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Information processing bias in anorexia nervosa

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Abstract

The aim of this study was to investigate preferential information processing style in Eating Disorders (ED). We compared the performance of participants with EDs against healthy controls in a task that measures cognitive style (reflection–impulsivity) and cognitive efficiency (inefficient–efficient). Sixty non-medicated female participants (healthy controls $n=26$, anorexia nervosa $n=20$, bulimia nervosa $n=14$) took part in the Matching Familiar Figures Test (MFFT), a difficult visual search paradigm with high response uncertainty. Participants with anorexia scored significantly higher on the efficiency dimension score than the control group. No significant differences were found across groups on the dimension 'reflection–impulsivity'. Participants with anorexia are more efficient (quicker response latencies in conjunction with fewer errors) in this visual search task that requires an analytic approach. This supports the hypothesis that individuals with anorexia have a positive bias toward local detail processing, indicative of weak central coherence.

Keywords: Eating disorders; Neuropsychology; Reflection–impulsivity; Central coherence; Obsessive-compulsive personality traits; Cognition; Matching familiar figures test

1. Introduction

The study of information processing can advance our understanding of psychiatric disorders (Keefe, 1995). Neuropsychological data may be used to predict prognosis or course of illness and can also be integrated into aetiological and treatment models (Southgate et al., 2005; Treasure et al., 2005; Cavedini et al., 2006; Baldock and Tchanturia, 2007).

Review of the neuropsychological literature in Eating Disorders (ED) highlights that information processing styles mirror phenotypic characteristics (Southgate et al., 2006). Links are clearly seen between obsessive-compulsive personality traits (preoccupation with details, lists and order; perfectionism; inflexible, rigid and stubborn mental set), significant vulnerability factors in the complex aetiology of EDs (Jacobi et al., 2004), and deficits in set-shifting ability or 'cognitive flexibility' in anorexia nervosa (AN) (Holliday et al., 2005; Tchanturia et al., 2005; Roberts et al., 2007). Heightened impulsivity, as reported in self-report personality measures and displayed in multi-impulsive behaviours, has been associated with binge/purge symptoms, with or without a diagnosis of AN (Lacey and Evans, 1986; Vitousek and Manke, 1994; Claes et al., 2002; Fassino et al., 2004). Two studies employing the matching familiar figures test (MFFT) as a measure

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of information processing style have reported analogous findings (Toner et al., 1987; Kaye et al., 1995).

Discrepancy in the performance seen across tests of visuo-spatial processing is suggestive of another information processing bias in AN that corresponds to clinical characteristics. Superior performance has been reported in tasks that require local information processing (e.g. embedded figures test) in comparison to those that require global information processing (e.g. object assembly, Rey-figure, Bender Gestalt test) (Jones et al., 1991; Gillberg et al., 1996; Kingston et al., 1996; Sherman et al., 2006; Tokley and Kemps, in press; Gillberg et al., 2007). This pattern of performance is consistent with the concept of weak central coherence, a cognitive style in which information remains fragmented as opposed to integrated, with processing occurring at the level of 'detail' as opposed to 'whole'(Happe and Frith, 2006). The hypothesis that weak central coherence reflects a preferential processing style in AN, concords with the extensive attention to detail found to be an enduring personality trait amongst individuals with AN (Anderluh et al., 2003). Thus cognitive style may account for both optimal and impaired performance across different tasks, depending on their processing requirements.

The aim of the current study was to expand upon previous research. Following a hypothesis driven approach, the MFFT was employed to explore 'the preferential mode of information processing a subject manifests in the majority of reasoning, learning and memorising experiences during an assigned task' (Weijers et al., 2001). The MFFT is a difficult matching to sample task that involves high response uncertainty. Participants are required to identify a target object amongst seven very similar distracter objects. Outcome measures include the accuracy of the participant and the time taken to make their response. The use of a dimensional scoring procedure, as opposed to the traditional categorical approach, contributes novel information with regards to performance in this task in ED samples. By distinguishing between the skills/ability required (content) and the way in which participants go about solving this task (process), the dimensional scoring procedure can provide information with regards to the phenotypic characteristics discussed above; reflection–impulsivity, and local–global biases.

Reflection–impulsivity reflects the process employed in problem solving; "the tendency to gather and evaluate information before making a decision" (p. 515; Clark et al., 2006). As performance in the MFFT involves high response uncertainty (a prerequisite for the accurate measurement of reflection–impulsivity; Kagan, 1966), the trade-off between speed and accuracy in responding is taken into consideration in this dimensional score. Impulsivity relates to fast and inaccurate responding, (decisions are made and acted upon with little consideration with regards to the accuracy). Conversely, at the other end of the continuum, a reflective 'perfectionist' cognitive style is implicated by slow and accurate performance.

