa (BN), are associated with impaired social functioning (Fairburn, Cooper, Doll & Welch, 1999; Fairburn et al., 1998; Godart et al., 2004; Troop & Bifulco, 2002) and with deficits in FER, particularly of expressions of negative emotions (Kucharska-Pietura, Nikolaou, Masiak, & Treasure, 2004; Zonnevijlle-Bender, van Goozen, Cohen-Kettenis, van Elburg, & van Engeland, 2002). It is plausible that deficits in FER exhibited by individuals with disordered eating might underlie or contribute to the social problems reported by these individuals. Jones, Harmer, Cowen & Cooper (2008) reported that participants exhibiting sub-clinical levels of disordered eating (indexed by the Eating Attitudes Test; EAT, Garner et al, 1982) demonstrated impaired recognition of happy and neutral expressions from static faces. They also reported that participants with high levels of disordered eating exhibited a problem in discriminating anger from other emotions. Similarly, a recent study conducted by Ridout, Thom and Wallis (2010) revealed that participants with sub-clinical disordered eating (indexed by scores on the Eating Disorders Inventory; EDI, Garner, 1991) exhibited deficits in recognising emotion from

dynamic stimuli (short video clips of social interactions). They reported that, compared with low scorers, participants with high EDI scores exhibited a general deficit in emotion recognition, with a particular impairment in recognising expressions of anger. Ridout et al. (2010) proposed that, due to the negative consequences for social functioning, this deficit might act as a risk factor for more serious eating pathology. In line with this proposal, Ferriter, Eberhart and Hammen (2010) demonstrated that the quality of social functioning moderated the relationship between depression and eating pathology (EP). Furthermore, Jackson, Weis, Lundquist and Soderlind (2005) reported that interpersonal problems in a sample of female college students were associated with a greater prevalence of disordered eating.

Despite the apparent consistency of the results concerning FER deficits in disordered eating, two studies have failed to replicate this finding (Kessler, Schwarze, Filipic, Traue, & von Wietersheim, 2006; Mendlewicz, Linkowski, Bazelmans, & Philippot, 2005). There are a number of plausible explanations for the variation in findings across studies. For example, it is possible that differences in mood may have contributed to impaired FER exhibited in the patients with EP, as previous studies have demonstrated that depression (e.g. Persad & Polivy; Surguladze et al, 2004) and anxiety (Surcinelli et al, 2002) are associated with impaired FER. Furthermore, variations in the personality trait alexithymia might account for differences in FER across studies. Alexithymia is characterised by a difficulty in describing and identifying feelings and with an externally oriented cognitive style. This personality trait is strongly associated with disordered eating (e.g. Beales & Dolton, 2000; Gilboa-Schechtman et al., 2006) and has been linked to emotion recognition deficits (Lane, Sechrest, Riedel, Shapiro, & Kaszniak, 2000; Ridout et al, 2010). Another factor that might account for the variation in FER deficits across studies concerns the tendency of most previous studies to utilise tests using static pictures of individuals posed in different emotional

expressions. These stimuli are comparatively easy to interpret, especially when the faces are presented for relatively long durations (e.g. 2000ms) and when participants are required to make forced choice decisions from a limited set of emotional labels, which may have masked group differences due to all participants' performance being at or near ceiling. Law Smith, Montagne, Perrett, Gill and Gallagher (2010) used dynamic facial stimuli that varied in their emotional intensity to examine FER in a group of patients with autism. They reported that the patients exhibited impaired FER, compared with the control group, and this deficit was more evident on trials featuring less intense emotional expressions. Following similar logic it would be expected that, compared with individuals with low levels of disordered eating, participants with high levels would exhibit greater deficits in FER at lower levels of stimulus intensity. The motivation for the present study was to establish if manipulating emotional intensity influenced the pattern of FER exhibited by participants with elevated levels of disordered eating.   Improving the current understanding of FER in these individuals is vital, given the potential link between impaired FER, social functioning deficits and serious eating psychopathology.

