The neuropsychology of starvation: Set-shifting, central coherence, perseveration, and persistence in a nonclinical sample.

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Overview

The literature review investigates recent advances in psychological treatments for anorexia nervosa (AN) in children, adolescents, and adults. Treatment studies are generally limited by small sample sizes and uncontrolled research designs. In adolescence, there is some evidence for Maudsley Family Therapy (MFT). Inpatient care or specialist outpatient care are not superior to routine community treatment in adolescents, which has implications for service delivery.

In adults, the findings are more mixed. One approach is not clearly superior to another. Future research using control and comparison groups with larger samples are needed to explore several approaches outlined in this review in more detail.

The empirical paper describes an exploration of the effects of short-term fasting on tasks measuring cognitive flexibility and information processing in a nonclinical sample. Findings from Bolton, Burgess, Gilbert and Serpell (in preparation) who reported that short-term fasting impaired the ability to shift mental set were replicated. Short-term fasting was also associated with weaker central coherence. These findings suggest that any model proposing cognitive rigidity and weak central coherence as endophenotypes of AN may also need to account for the role of starvation.

The critical appraisal explores some of the limitations of the research project. In particular the limitations of working with a nonclinical sample and of using novel experimental tasks are discussed.

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APPENDICES

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Part 1: Literature Review

Evidence-Based Psychological Treatments for Anorexia Nervosa 2006-2011

Abstract

Aims: Although Anorexia Nervosa (AN) is a serious and chronic eating disorder there is still no gold standard treatment. This systematic literature review updates and synthesises the most recent research on psychological interventions for AN across the lifespan.

Method: A brief synopsis of previous research is followed by an examination of all treatment studies using psychological interventions to treat AN and were published from 2006 to March 2011. Nineteen studies were included in this review.

Results: In adolescence, there is some evidence for the effectiveness of Maudsley family therapy, although this approach has not been subject to rigorous controlled studies and findings should be interpreted with caution. In adults, there have been less published treatment trials, and no single approach appears superior to another.

Conclusion: In general, the research base is limited by a lack of controlled studies, small sample sizes, and unclear outcome measures. The results from this review indicate the need for better designed and statistically powerful studies of treatments for AN.

Anorexia Nervosa (AN) is an eating disorder with a life time prevalence of less than 1% (Hudson, Hiripi, Pope, & Kessler, 2007). It is more common among females than males, and often begins in adolescence. AN has one of the highest rates of mortality of any psychiatric condition (Steinhausen, 2002).

The symptoms of AN are difficulty maintaining body weight at or above the normal level for age and height, amenorrhea, fear of gaining weight, and distorted experience of shape and weight (American Psychiatric Association, 1994). AN can be categorised as AN-restricting type or AN-binge/ purge type.

AN can be chronic and unremitting without treatment (Pike, 1998). Even those receiving treatment often find it difficult to maintain a healthy body weight. It is estimated that about half of those with AN do not recover within six years of their first treatment (Steinhausen, 2002). Co-morbid psychological difficulties such as anxiety and depression are also common (Hudson et al., 2007). Other social disturbances, lower body weight, inpatient admission, purging behaviours, and high familial expressed emotion are related to a longer recovery (Papadopolous, Ekborn, Brandt, & Ekselius, 2009). Chronic AN is associated with a range of physical complications, such as osteoporosis or problems with fertility (Bulik et al., 1999); these are often present even after recovery (Gendall & Bulik, 2006).

Rationale for the Current Study and Current Research Question

Although several reviews of the available evidence for treating eating disorders (EDs) have recently been published, the research field is constantly developing. Many recent reviews have investigated treatment for EDs in general, or outcomes for AN using one particular therapeutic approach. Several have not used a systematic search strategy and thus may have failed to include all relevant studies.

Hay and colleague's review (Hay et al., 2009) is the most recently published review of psychological treatments for AN across the lifespan, and this review included randomised controlled studies until 2007 only. Given the growing research in the area, a review of the most current literature investigating psychological treatments for AN across the lifespan will be useful as a central point of information for researchers and practitioners in the field. The current systematic literature review sought to answer the question; what is the current research evidence for psychological interventions in the treatment of Anorexia Nervosa?

Evidence Based Treatment of Anorexia Nervosa

There are a number of treatment options for those with AN, although there is no gold standard treatment as yet. Treatment can be provided on an inpatient or outpatient basis; this is often dependent on the physical well being of the individual and any associated risks. Interventions for AN can be psychological or pharmacological, or a combination of both. Psychological interventions include individual work with the person with AN and family-based interventions.

Previous reviews of treatment for AN. Several previous reviews have explored the evidence base for treatments of EDs and AN. In 2004, the National Institute for Clinical Excellence (NICE) published guidelines on the treatment of EDs. Most of the evidence for AN treatment received a Grade C, indicating that relevant good quality clinical studies were not available to inform practice, and that expert consensus should be used to guide decision-making. The only exception was the assertion that children and adolescents with AN should be offered family interventions that directly address their ED, which received a Grade B, indicating

there was evidence to support this point from good quality clinical trials but not from randomised control trials (RCTs).

NICE guidelines (2004) also state that individuals with AN should ideally receive outpatient care and only be admitted to inpatient care if the risks to their physical health become too great, or if they fail to make progress in outpatient settings. According to NICE, medication should not be used as the sole or primary treatment of AN, and caution should be exercised when prescribing medication due to the increased possibility of adverse side effects in underweight patients. The review reports that the aim of psychological treatments should be to increase weight, reduce the psychological aspects of the disorder, promote healthy eating, as well as emotional and physical recovery. In summary, NICE reports that the available evidence still does not support any single psychotherapy.

In 2005, Fairburn reviewed the evidence base for treatment of AN and concluded that treatment outcomes for adolescents with AN were generally good, whereas treatment outcomes for adults with AN were generally poor. More recently, Bulik and colleagues (Bulik, Berkman, Brownley, Sedway & Lohr, 2007) reviewed all of the RCTs investigating treatment of AN. Nineteen studies were included in their review. They concluded that the overall evidence for AN treatments was weak. There is no strong evidence to support treating AN with medication alone. There is some evidence that CBT prevents relapse after weight restoration, but little suggestion that CBT is effective in the acutely underweight phase of the illness. In adolescents, Bulik and colleagues concluded that there was moderately strong evidence for family therapy (FT).

In 2007, Wilson, Grilo and Vitousek published a narrative overview of psychological treatments for EDs, including AN. The authors conclude that although there is some evidence for MFT for adolescents with AN, it is not clear if the favourable results are due to the intervention or to the characteristics of the groups studied. In particular they suggest that it is unclear whether the promising results from MFT studies are confounded by reports from both naturalistic and controlled studies that outcomes for young adolescents are generally more positive than outcomes for older adolescents and adults (Steinhausen, 2002). Although the available research does suggest that MFT is most effective with younger adolescents, this explanation would not account for more recent findings suggesting that patients receiving MFT are significantly more likely to be in remission than patients receiving another active treatment (e.g., Lock et al., 2010). However, there is a paucity of studies comparing MFT with an active treatment, and most studies have been conducted with a young sample. Wilson and colleagues suggested that more controlled studies of MFT in adolescents, or with a sample of adult patients with longer illness duration could help to clarify the parameters of MFT. They indicate that studies of CBT for AN have been inconclusive; studies comparing CBT with another treatment appear to indicate no clear difference between CBT and other treatments at follow up. The authors also conclude that there was little evidence to support the use of medication, in particular anti-depressants in this population.

In 2007, Rutherford and Couturier systematically reviewed psychotherapeutic interventions available for children and adolescents with EDs. The review focused on FT studies with adolescents and some younger children with AN, and similar to previous reviews, the authors conclude there is some evidence for the effectiveness of FT notably MFT in the treatment of AN in adolescents.

Le Grange and Eisler (2008) reviewed family interventions in adolescents with AN. They summarise several uncontrolled and controlled studies of MFT in AN, and conclude that the evidence for the usefulness of this approach has been growing over the past 30 years. Based on the studies reviewed they concluded that between 50 and 75% of adolescents are weight restored at the end of MFT treatment. They acknowledge that the evidence should be reviewed with some caution, as there had not been extensive studies comparing MFT with other psychological approaches, such as CBT.

Also in 2008, Keel and Haedt conducted a systematic review of the evidence for psychosocial treatments for eating problems and EDs between 1985 and 2007. They conclude that while the research suggests that MFT is effective in treating adolescents with AN, that one study using MFT in adults did not report similarly positive findings (Russell, Szmuckler, Dare, & Eisler, 1987) and conclusions from studies with adolescents with AN should be generalised to other age groups with caution.

Hay and colleagues (2009) published a Cochrane Review of all of the RCTS exploring any form of individual psychotherapy for outpatients with AN. The review included studies of older adolescent and adult participants. Seven studies were included comparing a variety of different psychotherapeutic approaches, including CBT, interpersonal therapy, cognitive analytic therapy, and focal time-limited psychotherapy with each other as well as dietary advice and nonspecific control psychotherapy. Studies comparing FT with an individual therapy were not included as these were part of a separate Cochrane Review (Fisher, Hetrick, & Rushford, 2010).