With regards to content, as a difficult matching to sample task with high demands on visual search skills (Clark et al., 2006), it is clear that performance would benefit from local processing, a focus on the detail of the figures as opposed to processing the stimuli at the level of the gestalt. Local processing bias is therefore measured here using a dimensional efficiency score (efficiency associated with fast and accurate responses).

The hypotheses for this investigation were determined based upon the current knowledge regarding clinical phenotypes in EDs. In comparison to the control group, it was thought that participants with EDs would display information processing styles indicative of elevated impulsivity and efficiency. Firstly, participants with BN would be associated with elevated impulsivity, in accordance with the finding of previous research. Secondly participants with AN would show greater efficiency in the task, in line with the literature that suggests a bias towards detail level processing in this clinical group.

2. Methods

2.1. Participants

Sixty females took part in this study. Participants with AN ($n=20$) and BN ($n=14$) were recruited from the inpatient and outpatient ED services in the South London and Maudsley (SLAM) NHS trust, the Central and North West London (CNWL) NHS trust and from a confidential volunteer register maintained by the Eating Disorders Research Unit at the Institute of Psychiatry, London. Healthy control participants ($n=26$) were recruited from the local community, with no personal or family history of an ED. All participants were female, with English as their first language, aged between 16–57 years. Exclusion criteria included current use of psychotropic medication, a history of psychiatric illness, previous head injury or neurological illness and alcohol or substance dependency. The study received ethical approval from the SLAM and CNWL Research Ethics Committees. Written informed consent was obtained from each participant before entering into the study.

2.2. Materials

2.2.1. Diagnostic classification

ED participants were categorised according to their current diagnosis based on DSM-IV criteria (American Psychiatric Association, 1994). Diagnostic information from each clinical participant was elicited using the EATATE interview (Anderluh et al., 2003), a semi-structured clinical interview based upon the Eating Disorders Examination (Fairburn and Cooper, 1993) but adapted to assess lifetime symptoms of ED. The control participants were screened for ED symptoms using the Eating Disorders Examination questionnaire (EDEQ-IV; Fairburn and Beglin, 1994), with additional items added to clarify lifetime history of eating attitudes and behaviours.

2.2.2. Clinical comorbidity

The self-report Hospital Anxiety and Depression scale (HADS; Zigmond and Snaith, 1983) was used to assess state levels of anxiety and depression. The Maudsley Obsessive-Compulsive Inventory, (MOCI; Hodgson and Rachman, 1977), investigated the presence of four features of obsessive-compulsive symptomatology; checking, cleaning, doubting and slowness, reported here as a combined symptom score. High scores in these measures relate to greater severity of pathology. The National Adult Reading Test (NART; Nelson and Willison, 1991) was employed to ensure that participant groups were matched according to general intellectual ability.

2.2.3. Neuropsychological function: The matching familiar figures test (Adult version, Kagan, 1966)

The MFFT is a pencil and paper visual search task consisting of twelve trials. In each trial the participant is presented with a single picture of a familiar object, the 'target', on one page whilst eight very similar test pictures, one of which is identical to the target, are presented on another. Participants are asked to identify which of the test pictures is identical to the target by pointing to it. If correct, the participant moves onto the next trial. If incorrect, the participant is informed and is asked to try again. The participant continues responding on a single trial either until they make an accurate response or when eight incorrect responses have been made, upon which the next trial is presented. Participants are informed that each of their responses will be recorded (attention to detail), as will the time it takes for them to make their response (processing speed). Thus, instructions are not given as to whether it is more important to be accurate or fast in their decision making. Outcome measures include the mean latency to the first response in each trial and the total number of errors made across trials, from which dimensional (reflective–impulsive continuum and inefficient–efficient continuum) scoring can be determined.

The test–retest reliability for the outcome measures of speed, accuracy and the impulsivity index (reflective–impulsive continuum) over an interval of 3 years highlighted moderate stability in performance (r=0.42–0.51) amongst 11–14 year olds (Messer and Brodzinsky, 1981). Higher stability over a period of 1 year was reported with an older age group (speed: r=0.82; accuracy r=0.60) (Van Merrienboer, 1988).

2.3. Procedure

Prior to testing participants completed the NART and the HADS. Standardised verbal instructions were provided for each participant and two MFFT practice trials were conducted to ensure that participants understood the nature of the task. Throughout the task, the investigator sat next to the participant, with the test material positioned directly in front of the participant. Upon presentation of the target and test pictures the investigator started the stop watch to measure response latency. The response made by the participant and the time taken to make the response were recorded. If the response was incorrect, the investigator asked the participant to try again and the time record maintained. This procedure continued on each trial until the correct response was made by the participant. Upon completion of the MFFT, participants took part in the EATATE interview.