Overview and Predictions

Two groups of participants, categorised as high or low scorers on the Eating Disorders Inventory (EDI-II; Gardner, 1991), were presented with a series of faces, each featuring one of five emotional expressions (happiness, sadness, fear, anger & disgust) at one of four emotional intensities (50%, 75%, 100% & 125%), and were asked to identify the emotion portrayed. Participants also completed self-report measures of mood (Hospital Anxiety & Depression Scale; HADS, Zigmond & Snaith, 1983) and the personality trait alexithymia (Toronto Alexithymia Scale; TAS-20; Bagby, Parker & Taylor, 1994). It was predicted that high scorers on the EDI would recognise significantly fewer emotional expressions than

would low scorers. However, in line with our previous findings (Ridout et al., 2010), this deficit was expected to be particularly evident for angry expressions. Further, it was expected that group differences in FER would be greater when the intensity of expressed emotion was lower. Given that depression, anxiety and alexithymia have all been shown to impair FER the influence of these variables was assessed in the current study. In line with our previous findings (Ridout et al., 2010), it was predicted that impaired anger recognition would be associated specifically with eating psychopathology (body dissatisfaction) and not mood or alexithymia. In order to explore the nature of any observed FER deficits the pattern of errors (misidentifying one emotional expression as another emotion, e.g. angry faces as disgust) will also be examined.

Method

Participants

Eighty female participants were recruited from the undergraduate populations of Aston and Loughborough universities and from a self-help centre for people with concerns about their eating. All participants were categorised according to their scores on the eating subscales of the 2nd edition of the Eating Disorders Inventory (EDI-II; Gardner, 1991). As the students and self-referral groups did not form truly orthogonal groups with regard to the EDI scores, the two groups were formed using a median split of the scores on the EDI (median=18). Participants with scores of 17 and below were categorised as the low EDI group (Mean EDI=6.1, SD=4.8) and those with scores of 18 and above were classified as the high EDI group (Mean EDI=39.5, SD=14.1). It should be noted that the two groups differed significantly in terms of their age (low EDI group=22.8 years, SD=5.5; high EDI group=26.4 years, SD=9.8). This study was approved by the research ethics committees of Aston and

Loughborough universities. All participants provided full written informed consent prior to taking part in the study.

Assessment of facial emotion recognition (FER)

160 static images of faces were drawn from the Facial Expression of Emotion: Stimuli and Tests (FEEST: Young et al., 2002), each featuring one of five emotions (happiness, sadness, anger, fear & disgust) at one of four emotional intensities (50%, 75%, 100% & 125%). Emotional intensity refers to the extent to which the facial features had changed from neutral (0%) to a particular expression (100%). 125% intensity was created by exaggerating the changes to the facial features denoting each expression. Each emotion was portrayed by four male and four female actors. The stimuli were presented to the participants via a computer screen using version 2 of the experimental presentation software Superlab (Cedrus Corpation, 2002). The 160 trials were presented in a new random order for each participant. Each trial consisted of a focus point in the form of a cross (presented for 1000 milliseconds), which was replaced by one of the facial stimuli (presented for 2000 milliseconds), which in turn was replaced by a screen showing the five emotion labels (presented side-by-side across the screen). The participants' task was to press the key on the keyboard that corresponded to the position of the label of the emotion that they had just viewed. The order that the emotional labels appeared on screen changed on each trial; this was to prevent the participants from anticipating and pressing the key too early, and to ensure they focused on the emotional expression for the duration of the presentation. It was also to control for potential differences in the time taken to press particular keys on the keyboard. The range for the overall FER scores was 0 – 160, with a range for each emotion of 0 – 32 (8 at each intensity).

Measures

The short form (2nd edition) of the Eating Disorders Inventory (EDI-II; Gardner, 1991) was used to assess the degree of eating psychopathology present in the participant sample. The EDI-II (short-form) is a valid and reliable 23-item measure of eating-related psychopathology (Garner, 1991), which has previously been utilised in clinical (Kessler et al., 2006) and non-clinical samples (Ridout et al., 2010) and in student populations (Laquatra & Clopton, 1994; Quinton & Wagner, 2005). Three subscales contribute to the overall score on the EDI-II; these are drive for thinness (7-items), bulimia (7-items) and body dissatisfaction (9-items). The range of possible scores on the total EDI scale is 0 – 69, whereas the possible range of scores on the three subscales was 0 – 21 (drive for thinness & bulimia) and 0 – 27 (body dissatisfaction).

The 14-item Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) was included in the present study to assess the presence and severity of depression and anxiety in the participant sample. This is important, as previous studies have revealed that both depression and anxiety are associated with deficits in FER (Persad & Polivy; Surcinelli et al, 2002; Surguladze et al, 2004). HADS consists of two subscales with 7 items relating to symptoms of depression and 7 concerning symptoms of anxiety. This measure has been shown to be valid and reliable for use in clinical and non-clinical populations (Snaith, 2003). The range of possible scores for the HADS is 0 – 21 for each of the two subscales (depression & anxiety), with higher scores equating to greater symptom severity.