The authors report that the samples were small, the studies were generally underpowered, and it was difficult to draw conclusions from the available RCTs. In most studies some participants showed some improvement, however outcomes were defined differently in different studies making comparisons difficult. They conclude that no treatment or treatment as usual seems less effective than a specific psychotherapy, although no one approach can be recommended from this review. Larger, RCTs investigating specific approaches are urgently required.

In 2010, Murphy, Straebler, Cooper, and Fairburn reviewed the research base for CBT for EDs. No search strategy was described in the article, suggesting that the review was selective rather than systematic. The review states that there is a paucity of methodologically robust studies investigating CBT in those with AN. The preliminary findings from a three-site study investigating the use of an enhanced form of CBT to treat ED, including subthreshold-AN (CBT-E; Fairburn, et al., 2009) are briefly discussed; CBT-E was suitable for about 60% of patients, and of these patients, about 60% had a good outcome.

Fisher et al. (2010) recently published a Cochrane Review of FT in AN. This review included thirteen RCTs of FT with patients of any age with AN. The authors conclude that there is some evidence for the effectiveness of FT over treatment as usual in AN in the short term, although this is based on a small number of trials with small numbers of participants, which may lead to bias. The review states that there is no evidence that FT is considerably better than interventions that rely on education or other psychological interventions, and calls for larger controlled trials.

Also in 2010, Treasure, Claudino and Zucker, systematically reviewed the available research up to March 2009 for ED treatment. As with previous reviews,

they conclude that there is not a strong evidence base for any one psychological treatment of AN.

Method

Literature Search

A computerised search using related key words was carried out to identify relevant publications. I searched two online databases; PsychINFO and ScienceDirect using the search terms 'Anorexia Nervosa', in combination with the terms 'treatment', 'outcome', 'intervention' or 'psychotherapy'. I also manually searched the reference lists of relevant articles identified in this way. In addition, the 'find citing articles' and 'find similar articles' functions within the databases were used so that any related papers were also identified. As a number of reviews of similar topics have recently been published I included only articles published between 2006 and March 2011.

Inclusion and exclusion criteria. Only studies published in the English language were included in this review; although this may represent a loss of important data, no translation facilities were available. Any type of experimental design was included. Only those trials published in peer-reviewed journals and carried out with a human population were considered. Studies of people of all ages with AN were included. Studies of patients with subthreshold-AN (s-AN; all symptoms of AN except the amenorrhea criterion, or body weight less than 100% ideal body weight (IBW) and all other symptoms of AN) were included as there has been considerable debate about the usefulness of the amenorrhea criterion for diagnosis (Garfinkel et al., 1996). Furthermore, NICE guidelines (2004) recommend treating patients with s-AN who currently fall into the EDNOS (eating disorder not otherwise specified) category with the best available treatment for the disorder their

symptoms most closely resembles. Studies were excluded if they primarily focused on another Axis I or Axis II disorder, not AN. In addition, as the focus of the current review is AN, those studies that did not differentiate between ED diagnosis were not included (e.g., Fairburn et al., 2009). Studies investigating pharmacological treatment of AN were beyond the scope of this review and were not included.

Results

The initial search described above resulted in 3519 citations. This number was reduced to 19 when the exclusion criteria were applied, and any duplicate citations were removed. Table 1 is a summary of included studies.

Table 1

Summary of studies included in this review, including main findings

Authors (year)	sample characteristics	sample size	study design	treatment approach	outcome measures	follow-up	brief description of results
Eisler, Simic, Russell & Dare (2007)	Adolescents, DSM-IV AN diagnosis	N = 40	5 year follow-up comparing two types of FT	conjoint FT vs. separated FT	MR Scale	5-year follow-up	At follow-up: no significant differences between outcomes in SFT or CFT. 76% sample had good outcome. CFT may be less useful with high expressed emotion family
Lock et al. (2010)	Adolescents age 12-18 years, DSM-IV AN diagnosis except amenorrhea	N = 121, MFT = 60, AFT = 60	RCT	AFT vs. MFT	BMI, EDE-Q scores	6 and 12-month follow-up	no significant difference in rates of full remission at EOT. 12 month follow-up: significantly more patients in FT group in full remission (23% AFT vs. 49% FBT)
Couturier, Isserlin, Lock (2010)	Adolescents, DSM-IV AN diagnosis	N = 14	dissemination study, no control group	MFT	MR Scale	No	EOT: 54% sample ‘good’ or 'intermediate' MR outcome
Loeb et al. (2007)	Adolescents, AN or s-AN	N = 20	dissemination study, no control group	MFT	IBW, EDE scores, MR Scale	No	EOT: 65% sample 'good' MR outcome
Lock, LeGrange, Forsberg, & Howell (2006)	Children (9-12.9 years) with AN or s-AN	N = 32	retrospective case series	MFT	IBW, EDE scores	No	EOT: 75% of sample had IBW>85% (although 3 participants with s-AN at baseline)

Authors (year)	Sample characteristics	sample size	study design	treatment approach	outcome measures	follow-up	brief description of results
Paulson-Karlsson, Engstrom, Nevonen (2009)	Adolescents, DSM-IV AN diagnosis,	N = 32	no comparison group	family therapy 'inspired' by MFT	Rating of AN and BN-child and parent version	18- and 36-month follow-up	36 month follow-up: 78% sample no longer met criteria for any ED
Goldstein et al., 2011	Adolescents with AN	N = 26	case series	MDT transitional day programme	IBW	6-month follow-up	At follow-up 58% of sample with IBW> 85%
Prestano, LoCoco, Gullo, Lo Verso (2009)	Adolescents, DSM-IV AN diagnosis	N = 3	single group study	group analytic therapy	OQ, SEED	no	1 patient 'recovered', 1 patient 'remitted', 1 patient 'recovered' on general outcomes but no change on ED scale
Gowers et al. (2007)	Adolescents, DSM-IV AN diagnosis	N = 167, inpatient = 57, out-patient = 55, CAMHS = 55.	RCT population based study	inpatient vs. specialist outpatient vs. CAMHS	MR Scale	12- and 24-month follow-up	24-month follow-up: no significant differences between groups, 33% sample with no ED but 27% still met criteria for AN
Salbach-Andrae, Bohnekamp, Pfeiffer, Lehmkuhl & Miller (2008)	Adolescents, DSM-IV AN diagnosis	N= 6	case series	Dialectical Behaviour Therapy	SIAB-EX; BMI	No	Five of six participants with AN: no ED at EOT
Berman, Boutelle, & Crow (2009)	Adults, s-AN	N = 3	case series	Acceptance and Commitment Therapy	self-report quality of life measures, SCL-90, EDE-Q	12-month follow-up	Mixed findings. 2 participant reported at least some positive outcomes at 12-month follow-up

Authors (year)	Sample characteristics	sample size	study design	treatment approach	outcome measures	follow-up	brief description of results
Ricca et al., (2010)	Adults, AN and s-AN	N = 103	single group design	CBT	SCID, EDE-Q, BMI	36-month follow-up	No differences between AN and s-AN outcomes. 36-month follow-up: 33% of sample 'recovered'. 42% no change
Meguerditchian et al. (2010)	Adults, diagnosis of AN	N = 143, inpatient = 46, outpatient = 97	retrospective self-report	Inpatient/ outpatient: MDT including psychotherapy (mixed CBT & analytical)	Self-report BMI; social functioning; eating behaviour	mean follow-up: 4.8 years	No difference between inpatient and outpatient groups. 21% report being recovered in each group
Chen et al. 2010	Young adults with AN or s-AN	N = 4	case series	MFT	BMI, EDE scores	No	1 of 2 with IBW<85% at baseline IBW > 85% at EOT. 1 of 2 with clinical EDE scores at baseline in normal range at EOT
Dolhanty & Greenberg (2009)	Adult, AN	N = 1	single case study	emotion focussed therapy	EDI; Toronto Alexithymia Scale	No	EOT: EDI scores in normal range, BMI remained at 16kg/m2
Tchanturia et al., 2008	Adult inpatients with AN	N = 23	pilot case series	Cognitive remediation therapy	BMI, cognitive flexibility	No	Significant increases in BMI at EOT
Dean, Touyz, Rieger, Thornton (2008)	Adult inpatients with AN/ BN. No separation of diagnosis.	N = 42	RCT	motivational enhancement therapy (MET)	ANSOCQ, EDI-2, EDE-Q,	6-week follow-up	MET more likely to be engaged in active treatment at follow-up (84% MET vs. 44% control group)

Authors (year)	Sample characteristics	sample size	study design	treatment approach	outcome measures	follow-up	brief description of results
Wade, Frayne, Edwards, Robertson, Gilchrist (2009)	Adult inpatients with AN	N = 47	RCT	Motivational Interviewing (MI)	EDE-Q, ANSOCQ	two and six-week follow-up	No differences in outcome. Those in MI group significantly less likely to drop out than treatment as usual
Fichter, Cebulla, Quadflieg & Naab (2008)	Adults, AN-binge/purge	N = 102	wait-list control design	self-help manual based on CBT/ psychoeducation	length of inpatient stay	no	Those in manual group had shorter average inpatient stay

Note: AFT, Adolescent focused therapy; ANSOCQ, anorexia nervosa stages of change questionnaire; BMI, Body Mass Index; BN, bulimia nervosa; EDE-Q, eating disorder examination-questionnaire; EDE, eating disorder examination; EDI, eating disorder inventory; EOT, end of treatment; FT, family therapy; IBW, Ideal Body Weight; MFT, Maudsley Family Therapy; MR Scale, Morgan Russell average outcome scale; OQ. Outcome Questionnaire; SCID, structured clinical interview for DSM-IV; SCL-90 Symptom Checklist, 90; SEED, Short evaluation of eating disorders; SIAB-EX, the structured inventory for anorectic and bulimic syndromes; s-AN, subthreshold AN.