2.4. Statistical methods

To compute a dimensional score for each person on the reflection–impulsivity and inefficient–efficient scale (Salkind and Wright, 1977), each participant's mean latency to first response and total number of errors were transformed into standard scores (z-scores). The impulsivity index was determined using the equation: Impulsivity=*Z*score errors−*Z*score latency. The efficiency index was calculated using the equation: Efficiency=−(*Z*score errors+*Z*score latency).

The distributions of continuous variables were screened to ensure that the assumptions of parametric testing were met. Between-group analyses for normally distributed variables were conducted using one-way analysis of variance (ANOVA) with Bonferroni post-hoc analyses as appropriate. Where the assumptions of parametric testing were violated, non-parametric tests were

Table 1
Demographic and clinical variables according to current diagnosis

	Controls n=26 Mean (S.D.)	AN n=20 Mean (S.D.)	BN n=14 Mean (S.D.)	F (df=2,57)	Bonferroni post hoc
Age	27.27 (11.52)	26.80 (8.49)	25.71 (4.94)	0.13	
IQ	114.83 (5.84)	116.84 (4.84)	114.44 (7.33)	0.82	
BMI current [a]	21.95 (3.42)	16.31 (2.64)	21.12 (6.67)	38.00**	C>AN**, BN>AN**
BMI lowest	20.02 (2.03)	13.13 (1.91)	18.28 (1.44)	67.70**	C>AN**, BN*, BN>AN**
ED duration [b]	NA	9.12 (7.40)	7.46 (4.68)	0.70	
HADS	9.50 (7.52)	17.84 (7.78)	17.42 (7.40)	7.48**	C<AN, BN**
MOCI	4.75 (3.73)	9.25 (6.26)	6.00 (4.54)	3.78*	C<AN*

*P<0.05, **P<0.01.
[a] Non-parametric data: median and inter-quartile ranges presented with Kruskal Wallis chi-square and Mann–Whitney pairwise comparisons.
[b] Student t-test reported.

used; Kruskal Wallis to test for main effects and Mann–Whitney U–tests for pairwise analyses, applying Bonferroni correction procedure to correct for the risk of type 1 error.

The relationship between neuropsychological test performance and clinical variables were explored using Pearson and Spearman's Rho correlations as appropriate. All analyses were conducted using SPSS version 12.

3. Results

3.1. Demographic and clinical variables

As displayed in Table 1, differences in the clinical phenotype were found as expected across groups. Whilst matched for age and premorbid IQ, significant differences occurred in the expected directions between groups with regards to current and lowest ever BMI. The clinical groups (AN, BN) reported elevated levels of state anxiety and depression compared with the control group and the participants with AN reported more obsessive-compulsive features compared to the control group as indicated by the MOCI. The duration of ED history did not differ between diagnoses.

3.2. Performance measures in the MFFT

A significant negative relationship was found between the two dependent variables latency to first response and total number of errors (r=−0.61, P<0.001), confirming the trade off between speed and accuracy in the performance of this task.

IQ, BMI, state anxiety and depression and OCD pathology were not significantly related to MFFT performance, based upon correlational analysis. As displayed in Table 2, the only statistically significant difference between groups was in the dependent variable 'MFFT efficiency'. The AN group had a superior performance style in comparison to the control group, with a magnitude of difference of large effect.

4. Discussion

The aim of this study was to explore as to whether preferential information processing styles exist that are analogous to phenotypic characteristics in EDs. The MFFT explored both 'reflection–impulsivity' and a bias towards detail level processing, 'weak central coherence', as indicated by efficiency in this task. Participants with AN were found to be significantly more efficient in the MFFT than the control group, with the magnitude of difference being of large effect. This score reflects the superior accuracy and faster response times displayed by the AN participants in this task.

The results of this study endorse our hypothesis that participants with AN display a bias towards information processing at the level of detail as opposed to the gestalt. Whilst the MFFT has not been traditionally used as a

Table 2
Performance measures in the MFFT according to current diagnosis

	Control (n=26) Mean (S.D.)	AN (n=20) Mean (S.D.)	BN (n=14) Mean (S.D.)	F (2,57)	Bonferroni post hoc
Mean RL	42.62 (27.26)	35.42 (19.35)	40.14 (19.23)	0.55	
Total errors	12.19 (7.69)	9.55 (5.62)	9.79 (5.44)	1.11	
Impulsivity	−0.05 (1.97)	−0.12 (1.36)	−0.28 (1.22)	0.90	
Efficiency	−0.18 (0.76)	0.46 (0.67)	0.24 (0.85)	4.29	AN>C, P=0.02, ES=0.89 (0.26–1.48)

RL=Response latency in seconds; ES=effect size (95% confidence interval).

measure of central coherence, it shares the features of other measures employed to investigate local–global processing. With regards to content validity, the MFFT involves a complex visual search as required, for example, in the embedded figures test (EFT). A consistent overlap has been reported between performance in the MFFT and EFT (Messer, 1976). An examination into the factorial structure of the MFFT indicated that the number of errors made loaded slightly higher on a factor related to cognitive ability and disembedding skills (along with the EFT) than on an impulsivity factor (Amador-Campos and Kirchner-Nebot, 2001). Our exploratory findings reported here clearly warrant replication and further research into local–global processing in EDs.