The 20-item Toronto Alexithymia Scale (TAS-20; Bagby, Parker & Taylor, 1994) was also administered in order to assess the degree of alexithymia (ALX) present in the participant sample. This is important, as previous work has revealed that ALX is associated with impaired FER (Lane et al., 2000) and has been implicated in emotion recognition deficits in clinical (Pedrosa-Gil et al., 2008) and non-clinical populations (Ridout et al.,

2010). The TAS-20 consists of the three subscales measuring *difficulties identifying feelings*, *difficulties describing feelings* and *externally oriented thinking* and has been shown to provide a valid and reliable measure of alexithymia (Bagby et al, 1994). The possible range of scores for the TAS-20 is 0 – 60.

Procedure

Once general demographic information had been collected participants completed the facial emotion recognition task. They subsequently completed the HADS, TAS-20 and EDI-II.

Data Analyses

Group differences in age, depression, anxiety, eating psychopathology and alexithymia were assessed using independent t-tests. Differences in FER were assessed using a 2 (group; High EDI vs. Low EDI) x 5 (emotion; happiness vs. sadness vs. anger vs. fear vs. disgust) x 4 (intensity; 50% vs. 75% vs. 100% vs. 125%) mixed factorial ANOVA. FER errors were assessed by analysing the percentage of misidentifications, which were calculated for each of the emotional stimulus categories (happy, sad, anger, fear and disgust) as the percentage of trials in which the stimuli were erroneously labelled as one of the other four emotions. These were analysed by conducting separate 2 (group; High EDI vs. Low EDI) x 4 (emotion) mixed factorial ANOVA for any emotional stimulus category for which a significant recognition deficit was observed. Subsequent pairwise comparisons were conducted using Bonferroni corrected t-tests. The relative contributions of eating psychopathology, mood and alexithymia to any observed emotion recognition deficits were assessed using appropriate multiple regression analyses.

Results

Participant characteristics

Inspection of the data presented in Table 1 revealed that two groups differed significantly in terms of their age, with the High EDI group being on average four years older than the low EDI group. The High EDI group also scored significantly higher than the Low EDI participants on all subscales of the EDI, suggesting that the two groups were truly orthogonal. They also scored significantly higher than the Low EDI group on all three subscales of the TAS-20. It is also of note that the High EDI group reported significantly higher levels of anxiety and depression than did participants in the Low EDI group.

Emotion recognition accuracy

Analysis of the participants' emotion recognition accuracy (presented in Table 2) revealed significant main effects of Group; $F(1, 78) = 4.4$; $p<.05$; $\eta p^2 = .05$, Emotion; $F(4, 312) = 133.5$; $p<.001$; $\eta p^2 = .63$, and Intensity; $F(3, 234) = 207.4$; $p<.001$; $\eta p^2 = .73$. There was also a significant Emotion x Intensity interaction; $F(12, 936)=21.6$; $p<.001$; $\eta p^2 = .22$, and a significant Group x Emotion interaction (see Figure 1); $F(4, 312) = 2.7$; $p<.05$; $\eta p^2 = .03$, which was explored further using Bonferroni corrected independent t-tests (significant α set at .01 to account for multiple comparisons). These revealed that participants in the Low EDI group correctly recognised significantly more of the fear expressions than did the High EDI group; $t(78)=2.7$; $p<.01$. Similarly, participants in the Low EDI group recognised significantly more of the anger expressions than did the High EDI group; $t(78)=2.8$; $p<.01$. There was also evidence of an interaction between Group and Intensity; $F(43, 234) = 2.3$; $p=.09$; $\eta p^2 = .03$. Given the *a priori* expectation that the two groups would differ in emotion recognition as a function of emotional intensity, it was appropriate to explore this interaction further using Bonferroni corrected independent t-tests (significant α set at .01), which

indicated that the two groups differed significantly only at the 50% level of emotional intensity; t(78)=2.7; $p<.01$. The interaction between Group, Emotion and Intensity was not statistically significant (F<1; $\eta p^2 = .01$). Given that the two groups differed significantly in their age, the analysis of emotion recognition accuracy was repeated with age included as a covariate. Age did not contribute significantly to emotion recognition, ($p>.05$) and the results involving the EDI groups did not change, indicating that the previous findings should not be ascribed to age differences between the groups.