Evidence Based Treatment for Children and Adolescents with AN

Eisler, Simic, Russell and Dare (2007) report on five-year follow-up outcomes from an RCT comparing two types of MFT in treating adolescent AN (Eisler, et al., 2000). In conjoint FT (CFT) the whole family are seen together for treatment. In separated FT (SFT) adolescents are seen individually and their parents attend separate sessions with the family therapist. The original RCT compared these two treatments over one year.

Participants in this study were 40 adolescents (M_{age}= 15.5 years) with a DSM-IV diagnosis of AN. At five-year follow-up outcomes were assessed using a classification devised by Morgan and Russell (1975). A 'good' outcome is assigned to patients whose weight is within 15% of their Ideal Body Weight (IBW), with a return of menstruation and an absence of bingeing and purging. Patients who have reached 85% of IBW but without return of menstruation or who report bulimic symptoms of less than once a week have an 'intermediate' outcome. Patients whose weight is below 85% of IBW, or who are bingeing or purging more than once a week, have a 'poor' outcome.

Patients in the SFT and CFT had similar outcomes at end-of-treatment and follow-up. Across the sample, those rated as having a 'good' outcome increased from 37.5% to 76% between end-of-treatment and follow-up, whereas those with a 'poor' outcome fell from 37.5% to 16%. The authors suggest that CFT may be less effective in families with high levels of expressed emotion; at follow-up, having a critical mother was linked with poorer outcomes for those in the CFT group.

This study provides data on a five-year follow-up of FT for adolescents with AN and indicates that, in general, treatment effects were maintained. However there

are a number of limitations; given that this study compared two types of FT, the overall sample size is small. Of thirty-one participants interviewed at follow-up, eleven had sought additional inpatient or outpatient treatment during follow-up, although the researchers report that there were no difference in outcomes between those who had received additional treatment and those who had not. The treatments were not manualised, making it difficult to generalise or replicate these findings to other groups. As a no-treatment or control group were not included, the changes at follow-up are difficult to attribute to the effects of treatment.

In one of only a handful of studies of FT to include a comparison group, Lock et al. (2010) report on a two site RCT comparing MFT with adolescent focused therapy (AFT) amongst adolescents with AN. As mentioned already there is a small but growing evidence base suggesting that MFT is associated with good outcomes in adolescents with AN. Robin et al. (1999) report that AFT is also an effective treatment for AN. AFT is an individual therapy, proposing that adolescents with AN have 'ego-deficits' and are uncertain about the differences between self-control and their biological needs. AFT supports patients to identify and learn to tolerate their difficult emotions rather than avoiding these feelings through starvation. In this study, both interventions lasted for about a year.

One hundred and twenty one participants (M_{age}= 14.4 years) were included. All participants met the criteria for a DSM-IV diagnosis of AN, excluding the amenorrhea criterion. All participants were living with at least one parent.

Outcomes were assessed at baseline, end of treatment, six- and twelve- month follow-up. 'Full remission' was defined as IBW > 95% *and* global EDE score (Eating Disorder Examination; Fairburn & Cooper, 1993) within one standard

deviation of published community norms. This is similar to the Morgan Russell 'good outcome'. 'Partially remitted' was defined as IBW > 85% and EDE scores within two standard deviations of published community norms.

At end-of-treatment there was no significant difference between the two treatments in the number of participants in full remission. At six- and twelve-month follow-up, MFT had significantly more participants in full remission that AFT. At twelve-month follow-up, 23% of AFT group were in 'full remission' compared with 49% of the MFT group.

This study uses a relatively large sample to compare FT with another active psychological approach which makes it easier to explore the individual effect of each treatment on outcomes. The follow-up data provide valuable information about the longer term effects of treatment. Limitations were small sample sizes which may lead to a lack of statistical power and relatively short follow-up. Participants with very low body weight at the start of treatment were excluded, which reduces generalisability. Of those available at follow-up, about one quarter of participants had not achieved either full or partial remission. There were no significant differences between the groups in the number of people who did not improve. It is important to report this data clearly so that the efficacy of new treatments is not overstated.

Courturier, Isserlin, and Lock (2010) describe a dissemination study of MFT for adolescents with AN in a Canadian context. The rationale for this study was to investigate the effectiveness of FT in a trial not conducted by one of the model's authors, to explore the fidelity of therapists trained in this model, and the acceptability of the therapy for patients and their parents.

Fourteen adolescents with AN (M_{age}= 14 years) were offered about 20 sessions of MFT over one year. At the end of treatment 54% participants had eating pathology scores within two standard deviations of the normal population and weight at or above 85% of IBW. This is most similar to a combination of Morgan Russell 'intermediate' and 'good' outcome. Previous published FT studies have reported slightly better outcomes at end of treatment, for example, Eisler et al. (2000) report 62% of participants had a 'good' or 'intermediate' outcome, and Lock et al. (2010) report that 89% of participants receiving FT had a similar outcome (full or partial remission) at end-of-treatment. Therapists were only moderately faithful to the MFT manual (Lock, Le Grange, Agras & Dare, 2001). Further research may be needed to explore how best to train FT therapists to remain faithful to the approach. However, findings in this study are limited by the small sample size and lack of a control group, as well as exploratory statistical analyses used.

Loeb and colleagues (Loeb et al., 2007) conducted another trial of MFT not run by the approach's originators. Twenty adolescents (M_{age}= 14.9 years) with DSM-IV diagnosis of AN or subthreshold-AN (s-AN; weight loss to below 100% of IBW plus amenorrhea, or weight loss to below 85% IBW without amenorrhea).

Treatment was about 20 sessions based on the MFT manual (Lock et al., 2001). At end-of-treatment, 65% had a 'good' outcome (based on Morgan Russell weight and menstruation guidelines only), 15% of participants had an 'intermediate' outcome and 20% had a 'poor' outcome. However, using weight gain and menstrual status as primary outcomes in an MFT trial, where parents take responsibility for feeding their child may not be a useful measure of treatment effectiveness. Information on ED symptoms beyond weight gain/ menstruation status is unclear in this study. This makes it difficult to accurately compare outcomes in this trial with

previous trials of FT. In addition, seven patients with s-AN were included in this study (35% sample). All of these patients had a 'good outcome'. Excluding these patients from the analysis, it appears that only about 30% of AN patients had a 'good' outcome; considerably less than in previous MFT studies.

These findings are limited by the relatively small sample size. As patients with very low body weights were excluded from the study, the results cannot be generalised to this group. No follow-up data are provided; therefore it is difficult to establish whether gains were maintained after treatment ended. In addition, as FT was not compared with any other treatment or control group it is difficult to infer that the outcomes are due to FT rather than spontaneous remission. Finally, although the study was not run by the MFT manual's originators, two manual authors contributed to this paper, which raises some concerns about the independence of this dissemination study.

Lock, Le Grange, Forsberg and Hewell (2006) used medical records to retrospectively report on a case-series of age-adjusted MFT for children. Medical records for 32 children (M_{age} = 11.9 years) with AN or s-AN were compared with results from a treatment study of 78 adolescents receiving MFT (M_{age} = 15.5 years; Lock, Agras, Bryson & Kraemer, 2005). Baseline illness characteristics were similar in the child and adolescent groups, although children had significantly lower EDE scores.

At end-of-treatment participants had gained a significant amount of weight and EDE scores declined significantly, except for the weight concern subscale. There were no significant differences between outcomes in the child or adolescent group. As this was a retrospective study, outcome data was not complete for all participants.

Data was available for 25 participants, of these 19 had IBW>95%, and 5 had IBW>85% but <95%. This study provides limited evidence to support the use of MFT in children with AN, although the research design and lack of follow-up limit generalisability.

Paulson-Karlsson, Engstrom, and Nevonen (2009) conducted a pilot study of FT for 32 female adolescents with DSM-IV diagnosis of AN (M_{age}= 15 years). The intervention was described as 'inspired' by MFT, and incorporated aspects of separated FT and conjoined FT; however, it was not manualised. The extent to which this intervention diverges from the Maudsley approach is unclear.

At 18-month follow-up 72% of participants no longer met DSM-IV criteria for any ED; this rose to 78% after 36 months. Results indicated significant improvements in BMI, ED pathology and internalising problems at follow-up.

The findings from this study are impressive, although as no control group is used it is not possible to attribute them directly to treatment. Larger controlled studies comparing this approach to other approaches are clearly needed. In addition, it would be useful to compare this approach with manualised MFT to investigate differences and similarities.