The lack of association between outcome variables and BMI suggests that the data reported here can not be explained as an artefact of physical state. Indeed, the elevated efficiency of the AN participants (tested at a time of low weight) is revealing, as starvation and dieting has been associated with cognitive deficits (Green and Rogers, 1998; Green et al., 2003). In line with the current results, individuals with AN have also been reported to display enhanced performance in effortful tasks to the detriment of incidental learning (Strupp et al., 1986; Galderisi et al., 2003). These findings have been attributed to 'hyperarousal', a phenomenon described as the narrowing of the focus of attention onto the detail of the task to such a degree that it is performed with little awareness, processing or integration of extraneous variables. These reports appear congruous with the information processing bias found here, in addition to enhanced performance in detail orientated drawing and copying tasks (shorter reaction/drawing times) (Pieters et al., 2003, 2004, 2005).

The results of the current study are in contrast to the conclusions made in previous studies employing the MFFT (Toner et al., 1987; Kaye et al., 1995), both of which reported that individuals with bulimic symptoms displayed cognitive impulsivity. In this investigation, the BN participants displayed the least impulsivity, with efficiency scores, response latency and number of errors at an intermediate level between the AN and healthy control groups. Thus, based on the previous findings highlighted above, the absence of a difference in impulsivity across groups may be considered surprising. However, the incongruous findings across studies could be explained by diversity in participant samples (BN being a heterogeneous clinical group with regards to psychopathology; Wonderlich et al., 2005) and methodological procedures employed. For example, the significant negative correlation between speed and accuracy reported here reinforces the trade off between these variables when performing this task. Therefore, we used outcome variables that reflected this, as opposed to relying on raw performance measures (speed or accuracy) as previously found. In addition, impulsivity is deemed to be a multidimensional construct in both the personality and neuropsychological literature (Evenden, 1999; Whiteside and Lynam, 2001; Nigg, 2000). It may be that this relatively narrow measure of impulsivity (making and acting upon decisions with little consideration of accuracy) does not reflect the nature of impulsivity relevant to some subgroups of EDs. It is apparent that this conceptual debate, inconsistent results and limited sample sizes precludes distinct conclusions to be made with regards to the information processing style of BN participants.

The limitations of this study deserve discussion. Due to the novel use of this traditional information processing paradigm, the findings reported here remain tentative and require replication alongside other well validated central coherence tasks. It was impossible for the investigator to be blind to participant group due to the physical effects of AN, however care was taken to ensure that the presentation of the test was standardised for all participants. Furthermore, in comparison to computerised tests of information processing, there is a greater potential for examiner bias and measurement error in pencil and paper tasks. Thus the development of an automated version of the MFFT could overcome these difficulties in the future. The complex mix of information processing skills required in the MFFT questions the extent to which performance this task may be a true indication of a reflection–impulsivity. A novel information sampling task has been designed to overcome this, providing a neuropsychological measure of this processing style that does not require the visual search skills and working memory involved in the MFFT (Clark et al., 2006). Finally, as relevant to all non-community based research, issues relating to sample selection limit the extent to which the results from the current study may be generalised to the ED population as a whole.

To our knowledge this is the first study to employ the dimensional scoring procedure for the MFFT in an ED sample, taking into account the trade-off between speed and accuracy in the performance of this task. The bias in information processing style amongst participants with AN is consistent with the psychopathology of AN. Individuals are often so focused on maintaining their maladaptive behaviours they are unable to see the 'bigger picture' and the severe consequences these behaviours have on their life. Extreme 'attention to detail' is manifested in their eating behaviours and many other facets of life, spanning academic, work and home life. Furthermore, this information processing style may account for the disturbance of body image in the absence of frank visuo-spatial disorder (Gillberg et al., 1996).

In conclusion, this study endorses the concept of 'central coherence' as an informative avenue for further exploration into neuropsychological processing in AN. The inclusion of central coherence tasks within a broader neuropsychological test battery of will provide us with important information with regards to specificity of functioning. Furthering our understanding of preferential information processing style in EDs has clear implications for clinical practice (Tchanturia et al., 2006; Baldock and Tchanturia, 2007).

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