Mood, eating psychopathology, alexithymia and emotion recognition

In order to explore the relative contributions of eating psychopathology, mood and personality variables in accounting for the observed deficits in emotion recognition a series of multiple regression analyses were conducted. Given previous findings concerning deficits in the recognition of anger in disordered eating (Ridout et al, 2010), body dissatisfaction score was entered at the first level of a hierarchical regression, with depression, anxiety and alexithymia scores entered at the second level. These analyses produced a significant model that accounted for 7% of the variance (R^2=0.07; adjusted R^2=0.06); F(1, 78)=5.9, p<.05. Body dissatisfaction score entered as the only significant predictor; Beta=-.27, p<.05. Depression, anxiety and alexithymia did not explain any additional variance, R^2 change=.003, p>.05. Based on previous findings relating to a general emotion recognition deficit in disordered eating (Ridout et al, 2010), scores on the bulimia subscale of the EDI and the TAS-20 alexithymia scale were entered at the first level of a hierarchical regression. Depression and anxiety scores were entered at the second level. This analysis failed to account for a significant amount of the variance in the emotion recognition scores; F<1. As no previous studies have reported a specific deficit in fear recognition in disordered eating no theoretical hypotheses could be tested regarding the relative contribution of the different

mood, personality and eating variables. With this in mind, a stepwise multiple regression was conducted to determine the relative contribution of these factors in explaining the observed deficit in fear recognition. Results revealed that none of the factors explained a significant amount of the variance, F<1.

Analysis of FER errors

Analysis of the percentage of anger misidentifications revealed significant main effects of Emotion and Group; $F(3, 234)=56.2$, $p<.001$, $\eta p^2=.42$ and $F(1, 78)=8.48$, $p<.01$; $\eta p^2=.1$. However, there was no significant Group x Emotion interaction, F<1. Subsequent pairwise comparisons, using Bonferroni tests, revealed that participants were significantly more likely to misidentify anger as disgust (Mean=17.8, SE=1.3) than as sadness (M=12.4, SE=.94), fear (M=8.8, SE=.76) or happiness (M=1.5, SE=.28), all tests p<.01. Furthermore, they were significantly more likely to misidentify anger as sadness than as fear or happiness, both tests p<.01. The difference between the number of anger as fear and anger as happiness errors was also significant, p<.01. Interestingly, a stepwise multiple regression produced a significant model that accounted for around 5% of the variance in the number of angry expressions misidentified as sadness ($R^2=.052$, Adjusted $R^2=.039$); $F(1, 78)=4.2$, $p<.05$. Body dissatisfaction score was the only significant predictor that entered the model, Beta=.23, p<.05. The mood, personality or eating psychopathology did not contribute significantly to the explanation of the variance in other types of anger-as errors, all tests F<1.

Analysis of the number of fear misidentifications revealed significant main effects of Emotion and Group; $F(3, 234)=30.8$, $p<.001$, $\eta p^2=.28$ and $F(1, 78)=9.4$, $p<.01$, $\eta p^2=.11$ respectively. However, there was also evidence of a Group x Emotion interaction that approached conventional significance; $F(3, 234)=2.65$, $p=.06$, $\eta p^2=.03$. Subsequent pairwise comparisons (alpha adjusted to .0125) revealed that the high EDI group were significantly

more likely than the low group to misidentify fear as anger or sadness; $t(78)=3.5$, $p<.001$ and $t(78)=2.6$, $p<.01$ respectively. Separate stepwise multiple regressions were conducted to determine the influence of depression, anxiety, alexithymia and eating psychopathology on the number of these recognition errors. Results revealed a significant model that accounted for around 7% of the variance in the number of fearful expressions misidentified as anger ($R^2=.066$, Adjusted $R^2=.05$); $F(1, 78)=5.5$, $p<.05$, with body dissatisfaction score entering as the only significant predictor; Beta=.26, $p<.05$. Results also revealed a significant model that accounted for about 9% of the variance in the number of fearful expressions that were misidentified as sadness ($R^2=.088$, Adjusted $R^2=.076$); $F(1, 78)=7.5$, $p<.01$, with HADS depression score entering as the only significant predictor; Beta=.3, $p<.01$.

Discussion

The aim of the current study was to establish if manipulating emotional intensity influenced the pattern of facial emotion recognition (FER) exhibited by participants with elevated levels of eating psychopathology. Further, we aimed to establish if FER deficits in those with high eating psychopathology were related to a specific pattern of recognition errors. To this end, high and low scorers on the EDI-II were presented with photographs of emotional faces featuring one of five emotions (happiness, sadness, anger, fear & disgust) at one of four intensities (50%, 75%, 100% & 125%) and were asked to identify the emotion portrayed. In line with predictions, participants with elevated scores on the EDI correctly recognised significantly fewer emotional expressions than did low scorers. This is consistent with previous findings in patients with clinically diagnosed eating disorders (Kucharska-Pietura et al., 2004; Zonnevijlle-Bender et al., 2002) and participants with sub-clinical eating psychopathology (Jones et al, 2008). The current findings are also consistent with our

previous work (Ridout et al, 2010), which demonstrated that non-clinical eating psychopathology was associated with impaired emotion recognition from film clips of social interactions. Present findings also demonstrated that participants with high EDI scores recognised fewer expressions of anger, and that recognition of anger was negatively related to scores on the body dissatisfaction subscale of the EDI. This supports our predictions and is consistent with the findings of our previous study (Ridout et al., 2010). Results of the current investigation also revealed a significant impairment in the recognition of fear in those with high EDI scores. This finding was not expected, based on previous work in the field.