Goldstein et al. (2011) report on a transitional day programme for 26 adolescent patients with AN or s-AN (all criteria for AN except amenorrhea). Participants attended a day programme for three half-days each week for ten weeks, with a follow-up session after six months. The programme was manualised and used a multi-disciplinary approach including supervision of meals, motivational, cognitive-behavioural, narrative, and nutritional strategies as well as about four hours each week of joint patient and parent sessions. Eight participants with IBW < 85% at pre-treatment had IBW >85% at the end of treatment, with a further seven

participants maintaining IBW> 85% from baseline to end-of-treatment, however, 42% had IBW < 85% at follow-up, indicating continued symptoms of AN.

This study evaluates an established day programme for those with AN, therefore it represents treatment of AN in a community setting. No control or comparison group is used however, which makes it difficult to attribute any changes to the intervention. More research will be needed in order to establish whether this intervention is superior to other treatment approaches.

Prestano, Lo Coco, Gallo and Lo Verso (2008) describe a single group study of group analytic therapy for EDs in adolescents. Participants were three adolescents meeting criteria for DSM-IV AN and three adolescents with BN (M_{age}= 16 years). Outcomes were analysed on a case-by-case basis.

Treatment involved long-term analytic group treatment (weekly for two years). Participants were classified as 'recovered' if their change on outcome measures were statistically reliable using the reliable change index (95 % confidence interval), and if the change had been clinically significant, i.e. if an individual's scores moved from the clinical to the functional range. Of the three AN participants, one was classified as 'recovered' on both general psychopathology (Outcome Questionnaire; Lambert et al. 1996) and ED measures (Short Evaluation of Eating Disorders (SEED); Bauer, Winn, Schmidt, & Kordy, 2005). One was classified as 'remitted' (reliable change index 90% confidence interval and clinically significant change) on measures of general psychopathology and 'recovered' on ED measures and one made some improvements on measures of general psychopathology but showed no change on measures of eating pathology. No information is provided about BMI following treatment.

The study is clearly limited by the small sample size, and the lack of a control group is particularly problematic given that therapy lasted for two years. The authors suggest their study provides preliminary evidence that this type of treatment could be effective in improving general psychological functioning, although it may be less helpful in reducing specific ED related behaviours in patients with AN. Given the physical risks associated with ongoing AN symptoms and low body weight, effective AN treatments should be associated with a reduction in AN symptoms and weight restoration (NICE, 2004).

Gowers et al. (2007) compared inpatient with specialist outpatient treatment and treatment as usual (treatment in a child and adolescent mental health service; CAMHS) of AN in an RCT. Participants were 167 adolescents (M_{age}= 14.9 years) with a DSM-IV diagnosis of AN.

Participants were randomised to one of three treatments. Inpatient treatment took place in a general adolescent inpatient psychiatric unit. Patients with a range of difficulties are treated in these units, although a large proportion of those admitted are likely to have an ED. Inpatient treatment lasted for at least six weeks (M_{stay}= 15 weeks). Inpatient treatment was not manualised but consisted of a multidisciplinary approach, aimed at normalising eating, restoring a healthy weight, and bringing about psychological change. Inpatients received individual supportive or cognitive therapy as well as FT, although it is unclear if this was MFT.

Specialist outpatient treatment was manualised and included dietary therapy, an initial motivational interview followed by 12 sessions of individual CBT (with parental feedback), four to eight sessions of parental counselling with the adolescent present, and four sessions of multi-modal feedback aimed at enhancing motivation.

CAMHS treatment is generally the first line service for young people with EDs in the UK. In this study, CAMHS treatment was not manualised but typically included a multidisciplinary, family-based approach, with variable individual therapy, dietetic and medical input. CAMHS treatment was not matched with the intensity of specialist outpatient treatment; however the duration of both treatments was set at six months to allow comparison.

At one year follow-up all three groups had made significant improvements in terms of weight, global functioning, and specific ED pathology. There were no significant differences between the groups. At two-year follow-up all groups showed further improvements. A third of participants had a 'good' Morgan Russell outcome. However, 27% of the sample still had AN at this time. This study does not show any advantage of inpatient care over specialist outpatient care, or any advantage of specialist outpatient over general CAMHS treatment. These findings are interesting from a service context given that inpatient treatment is significantly more expensive than outpatient care. As those admitted to an inpatient setting were randomly selected, this finding could not be accounted for by those in inpatient settings being more severely ill. The outcomes for those who received inpatient care following outpatient treatment are complex, and the pathway to this treatment (i.e., failure to improve in outpatient treatment) is likely to impact on outcomes. Nevertheless the trend in this study suggests that inpatient treatment alone rarely results in recovery from AN.

This is a well-powered population-based study. Two-year follow-up and the excellent rate of tracing participants provide us with good information about the longer term effects of treatment. Unlike many other controlled studies, participants

were not excluded because of medical severity, although participants were referred for acute medical treatment if required. Further research is needed to explore which aspects of each treatment have the greatest impact on outcomes. As all treatments were not manualised it is difficult to generalise these results, or to replicate the study. It is of note that the rates of those with a 'good outcome' are lower in this study than in studies of other models, for example, Lock et al. (2010), however, rates of those showing no improvements are similar to findings from Lock et al.'s study comparing MFT with AFT. It is difficult however, to compare outcomes across different studies. Future research directly comparing components of each of these treatments with more specific approaches to treatment, for example MFT or CBT may yield interesting findings.

Dialectical Behaviour Therapy (DBT) proposes that people with AN have difficulties identifying emotions and often engage in strategies to avoid emotions (Wisniewski & Kelly, 2003). Salbach-Andrae, Bohnekamp, Pfeiffer and Lehmkuhl (2008) describe a case series design evaluating DBT in adolescents with AN and BN in an outpatient setting. As each case is analysed separately it is possible to examine the effect of DBT for those with AN. Six female adolescent participants (14-19 years) with a DSM-IV diagnosis of AN were included in the study.

Treatment was 25 weeks of twice-weekly therapy, comprising of one individual session and one group skills-based session, as well as intersession telephone support with a therapist. A specific skills training module dealing with food and body image was also included. Parents took part in eight skills-training sessions, and in individual sessions when appropriate.

Of the four participants who initially met criteria for AN-restricting type, none met criteria for any ED at end-of-treatment. Of the two participants who initially met criteria for AN-binge/purge type, one had no ED and one still met criteria for AN-binge/purge type.

These results are promising for young patients with AN, although no follow-up data is available, and the sample was very small. It is also of note that the five participants who recovered in this study had no co-morbidity. More research is needed to compare DBT with approaches such as FT.

Treatment studies in Adults with AN

There are fewer treatment studies of adults with AN. Steinhausen (2002) reports that longer illness duration is associated with poorer outcomes for patients with AN. This suggests that adults that developed AN in adolescence may be less likely to have good outcomes than both adults developing AN in adulthood, or adolescents with shorter illness durations (Dare, Eisler, Russell, Treasure, & Dodge, 2001). More research investigating treatment outcomes for these groups is needed to establish whether this is related to a lack of effective treatments, or whether longer illness duration may make AN more intractable (Treasure, 2007).

Berman, Boutelle & Crow (2009) conducted a case series using Acceptance and Commitment Therapy (ACT) in three patients with AN. Participants had all previously received at least one year of treatment for AN. At the time of entry into the study participants met criteria for subthreshold-AN (all the symptoms of AN, except amenorrhea or BMI < 17.5kg/ m^2). BMIs ranged from 18.6kg/ $m^2$to 19.1kg/ m^2. Treatment was 17 twice-weekly individual sessions of ACT and two optional

sessions of family psychotherapy. Sessions were adapted from Heffner and Eifert's (2004) self help ACT manual for AN.

Participant 1 showed some overall improvement on measures of general psychopathology between baseline and one-year follow-up. She reported however, that ACT had changed her life, and after 12 years of continuous treatment for AN, following the ACT sessions she did not seek other treatments, and maintained her job and relationship for the twelve months to follow-up.

Participant 2 showed some improvement in general psychopathology between baseline and end-of-treatment and these gains were maintained at follow-up. She also gained a significant amount of weight during treatment and follow-up. Participant 3 showed more modest improvements. She had some improvements on measures of general psychopathology but she also reported some deterioration in ED symptoms between baseline and follow-up. The authors suggest that this may have been due to her reports that ACT was leading her to think about things in her life more carefully. However, in behavioural terms, her weight did not reduce during treatment and she took some reportedly positive steps in her career.

The outcome measures used in this study assessing quality of life and behaviours are one of its strengths. However, it would have been useful to include a standardised quality of life measure as unstandardised outcomes such as career progression are difficult to replicate in larger studies. As all participants in this study had a long history of AN and had previously received treatment for AN, this sample represents some of the complexity of ED seen in community settings. Although they all presented with significant current difficulties with AN symptoms, they were below the threshold for DSM-IV criteria for AN, suggesting that their previous treatment had led to some improvements. This is a small case-series and provides

only preliminary data about the possibility of using ACT as a treatment for subthreshold-AN patients. Further, large scale research is needed to investigate whether ACT would be suitable for use with those with a current diagnosis of AN.

Ricca et al. (2010) describe a longitudinal design to assess the effectiveness of CBT in treating patients with AN and subthreshold-AN. No details on BMIs were included. Participants were 103 female patients (53 with AN), aged between 17 and 39 ($M_{\text{age AN}}$: 27 years, $M_{\text{age s-AN}}$: 30 years). Treatment was 40 sessions of manualised CBT for ED, delivered over at least forty weeks.

Participants were assessed at the start of treatment, at end-of-treatment, and at three-year follow-up. In this study outcomes were defined as 'recovered' when participants did not meet DSM-IV criteria for any ED; 'treatment resistant' when there was no change in diagnostic category and 'change in ED diagnosis' when AN or s-AN patients moved across diagnostic categories during the trial or follow-up.

Treatment outcome did not differ significantly according to diagnostic group (AN vs. s-AN). At end-of-treatment 30% of the total sample had 'recovered'. At three-year follow-up 33% of the total sample had 'recovered' and 42% showed no change or were 'treatment resistant'. It was difficult to disentangle the complex patterns of diagnostic migration, although many participants in each group moved between diagnostic categories. The rationale for using these outcome categorisations is unclear, and it may have been more helpful to analyse outcomes in terms of weight restoration and ED behaviours, for example by using categories similar to Morgan Russell outcomes. The authors suggest a differential response to treatment according to symptoms; those with AN- or s-AN-restricting type had higher levels of 'treatment resistance' than with those with AN- or s-AN-binge/ purge type.

This study is limited as, without a control group, it does not investigate the specific effect of CBT on outcomes. The sample is also relatively small. Furthermore, although a three-year follow-up gives some indication of the medium term effects of treatment, no information was gathered about other treatments patients may have pursued between treatment ending and follow-up.

Meguerditchian et al. (2010) retrospectively compared outcomes for patients who had received inpatient treatment with those who had received outpatient care. All female patients with a diagnosis of AN who had received treatment at a specialist ED treatment centre in the past 15 years were asked to participate. One hundred and forty-three participants responded to a questionnaire asking about their current weight and eating behaviour, physical well-being and social functioning. Of these, 46 had received inpatient care and 97 had received outpatient care during their initial six months at the centre.

Treatments were a combination of medical, nutritional, and psychological approaches however, they were not manualised. Outpatient care was based on a weight contract, and included nutritional assessment and education, medical supervision and weekly psychotherapy sessions ('mixed cognitive-behavioural and analytic approach'). Inpatient treatment was for patients with life-threatening conditions related to undernourishment, considerable risk of suicide, or if the patient requested to be admitted or had failed to gain weight in the outpatient programme. Follow-up nutritional and psychotherapeutic support was provided after discharge as needed. The duration of treatment was determined on an individual basis.

The length of time since treatment had ended varied from one to 14 years (M = 4.8 years). At follow-up, there were no differences between the groups in terms of

those who had maintained their BMI >18.5kg/m^2 (about half of each group), or the proportion of participants reporting they were 'completely recovered' (21% in each group). Those who had received inpatient treatment were more likely to have required additional inpatient treatment. They were also more likely to still be receiving follow-up nutritional support than those in the outpatient group. In terms of social functioning, there were few differences between the groups, suggesting that although those admitted to inpatient care had been more seriously unwell in the past, over time both groups seem to fare as well as each other.

The findings are limited by the design of the study which is retrospective. There were variable durations of treatment and length of follow-up which could confound the findings. In addition, treatments were not manualised and the lack of details of the therapy provided would make it difficult to replicate this approach, and limits the generalisability of the findings.

Chen et al. (2010) report on a case series using MFT with four young adults (age range 18-21 years); two meeting DSM-IV criteria for AN and two participants with s-AN (all the criteria excluding weight loss to <75% IBW). Treatment was between 11 and 20 sessions of FT based on manualised MFT (Lock et al., 2001), conducted over six to twelve months. According to the authors, therapists took a more collaborative approach with the patient and his/ her family than in FT for adolescents. All cases were followed up, although length of follow-up is not clear. At follow-up, one of the two patients with AN had a BMI >18.5kg/ m^2, and one of the two participants with ED symptoms in the clinical range at baseline, had ED scores in the nonclinical range at end-of-treatment and follow-up. These preliminary findings provide limited support for the use of MFT with young adults with AN or s-

AN. More research is needed perhaps with a more clinically homogenous sample in order to explore the effectiveness of MFT with young people in more depth.

Dolhanty & Greenberg (2009) describe a single case study using Emotion Focused Therapy (EFT) to treat a 24 year old female with a nine-year history of AN. The participant entered therapy following a hospital admission where her BMI had increased from 10 to 16. EFT proposes that as people with AN frequently have difficulties regulating their emotions that EFT is a suitable treatment for AN as it explicitly targets identifying and learning to tolerate difficult emotions.

EFT consisted of weekly one-hour therapy sessions, as well as regular physician and dietician sessions as needed. The treatment in this study was described up to 18 months; it is unclear if treatment continued after this point or whether the client was discharged. The focus of this paper is on the processes involved in case formulation and treatment using EFT in AN. As this is a single case design it is difficult to generalise to other cases.

The client maintained her BMI at 16 throughout treatment. Her scores on the Eating Disorder Inventory (EDI; Garner & Olmstead, 1984) and the Toronto Alexithymia Scale (Bagby, Parker and Taylor, 1994) fell from the clinical to the normal range as treatment progressed. No follow-up information is available, so it is unclear if these gains were maintained. Further research could explore the effectiveness of EFT in a larger sample of people with AN, perhaps by comparing it with another psychological treatment. However, it is of note that the client remained significantly underweight throughout treatment. Weight restoration and physical health would need to be monitored closely in any subsequent trials of EFT.

Tchanturia et al. (2008) report on the use of cognitive remediation therapy (CRT) to target the rigid thinking style conceptualised as a core component of AN. Twenty-three adults with AN completed ten sessions of CRT while admitted to an inpatient unit. At the end of the intervention, participants showed marked improvements on measures of cognitive flexibility and central coherence, as well as significant increases in BMI. There were no changes on self-report measures of anxiety or obsessive compulsive traits. As no control group was used it is unclear whether the changes in ED symptoms or cognitive flexibility are related to the CRT or concurrent inpatient treatment. More research will be needed comparing CRT with other treatments or a control group before any firm conclusions can be drawn.

People with AN are often reluctant to engage in treatments and maintain a healthy body weight as the symptoms of AN can be ego-syntonic (Orimoto & Vitousek, 1992). Dean, Touyz, Rieger and Thornton (2008) explore the effectiveness of a short Motivational Enhancement Therapy (MET) on outcomes in an inpatient facility. Unfortunately, in this study those with AN and other EDs (BN and EDNOS) were grouped together, so it is difficult to clearly see if the intervention had similar effects for those with AN and those with other EDs. However, as this was an adjunct treatment for ED, it was decided to include it in this review.

Forty-two consecutive female inpatients with EDs were allocated to either treatment as usual (TAU) or four sessions of MET and TAU. The MET intervention included four weekly group sessions in the inpatient unit. MET explored the costs and benefits of change and addressed patients' ambivalence about change using specific strategies, for example, discussion of the stages of change model

(Prochanska & DiClemente, 1982). Outcomes were assessed pre-treatment, after MET, and at six-week follow-up.

There were few significant changes between the MET and control group at end of MET or follow-up. However, there was a trend towards patients in the MET group continuing to show increased motivation to change between end-of-treatment and follow-up. In addition, a significantly higher proportion of those in the MET group were engaged in appropriate treatment at follow-up (84% of MET group vs. 44% of control group). It would have been useful to explore any differences between the groups at a longer follow-up. While these findings are interesting, their generalisability is limited by the small sample size and nonrandomised design. Further research will be required to investigate the effect of MET on treatment outcomes for specific EDs.

Wade, Frayne, Edwards, Robertson and Gilchrist (2009) describe another study exploring the relationship between motivation and treatment effectiveness in a specialist AN inpatient unit. Forty-seven patients with AN or s-AN (all symptoms of AN except amenorrhea or BMI<19kg/ m^2) were randomly allocated to receive TAU or TAU plus four individual sessions of Motivational Interviewing (MI). The content of the MI sessions included exploring the impact of AN on the patient's life, and their motivation to change. It is unclear how this differed from the MET described in Dean and colleagues' (2008) study; as MI was individually based, the focus of each session followed on from the previous session, and participants were asked to complete homework tasks, whereas the MET described by Dean et al. was administered as an open group, so each session was designed to be a standalone session.

MI did not significantly increase motivation for treatment or decrease eating pathology. However, those who received MI were significantly more likely to remain in treatment than those receiving TAU. Regardless of treatment condition, baseline motivation levels predicted eating pathology after six weeks. These findings are interesting as they suggest that a motivational intervention may impact on attrition rates. They also suggest that treatment may be more helpful for those with higher levels of motivation. More research is needed to explore how to increase motivation levels, and perhaps how to sustain levels of motivation throughout treatment. The generalisability of these findings is limited by the small sample size, and the short follow-up.