In sum, our results confirm the presence of a deficit in the processing of anger in those with high levels of eating psychopathology. This is compatible with evidence that those with clinical levels of eating disorders have higher levels of both state anger and anger suppression than do control individuals (Waller, Babbs, Milligan, Meyer, Ohanian, & Leung, 2003). One possibility is that in trying to suppress their own anger individuals with high levels of eating psychopathology may become less sensitive to the displays of anger in others. Another possibility is that these individuals may have a protective mechanism where they try to avoid confrontations with others, thus they may have a tendency to avoid processing social signals of anger. These proposals need to be tested directly in clinical and subclinical populations.

Interestingly, the impairment of anger and fear recognition that was evident in the High EDI group mirrors the deficits that have consistently been reported in patients with lesions to the amygdala (e.g. Adolphs, 2008; Calder et al, 1996). Therefore, it is plausible that FER deficits associated with eating psychopathology may, at least in part, reflect variations in the functioning of this region. In line with this logic, Giordano et al (2001) reported evidence of reduced amygdala volume in patients with AN. Furthermore, there is evidence of changes in amygdala activity in participants with eating disorders (e.g. Takano et al., 2001). However,

the present finding that the misidentification of fear as sadness was related to depression severity (indexed by the HADS), suggests that concomitant depression may have contributed to the deficit in fear recognition. Nevertheless, as the number of fear-as-anger errors was predicted by level of body dissatisfaction (and not depression) this suggests that impaired fear recognition may be a consequence of a combination of depression and eating psychopathology.

It was predicted that the FER exhibited by the High EDI group would be more evident when the emotional expressions were presented at lower intensities. The trend significant interaction between group and intensity provides partial support for this prediction. It is notable that significant group differences in overall FER only emerged at the 50% level of emotional intensity. This suggests that, when compared with individuals with low eating psychopathology, participants with high levels may be less sensitive to subtle facial expressions. Although caution must be taken in interpreting these findings, if those with high levels of eating psychopathology are less sensitive to the presence of emotion then this have important implications concerning everyday social interactions. For example, in comparison to tasks used to study FER (including the current study), where static facial stimuli are presented at full intensity for several seconds, everyday social interactions are associated with rapidly changing dynamic facial expressions. Therefore, it would seem likely that these everyday interactions would put greater demands on the cognitive and neural processes that underlie FER. Thus, it is likely that a blunting of sensitivity to subtle expressions would be associated with greater deficits in emotion recognition under these challenging conditions. In line with this proposition, Surguladze et al. (2004) reported that depressed patients demonstrated greater impairments in FER when facial stimuli were presented for short (100ms) rather than long durations (2000ms). This has yet to be confirmed in those with high levels of eating psychopathology.

This study represents the first systematic examination of the pattern of emotion recognition errors in those with high levels of eating psychopathology. Results revealed a consistent pattern of errors, such that body dissatisfaction was associated with misidentifying fear as anger and anger as sadness. Both of these findings confirm a specific deficit in the normal processing of anger in this group. However, the observed tendency in the high EDI group to misidentify fear as sadness was actually related to concomitant depression.

Methodological strengths include using a standardised test of facial emotion recognition (FEEST, Young et al, 2002), systematic exploration of both recognition accuracy and recognition errors, and controlling for potential confounding variables (i.e. mood and alexithymia).   One limitation of the present study is the absence of diagnostic information relating to history of DSM-IV Axis I disorders based on Structured Clinical Interviews. Given that clinical disorders of mood and eating can influence emotion recognition ability, it would be pertinent for future research to address this limitation formally. However, as symptoms of depression, anxiety and disordered eating were measured using validated questionnaires and intrinsic to the data analytic strategy, the cognitions and behaviours associated with such diagnoses were accounted for within the study. Another possible limitation to the current study was the omission of expressions of surprise from the FER task. Previous work (Legenbauer, Vocks & Ruddel, 2008) reported impaired recognition of surprise in patients with clinically diagnosed bulimia. It is plausible that had we included expressions of surprise a further deficit may have emerged, which may in turn have been associated with scores on the bulimia subscale of the EDI (although there was no evidence of such a deficit in our previous study; Ridout et al, 2010). The decision to omit expressions of surprise from the current study was taken in order to reduce the overall number of stimuli to be presented to the participants, given that each emotion was going to be presented several times at four different intensities. However, the omission of surprise is in line with theorists

who have questioned the notion that surprise represents a discrete emotion, e.g. the influential

SPARS model of emotion (Power & Dalgleish, 1988).