Fichter, Cebulla, Quadflieg and Naab (2008) describe the effect on outcome of using a self-help manual (SHM) prior to inpatient admission for AN-binge/purge. This study took place in Germany where inpatient treatment is routine for those with AN. A wait-list-control design was used. Participants were 102 females consecutively referred for inpatient treatment. All participants met DSM-IV criteria for AN-binge/purge type.

The SHM was based on concepts from CBT and psycho-education. Participants were expected to complete one of six topics each week. Participants in the manual group also received telephone support from a clinical psychologist, limited to thirty minutes each week. The aim of the telephone support was to introduce, discuss and summarise that week's topic from the SHM.

The primary outcome in this study was the duration of participants' inpatient stay. Inpatient treatment in the manual group was an average of 5 days shorter than

the control group. This difference was statistically significant. General psychopathology and BMI did not differ across groups.

Although those in manual group had shorter overall admissions, the clinical significance of five days is minimal, in the context of an average stay in the manual group of 67 days. It might have been interesting to assess motivation before and after self-help treatment, to evaluate whether the SHM impacted on motivation for treatment. It is unclear why the SHM was based on CBT and psycho-educational concepts rather than on other approaches, for example DBT, ACT or family-based approaches. The findings cannot easily be generalised as they evaluate the effectiveness of SHM before an inpatient stay. Further research will be needed to investigate whether SHMs can effect change in participants engaged in outpatient treatments.

Discussion

Summary of the Evidence

Outcomes for children and adolescents. Ten of the 19 studies included in this review explored the effects of treatment on adolescents or children with AN. Six used MFT (or a derivative of it). Previous research suggests that there is some evidence to support the use of MFT in adolescents with AN (Le Grange & Eisler, 2008). Studies included in the current review suggest that MFT may be less effective in treating patients at sites where one of the originators of the model is not present (Couturier et al. 2010; Loeb et al. 2007). Therapists were however, only moderately faithful to the manual in these studies.

Only one RCT compared MFT with another treatment (Lock et al., 2010). This study reported that at one-year follow-up, significantly more participants in the MFT group than the AFT group met criteria for 'full remission'. Overall, MFT is associated with good outcomes for between 30-75% of adolescent patients and these gains appear to be maintained at follow-up. However, most of these studies are small and uncontrolled, making it difficult to attribute outcomes to any element of the treatment.

One study compared inpatient and specialist outpatient treatment with general CAMHS treatment for adolescents with AN using a randomised control design (Gowers et al., 2007). At two-year follow-up there were no differences between the groups in terms of outcomes; about one-third of patients in each group no longer met criteria for an ED. This was a methodologically robust trial and suggests that specialist inpatient or outpatient treatments may provide no advantage over general CAMHS treatment.

Three case studies explored DBT, group analytic therapy, and a day programme for adolescents with AN. Although the design of these studies make it difficult to generalise the findings, early indications suggest that DBT may be associated with positive outcomes in AN. However, results from the transitional day programme were more mixed. Outcomes from the group analytic therapy study are difficult to interpret as there is no information available about weight after treatment, and ED pathology outcomes were also mixed.

Outcomes in adulthood. Nine studies exploring treatment for adults with AN are included in this review. Five are uncontrolled studies of different psychotherapeutic approaches, one is a retrospective study, and three are of adjunct

treatments. Outcomes for adults with AN appear more complex than for adolescents with AN. It is not possible to conclude that one of the approaches used (CBT, ACT, CRT, EFT) is superior to another approach. ACT may be useful for patients who are weight restored but struggling to make progress in their lives. It is difficult to get a clear picture of how patients fared in Ricca and colleagues' (2010) study as outcomes have been defined in very narrow terms. Dolhanty and Greenberg's (2009) EFT study did not show weight restoration after 18 months which raises concerns about the appropriateness of this approach for AN. Tchanturia et al. (2008) report promising results for CRT, although the lack of a comparison group and concurrent inpatient treatment makes it difficult to generalise these findings. Similar to Gowers et al. (2007), Meguerditchian et al. (2010) report few significant differences between outcomes for in- and outpatients.

Three studies of adjuncts to treatment are also included in this review. From the two studies on motivational therapy, it appears that patient motivation is linked with short-term outcomes and treatment adherence. The motivational therapies used in these studies did not improve outcomes or increase motivation. However, in both studies those who received a motivational intervention were more likely to remain in treatment than those in the control group. Patients using an SHM prior to inpatient admission were discharged from hospital an average of five days before patients in a control group (Fichter et al., 2008). Further research, perhaps in an outpatient setting will be needed before the utility of SHMs with this population is better understood.

Limitations of this Review

This review is limited by a number of factors. Firstly, the methodological quality of some of the studies included limits their usefulness, and therefore the

scope of the review. Some of the studies included did not report on the details of the psychological approach used. (e.g., Meguerditchian et al., 2010), others described approaches that were not manualised (Gowers et al., 2007), or novel treatments for AN (Dolhanty & Greenberg, 2009), and this limits the utility of these studies in clinical practice. This review focussed on the available evidence for psychological treatment of AN or s-AN only. Previous reviews have suggested that patients with AN respond differently to treatment than those with BN or BED (NICE, 2004). Several studies, (e.g., Fairburn et al., 2009; Jurascio, Forman, & Herbert, 2010) do not differentiate between ED categories, and these were not included in this review. However, studies with s-AN participants were included, as there is some uncertainty about the clinical value of current diagnostic criteria (Fairburn et al., 2007; Garfinkel, et al., 1996). These studies of s-AN participants were also included as there was a general lack of research investigating psychological treatment of AN.

Clinical Significance of the Review

There are mixed findings to support the dissemination of MFT. That treatment fidelity has been moderate at best may indicate that ways to build adherence need to be developed. However, a nonmanualised study 'inspired' by MFT (Paulsson-Karlson et al., 2009), reported positive treatment outcomes comparable to larger FT trials, calling into question the need for MFT to be manualised, which is likely to impact on clinical services.

Whether to have FT sessions together as a family or separate sessions for parents and adolescents is another important clinical consideration. Eisler et al. (2007), suggest patients with critical mothers had poorer outcomes if they received conjoint rather than separated FT. All patients included in these MFT trials are from

intact families or living with at least one parent, who was willing to actively participate in treatment. Treatment options that are suitable for children from less traditional families or looked after children may also be interesting to explore further.

Few trials have compared MFT with no treatment or other active treatments. In all MFT studies a significant proportion of patients have a poor outcome following treatment; usually about a quarter of patients. This rate is comparable to results from less specialised treatments (e.g. Gowers et al., 2007). However, it is of note that Gowers et al. report that only about one third of patients no longer had an ED at two-year follow-up. These are markedly less impressive outcomes than those reported in MFT trials (Lock et al., 2010), although it is difficult to compare results from this population based study with more selective FT trials.

Findings from Gowers and colleagues (2007) population study also suggest that inpatient treatment should only be used in a medical emergency, or if outpatient treatment has not been successful. Given that inpatient care is more costly and more disruptive to the patient's life than outpatient care, this research along with findings from Meguerditchian et al. (2010) has important implications for service delivery, and suggests that outpatient treatment should be offered as the first choice for patients.

The clinical significance of studies with adults is less promising. None of the approaches reviewed present clear evidence of good outcomes for a majority of patients. Ricca and colleagues (2010) suggest that around a third had a good outcome at follow-up, although as this was an uncontrolled study, it is not possible to attribute this change to the CBT.

The two studies exploring the effects of motivational interventions on outcomes provide some evidence to support the idea that motivational levels can be predictive of outcomes. Surprisingly, researchers have yet to show that motivational interventions significantly impact on motivation levels, although this will be an interesting field for future research.

Several studies examined the subtypes or symptoms of AN-restricting and AN-binge/ purge types separately (Couturier et al., 2010; Salbach-Andrae et al., 2008). It is possible that AN-restricting and AN-binge/purge have different core difficulties (Ricca et al., 2010) and that the different subtypes may respond differently to treatment. For example in Salbach-Andrae et al.'s study, all four participants with AN-restricting type were 'recovered' at end-of-treatment, compared with only one of the two participants with AN-binge/purge type. As these differences were not the primary focus of any of the studies included in this review, it is unclear if these differences are related to AN symptoms or other factors, for example, co-morbidity. Future research is needed to establish whether these subtypes do respond differently to treatment, and which treatments are best suited to each subtype.

Implications for Future Research

There are a number of limitations to the current research base which could be addressed in future research. Firstly, using appropriate outcome measures that can provide useful information about treatment effectiveness is crucially important. Ideally, researchers in the field of ED could reach a consensus about what outcomes will be useful to measure in all studies, which would make it easier to compare across studies. Outcome measures need to take account of the major aspects of AN, such as body weight *and* preoccupation with shape and weight. Studies that focus on

only one of these factors, (e.g. Prestano et al., 2009), or that create their own outcome categories (e.g. Ricca et al., 2010) make it difficult to get a clear grasp of what the effect of treatment on outcome actually was.

This review highlights the lack of evidence to support any one psychological approach to treating what is a serious and chronic illness. Researchers have suggested that RCTs may be unethical or very difficult with this population (Fairburn, 2005). However, as is highlighted by the current review, the majority of recent research does not include even a control or comparison group. It is difficult to draw any firm conclusions about treatment effectiveness or efficacy from uncontrolled studies. It could be argued that conducting underpowered or poorly designed research with this vulnerable patient group is also unethical. More methodologically rigorous studies comparing one psychological approach with another treatment or control condition are needed to establish the role of specific treatment factors on outcomes.

This review also highlights the need for more controlled studies exploring MFT approaches with children and adolescents. The evidence for this model should not be overstated and MFT needs to be explored in larger controlled comparisons with other therapies, perhaps at sites not run by the approach's originators. Future research into MFT also needs to address questions such as what family, individual, or therapist factors make good outcomes more likely. Eisler and colleagues (2007) suggest that conjoint family therapy may be associated with less positive outcomes for those with high expressed emotion in their families; the role of criticism and how best to assess for this pre-treatment should also be explored in future research.

Conclusion

In summary, the findings from studies included in this review suggest that at present there is no strong evidence to support any one psychological approach in treating children, adolescents, or adults with AN. In the past five years, few well-powered, controlled outcome studies have been carried out in this area, which has limited the evidence base for treatments of AN. Somewhat more research has been carried out with adolescents, in particular using family-based approaches to treatment. Although there have been some promising outcomes using this model, more rigorous and methodologically sound research is needed. Few conclusions can be drawn from the recent adult research in the field. In reviewing the research base it is clear that there is an urgent need for well-designed studies comparing different psychological treatments, using clinically relevant outcome measures.

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Part 2: Empirical Paper

The neuropsychology of starvation: Set-shifting, central coherence, perseveration, and persistence in a nonclinical sample.

Abstract

Aims: Recent research suggests that a range of neuropsychological deficits occur in anorexia nervosa (AN, Fowler et al., 2006; Treasure, 2007). However the impact of starvation on these deficits is unknown.

Method: Using a within-subjects repeated measures design, nonclinical participants were tested twice, once after fasting for 18 hours, and once when satiated. Measures included the Group Embedded Figures Test (Witkin, Oltman, Raskin, & Karp, 1971) and a local-global processing task (White, O'Reilly & Frith, 2009) to measure central coherence; the Brixton task (Burgess & Shallice, 1997) and a rule-change task (Bolton, Burgess, Gilbert, & Serpell, in preparation) to measure set-shifting, and a novel gambling task to measure persistence.

Results: Results indicate that fasting exacerbates set-shifting difficulties on a novel rule-change task. Fasting was also associated with stronger local and impaired global processing, indicating weaker central coherence.

Conclusions: Findings suggest that any proposal of set-shifting difficulties or weak central coherence as possible endophenotypes of AN should be treated with caution until the impact of starvation is clarified.

Anorexia Nervosa (AN) is a serious and chronic illness that can be difficult to treat. The mortality rate from AN is higher than any other psychiatric illness, estimated at 5.6% for every decade of illness (Sullivan, 1995). Longer illness durations are associated with poorer outcomes (Steinhausen, 2002) and AN is also associated with a range of physical difficulties, which are often still present after recovery, for example osteoporosis, problems with reproduction, and major depression (Bulik et al., 1999; Finfgeld, 2002; Gendall & Bulik, 2005). Despite the serious outcomes associated with AN, and ongoing, extensive research in this area, treatment outcomes are mixed; in their review, Bulik, Berkman, Brownley, Sedway and Lohr (2007) report that between 27% and 58% of patients with AN have a 'good' treatment outcome.

Although the underlying causes of AN are not yet fully understood, it is thought that several factors are involved in its aetiology. Researchers have drawn parallels between the clinical features of AN and obsessive compulsive disorder (Serpell, Hirani, Willoughby, Neiderman, & Lask, 2006; Serpell, Livingstone, Neiderman, & Lask, 2002; Shafran, 2002). Holliday, Uher, Landau, Collier and Treasure (2006) report that those with a lifetime history of AN scored higher on measures of compulsivity than healthy controls. Brecelj Anderluh, Tchanturia, Rabe-Hesketh, and Treasure (2003) report that patients with AN retrospectively recollect the presence of obsessive-compulsive features even before AN onset, suggesting that these behaviours are not simply associated with the acute phase of AN and may be implicated in its aetiology.

Treasure (2007) suggests that anomalies in information processing, in particular involving set-shifting and central coherence may underpin these obsessive-

compulsive traits in AN. She suggests that exploring these deficits may uncover endophenotypes of AN, which may in turn lead to more effective treatments for the disorder.

The Role of Starvation

By definition, patients with AN are seriously undernourished. This is typically characterised by a combination of short-term food restriction and more chronic starvation (Sidiropoulos, 2007; Vitousek & Manke, 1994). Prolonged food restriction in healthy volunteers is associated with a range of difficulties including stereotypic and obsessive rituals (Keys, Brozek, Henschel, Mickelsen & Taylor, 1950). There is also some evidence to suggest that unintentional weight loss can trigger AN (Brandenburg & Anderson, 2007; Epling, Pierce & Stefan, 1981). Patients with AN experience specific structural and metabolic change in their brain, for example, decreased grey matter in the anterior cingulate cortex (Mühlau et al., 2007), compared with healthy controls, most likely as a result of their prolonged malnutrition (Suchan et al., 2010).

Set-Shifting

Set-shifting is the ability to move back and forth between different tasks or mental ‘sets’. It is an important part of executive functioning, and is not directly related to IQ (Holliday, Tchanturia, Landau, Collier & Treasure, 2005). Difficulties in set-shifting have important implications for everyday life and may manifest as cognitive or behavioural inflexibility, for example rigid approaches to problem solving or difficulties managing dynamic social interactions.

Eating disorder (ED) research suggests a consistent deficit in set-shifting ability in individuals with AN and Bulimia Nervosa (BN), as well as in those recovered from AN and BN (Roberts, Tchanturia, Stahl, Southgate, & Treasure, 2007; Roberts, Tchanturia, & Treasure, 2010). Holliday and colleagues (2005) report that unaffected sisters of those with AN also show some set-shifting impairments. A handful of studies have investigated the neural correlates of cognitive flexibility in patients with AN (Sarrar, et al., 2011; Zastrow et al., 2009). These suggest that impaired set-shifting in AN is associated with specific differences in brain activity or hormone levels in response to set-shifting tasks, for example, Zastrow and colleagues (2009) report differential activations of several brain regions in those with AN compared with healthy controls on tasks of set-shifting.

Although set-shifting difficulties have been proposed as a possible endophenotype for AN (Holliday et al., 2005; Roberts et al., 2007), the role of starvation in set-shifting is not yet clearly understood. Roberts et al. (2010) report that set-shifting difficulties were not related to Body Mass Index (BMI) in their study with AN patients, although it is not clear that BMI and short-term starvation are related to one another. Tchanturia, Morris, Surguladze, and Treasure, (2002) report that although there was no improvement in set-shifting after weight restoration for those with acute AN, those recovered from AN had fewer set-shifting difficulties than those with acute AN. In a recent meta-analysis of cognitive impairments in AN, Zakzanis, Campbell and Polsinelli (2010) conclude that cognitive impairments in AN are closely associated with BMI. The exact role of hunger or malnutrition in these difficulties remains unclear, however. Any model accounting for the role of cognitive rigidity in AN also needs to account for the effects of both short-term and chronic starvation on cognitive performance.

Central Coherence

In typically developing adults, central coherence is a tendency to integrate information received into the bigger picture. Weak central coherence is a bias towards local information processing as well as a deficit in global processing (Happé & Frith, 2006). It is associated with autistic spectrum disorders, and recent research has also identified links between central coherence and EDs.

Clinically, weak central coherence could be associated with paying attention to details, and difficulties integrating global concepts into our understanding, for example, an AN client who focuses intently on the details of exactly what she has eaten, and does not acknowledge the long-term health consequences of starvation.

In a systematic review, Lopez, Tchanturia, Stahl and Treasure (2008a) report that individuals with EDs (AN and BN) showed poorer performance on tasks requiring global processing. There is also some evidence to support the idea of superior detail focussed processing in those with AN (Lopez, Tchanturia, Stahl, Booth et al., 2008). These information processing biases appear independent of intelligence (Lopez et al., 2008a; Treasure, 2007).

Research suggests a strong link between weak central coherence and AN, however, the effect of food deprivation on central coherence is not yet known. Lopez, Tchanturia, Stahl and Treasure (2008b) report that participants at normal weight (those recovered from AN or with current BN) have an intermediate profile of central coherence between those with acute AN and healthy controls. These findings support the idea that weak central coherence may be another possible nonspecific endophenotype for AN (Treasure, 2007). However, they also suggest a role for food

deprivation in central coherence. To date, this role has not been explored in an experimental manipulation.