In sum, participants reporting elevated levels of eating psychopathology exhibited

impaired facial emotion recognition, with specific deficits in the recognition of fear and

anger. There was also some evidence to support the existence of a particular deficit in the

recognition of subtle expressions of emotion. Results also revealed that these individuals

exhibited a specific pattern of emotion misidentification errors. Specifically, body

dissatisfaction was associated with impaired anger recognition and a greater tendency to

misidentify fear as anger and anger as sadness. Taken together with our previous findings

(Ridout et al., 2010) these results confirm a specific deficit in the processing of anger in those

high in eating psychopathology. These findings require confirmation and replication in

clinical samples. Deficits in the recognition of facial emotion expressed by significant others,

specifically when they are angry, could result in interpersonal conflict, which in turn could

act to undermine these important social bonds. This could have implications for the

development of more serious psychopathology.

References

Adolphs, R. (2008). Fear, faces, and the human amygdala. Current Opinion in Neurobiology, 18(2), 166-172.

Bagby, R. M., Parker, J. D., & Taylor, G. J. (1994a). The twenty-item Toronto Alexithymia Scale—I. Item selection and cross-validation of the factor structure. Journal of Psychosomatic Research, 38(1), 23−32.

Bagby, R. M., Taylor, G. J., & Parker, J. D. (1994b). The Twenty-item Toronto Alexithymia Scale—II. Convergent, discriminant, and concurrent validity. Journal of Psychosomatic Research, 38(1), 33−40.

Beales, D. L., & Dolton, R. (2000). Eating disordered patients: Personality, alexithymia, and implications for primary care. British Journal of General Practice, 50(450), 21−26.

Besel, L. D. S., & Yuille, J. C. (2010). Individual differences in empathy: The role of facial expression recognition. Personality and Individual Differences, 49(2), 107-112.

Calder, A. J., Young, A. W., Rowland, D., Perrett, D. I., Hodges, J. R., & Etcoff, N. L. (1996). Facial emotion recognition after bilateral amygdala damage: Differentially severe impairment of fear. Cognitive Neuropsychology, 13(5), 699-745.

Fairburn, C. G., Cooper, Z., Doll, H. A., & Welch, S. L. (1999). Risk factors for anorexia nervosa - Three integrated case-control comparisons. Archives of General Psychiatry, 56(5), 468-476.

Fairburn, C. G., Doll, H. A., Welch, S. L., Hay, P. J., Davies, B. A., & O'Connor, M. E. (1998). Risk factors for binge eating disorder - A community-based, case-control study. Archives of General Psychiatry, 55(5), 425-432.

Ferriter, C., Eberhart, N. K., & Hammen, C. L. (2010). Depressive Symptoms and Social Functioning in Peer Relationships as Predictors of Eating Pathology in the Transition to Adulthood. Journal of Social and Clinical Psychology, 29(2), 202-227.

Garner, D. M. (1991). Eating Disorder Inventory—2: Professional manual. Odessa, FL: Psychological Assessment Resources.

Gilboa-Schechtman, E., Avnon, L., Zubery, E., & Jeczmien, P. (2006). Emotional processing in eating disorders: Specific impairment or general distress related deficiency? Depression & Anxiety, 23(6), 331−339.

Giordano, G. D., Renzetti, P., Parodi, R. C., Foppiani, L., Zandrino, F., Giordano, G., et al. (2001). Volume measurement with magnetic resonance imaging of hippocampus-

amygdala formation in patients with anorexia nervosa. Journal of Endocrinological Investigation, 24(7), 510-514.

Godart, N. T., Flament, M. F., Perdereau, F., & Jeammet, P. (2003). Social disability in Anorexia nervosa and bulimia nervosa. Encephale-Revue De Psychiatrie Clinique Biologique Et Therapeutique, 29(2), 149-156.

Gollan, J. K., McCloskey, M., Hoxha, D., & Coccaro, E. F. (2010). How Do Depressed and Healthy Adults Interpret Nuanced Facial Expressions? Journal of Abnormal Psychology, 119(4), 804-810.

Jackson, T.,Weiss, K. E., Lunquist, J. J., & Soderlind, A. (2005). Sociotropy and perceptions of interpersonal relationships as predictors of eating disturbances among college women: two prospective studies. Journal of Genetic Psychology, 166(3), 346−359.

Jones, L., Harmer, C. Cowen, P. & Cooper, M.J. (2008). Emotional face processing in women with high and low levels of eating disorder related symptoms. Eating Behaviors, 9, 389-397

Kessler, H., Schwarze, M., Filipic, S., Traue, H. C., & von Wietersheim, J. (2006). Alexithymia and facial emotion recognition in patients with eating disorders. International Journal of Eating Disorders, 39(3), 245−251.

Kucharska-Pietura, K., Nikolaou, V., Masiak, M., & Treasure, J. (2004). The recognition of emotion in the faces and voice of anorexia nervosa. International Journal of Eating Disorders, 35(1), 42−47.

Lane, R. D., Sechrest, L., Riedel, R., Shapiro, D. E., & Kaszniak, A. W. (2000). Pervasive emotion recognition deficit common to alexithymia and the repressive coping style. Psychosomatic Medicine, 62(4), 492−501

Laquatra, T. A., & Clopton, J. R. (1994). Characteristics of Alexithymia and Eating Disorders in College-Women. Addictive Behaviors, 19(4), 373-380.

Law Smith, M. J., Montagne, B., Perrett, D. I., Gill, M., & Gallagher, L. (2010). Detecting subtle facial emotion recognition deficits in high-functioning Autism using dynamic stimuli of varying intensities. Neuropsychologia, 48(9), 2777-2781.

Legenbauer, T., Vocks, S., & Ruddel, H. (2008). Emotion recognition, emotional awareness and cognitive bias in individuals with bulimia nervosa. Journal of Clinical Psychology, 64(6), 687-702.

Mendlewicz, L., Linkowski, P., Bazelmans, C., & Philippot, P. (2005). Decoding emotional facial expressions in depressed and anorexic patients. Journal of Affective Disorders, 89(1–3), 195−199.

Pan, Y. J., Chen, S. H., Chen, W. J., & Liu, S. K. (2009). Affect recognition as an independent social function determinant in schizophrenia. Compr Psychiatry, 50(5), 443-452.

Pedrosa Gil, F., Ridout, N., Kessler, H., Neuffer, M., Schoechlin, C., Traue, H. C., et al. (2008). Facial emotion recognition and alexithymia in adults with somatoform disorders. Depress Anxiety, 25(11), E133-141.

Persad, S. M., & Polivy, J. (1993). Differences between depressed and nondepressed individuals in the recognition of and response to facial emotional cues. Journal of Abnormal Psychology, 102(3), 358−368.

Power, M. and Dalgleish, T. (1997). Cognition and Emotion: From Order to Disorder. Hove: Psychology Press.

Quinton, S., & Wagner, H. L. (2005). Alexithymia, ambivalence over emotional expression, and eating attitudes. Personality and Individual Differences, 38(5), 1163-1173.

Ridout, N., Thom, C., & Wallis, D. J. (2010). Emotion recognition and alexithymia in females with non-clinical disordered eating. Eat Behav, 11(1), 1-5.

Surcinelli, P., Codispoti, M., Montebarocci, O., Rossi, N., & Baldaro, B. (2006). Facial emotion recognition in trait anxiety. Anxiety Disorders, 20, 110−117.

Surguladze, S. A, Young, A.W., Senior, C., Brebion, G., Travis, M. J., & Phillips, M. L. (2004). Recognition accuracy and response bias to happy and sad facial expressions in patients with major depression. Neuropsychology, 18(2), 212−218.

Takano, A., Shiga, T., Kitagawa, N., Koyama, T., Katoh, C., Tsukamoto, E., & Tamaki, N. (2001). Abnormal neuronal network in anorexia nervosa studied with I-123-IMP SPECT. Psychiatry Research, 107(1), 45-50.

Troop, N. A., & Bifulco, A. (2002). Childhood social arena and cognitive sets in eating disorders. British Journal of Clinical Psychology, 41, 205-211.

Waller, G., Babbs, M., Milligan, R., Meyer, C., Ohanian, V., & Leung, N. (2003). Anger and core beliefs in the eating disorders. International Journal of Eating Disorders, 34, 118−124.

Young, A. W., Perrett, D. I., Calder, A. J., Sprengelmeyer, R., & Ekman, P. (2002). Facial expressions of emotion: Stimuli and tests (FEEST) [Computer software]. Bury St. Edmunds, England: Thames Valley Test Company

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. Acta Psychiatr Scand, 67(6), 361-370.

Zonnevijlle-Bender, M. J., van Goozen, S. H., Cohen-Kettenis, P. T., van Elburg, A., & van Engeland, H. (2002). Do adolescent anorexia nervosa patients have deficits in emotional functioning? European Child and Adolescent Psychiatry, 11(1), 38−42.

Table 1: Participant characteristics

	High EDI N=40	Low EDI N=40	t	*p*
Age	26.4 (9.8)	22.8 (5.5)	2.0	<.05
Hospital Anxiety & Depression Scale				
Anxiety	11.5 (4.7)	6.8 (3.1)	5.2	<.001
Depression	7.7 (4.6)	2.2 (1.7)	7.1	<.001
Toronto Alexithymia Scale (TAS-20)				
Total	53.8 (15.0)	40.8 (10.5)	4.5	<.001
Difficulty Describing Feelings	14.8 (5.1)	10.6 (4.2)	4.0	<.001
Difficulty Identifying Feelings	19.7 (7.0)	13.5 (4.8)	4.6	<.001
Externally Oriented Thinking	2.0 (4.7)	16.8 (4.7)	3.0	<.01
Eating Disorders Inventory (EDI)				
Total	39.5 (14.1)	6.1 (4.8)	14.2	<.001
Drive for Thinness	12.9 (5.6)	1.0 (2.0)	12.7	<.001
Bulimia	6.0 (5.6)	0.9 (1.7)	5.6	<.001
Body Dissatisfaction	20.4 (10.1)	4.2 (4.2)	12.4	<.001

Table 2: Percentage of emotional expressions correctly identified by the two groups of participants, as a function of type and intensity of emotional expression (standard errors presented in parentheses)

| Emotional expression	Intensity	High EDI (n=40)	Low EDI (n=40)
Happy	50%	86.6 (2.4)	88.1 (2.0)
	75%	95.3 (1.3)	96.1 (1.2)
	100%	97.5 (1.1)	98.4 (0.8)
	125%	98.1 (0.8)	97.8 (0.8)
Fear	50%	69.3 (3.5)	79.7 (2.3)
	75%	82.9 (2.9)	90.9 (2.6)
	100%	87.6 (2.2)	90.6 (2.0)
	125%	84.2 (2.2)	92.2 (2.2)
Anger	50%	28.4 (3.3)	42.6 (3.0)
	75%	50.4 (3.7)	57.5 (2.7)
	100%	69.6 (3.3)	74.7 (2.6)
	125%	69.6 (2.9)	79.1 (2.3)
Sadness	50%	73.1 (3.3)	74.5 (3.5)
	75%	78.9 (2.4)	77.3 (2.8)
	100%	79.2 (2.6)	81.8 (2.3)
	125%	80.4 (2.8)	76.8 (2.7)
Disgust	50%	45.3 (3.0)	47.7 (2.9)
	75%	62.8 (3.7)	63.5 (2.7)
	100%	64.3 (3.3)	64.8 (2.9)
	125%	67.4 (3.1)	65.3 (2.6)
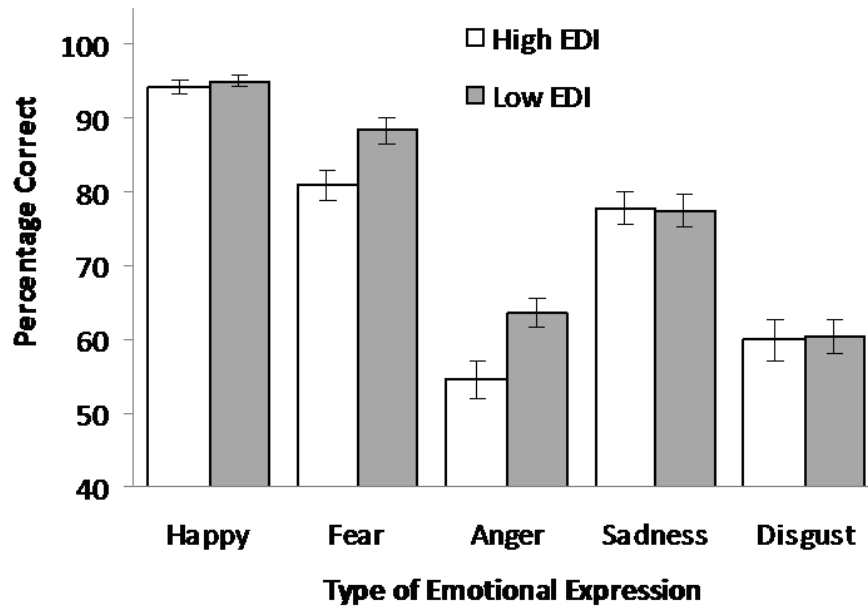
Figure 1: Percentage of emotional expressions correctly identified by the two groups of participants as a function of type of emotional expression (error bars show ± one standard error)