Persistence

Difficulties with set-shifting and weak central coherence may be aspects of the rigid personality types often reported amongst patients with AN (Cassin & Von Ranson, 2005). Perfectionism has also been associated with EDs and this rigid personality type, and may be a risk factor for the development of an ED (Fairburn, Cooper, Doll, & Welch, 1999). Although the traits of persistence, perseveration and perfectionism are often confused Serpell, Waller, Fearon and Meyer (2009) suggest that persistence and perseveration may be separable from the trait of perfectionism. People who continue with a task in order to achieve a goal, even if the task is long and difficult are said to have high levels of persistence. While perseveration may overlap with set-shifting difficulties, Serpell and colleagues suggest that persistence is an adaptive trait, and may be protective against a range of psychopathology. In line with this theory, low levels of self-reported persistence have been reported in those with EDs (Waller et al. under consideration). Whether self-reported persistence is associated with performance in a task assessing persistence has not yet been explored. In addition, the effect of food deprivation on tasks measuring persistence remains unknown.

The Current Study

This study aimed to replicate the findings from Bolton, Burgess, Gilbert and Serpell (in preparation), that short-term fasting exacerbates set-shifting difficulties on a computerised rule-change task. The Brixton task was also included as a measure of

set-shifting, as this task has previously been used to measure set-shifting in ED research (Holliday et al., 2005; Tchanturia et al., 2004).

The effect of short-term fasting on central coherence was also explored. In line with research reporting that those with current AN show greater deficits in central coherence that those recovered from AN (Lopez et al., 2008b), it was expected that short-term fasting would intensify any local processing bias and attenuate global processing. Central coherence was measured using a computerised local-global processing task and the Group Embedded Figures Task (GEFT; Witkin, Oltman, Raskin, & Karp 1971).

As depression is reported to moderate impaired set-shifting in AN (Wilsdon & Wade, 2006), and to be associated with increased perseveration (e.g., Ilonen, et al., 2000), it was important to examine the impact of mood on performance in this study. It was expected that low mood would be associated with greater set-shifting difficulties on the experimental tasks. Self-reported eating pathology and perseveration were also assessed; higher levels of self-reported perseveration and ED pathology were expected to be linked to poorer performance on tasks assessing set-shifting and central coherence.

Research reports that those with AN have impaired set-shifting abilities and weaker central coherence than healthy controls, however, to date no ED research has investigated whether these concepts are related to one another, either in a healthy sample or a clinical group. If there is a relationship between cognitive flexibility and central coherence this may suggest that particular cognitive profiles are associated with ED pathology, which could further our understanding of EDs.

Specific hypotheses

i. In the rule-change task, participants will have slower mean RTs on shift trials, compared to stay trials.

ii. In the rule-change task, fasting will increase RTs for both stay and shift trials. In particular on trials requiring a shift, fasting will lead to longer RTs, i.e. fasting will exacerbate shift costs.

iii. In the Brixton task, fasting will impair set-shifting and participants will make more errors when they are fasting.

iv. In the local-global processing task, participants will identify fewer letters when asked to switch from a global to a local letter or vice versa than when there is no switch required.

v. On the local-global processing task fasting will be associated with improved performance when processing local letters and impaired performance when processing global letters.

vi. In the gamble task, fasting will be associated with less persistence, i.e., participants will stay with the winning deck less in the fasting condition.

vii. In the GEFT, fasting will be associated with faster median completion times, and fewer false claims to have found the figure, suggesting a local processing bias.

viii. As all experimental tasks have been used or designed to assess different aspects of cognitive performance associated with AN, performance on these tasks will be intercorrelated. In particular, as the local-global processing task

and the GEFT have previously been used as measures of central coherence there will be a strong relationship between performance on these tests.

ix. In line with previous research (Bolton et al., in preparation), PPPQ-22 perseveration will be correlated with EDE-Q6 scores and with experimental tasks measuring set-shifting, i.e., the rule-change task and the Brixton task.

x. Short-term fasting will increase rates of self-reported perseveration and decrease self-reported persistence on the PPPQ-22.

Method

Participants

A power analysis specifying an alpha level of five percent, a power level of 80 percent, and a moderate effect size estimated that the required sample size was 34. The estimate of a moderate effect size was based on research comparing AN participants with healthy controls on tasks of set-shifting and central coherence (Lopez et al., 2008b; Roberts et al., 2007). I aimed to recruit 60 participants to allow for variations in power in a within-subjects design with a nonclinical sample and to allow for missing data and drop-out.

Participants were 60 female volunteers who responded to a poster (Appendix A) or a UCL-based website aimed at recruiting participants for psychology research. Participants were eligible if they were fit and healthy, female, aged 18 to 30, and spoke English fluently. Participants were excluded if they reported a lifetime history of any ED or psychiatric illness, or if they knowingly had any medical condition that would make fasting dangerous, such as pregnancy or diabetes. Participants were paid £15 or received course credits for their time. Although the study aimed to recruit

healthy volunteers, no psychological or physical health screens were administered prior to participation, which allowed for natural variation in the sample.

Ethics

This study was approved by the University College London (UCL) Research Ethics Committee (Appendix B). The ethical implications of asking participants to fast for 18 hours were carefully considered. Participants were given an information sheet outlining the possible risks of fasting (Appendix C) as well as some advice on fasting (Appendix D). Participants were advised to stop fasting immediately if they felt unwell. A cereal bar was offered after the testing session, so that participants did not leave the session hungry.

Measures

Body Mass Index (BMI). BMI was calculated by dividing participants' weight in kilograms by their height in metres squared. Height and weight were measured using a portable stadiometer and a digital weighing scale accurate to within 0.05kg.

Diary measures. Prior to the fasting session, participants were emailed a diary measure (Appendix E) to complete while fasting. Participants were asked to rate their mood, hunger, and preoccupation with food on a 7-point Likert scale (1= *not hungry at all* and 7 = *very much so*) at five points during the fasting period.

Self-report mood and anxiety. Participants rated their mood and anxiety at each session using the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983). This is a brief 14-item self-report measure yielding separate subscale scores for anxiety and depression. It is widely used in research and clinical settings.

For each item, participants are asked to choose which of four statements they agree with the most, which yields an item score of between 0 and 3. The maximum score for each subscale is 21.Higher scores indicate more symptoms and higher levels of distress. The HADS has acceptable levels of reliability and validity when used in a nonclinical sample (Bjelland, Dahl, Haug & Neckelmann, 2002).

Self-report perfectionism, persistence, and perseveration. The 22-item self-report Perfectionism, Persistence and Perseveration Questionnaire (PPPQ-22; Serpell et al., 2009) is divided into three subscales; perfectionism, persistence and perseveration. Participants are asked to consider the past few weeks as they rate each statement on a 5-point scale of how much they endorse it (1= *not at all true of me* and 5= *totally true of me*), for example, 'When shopping in the supermarket, I walk down the aisles one-by-one until I have covered the whole store, even if I only need a couple of items'. The PPPQ-22 has adequate test-retest reliability and internal consistency in a nonclinical sample (Serpell et al., 2009).

Self-report eating disorder symptoms. The Eating Disorder Examination-Questionnaire-6 (EDE-Q6; Fairburn, & Beglin, 2008) is a 28-item self-report questionnaire based on ED symptoms. Participants are asked to rate on a 5-point scale on how many days these symptoms have been present in the last month (0= *no days* and 6= *everyday*). The EDE-Q6 yields four subscale scores (dietary restraint, shape concern, weight concern, and eating concern) and a global score. The EDE-Q6 has acceptable validity and test-retest reliability in a community sample (Passi, Bryson, & Lock, 2003). Participants were asked to discount the fasting period when answering this questionnaire, for example, when answering questions such as, 'have you gone for a period of eight or more hours without eating anything?'

Experimental tasks

The Brixton task. The Brixton Spatial Anticipation Test (Burgess & Shallice, 1997) is part of a neuropsychological test battery assessing executive functioning. It has previously been used with patients with AN as a measure of set-shifting (Holliday et al., 2005; Lounes, Khan, & Tchanturia, 2011). A computerised version of the Brixton task was used in this study.

On all trials the set-up on screen was identical; there was always a white background with ten circles. On each trial one circle was coloured blue, however, the position of the blue circle changed. Participants were asked to determine the pattern of the blue circle and anticipate where it would be on the next screen. Participants were advised that intermittently the rules governing the pattern of the blue circle changed without warning and it was necessary to determine the new pattern.

Participants were given verbal instructions for this task (Appendix F). The number of errors was taken as a measure of set-shifting; fewer errors being associated with better set-shifting ability.

Rule-change task. Participants were asked to make a judgement about the number of photographs presented on a computer screen. Between one and six identical photographs of everyday items, such as a telephone or a pen, were presented on screen. Participants were informed that odd numbers were 1, 3, and 5, even numbers were 2, 4, and 6, low numbers were 1, 2, and 3 and high numbers were 4, 5, and 6. At the bottom of each screen was one of four questions: Odd? Even? High? Low? Participants were asked to respond to each question by pressing the computer keys corresponding to Yes or No. Consecutive trials when the question

remained the same are referred to as “stay trials”; trials in which the question changed are referred to as “shift trials”. On each trial the probability of a change of task was one in three. Full details of this task and the procedure involved are outlined by Bolton et al. (in preparation).

In the current study, participants were given written instructions (Appendix G) and verbal clarification of these. Bolton and colleagues (in preparation) used both food and nonfood photographs in their study, and reported no differences between food and nonfood trials, therefore only neutral photographs were included in the current study. Bolton et al. reported an effect of fasting on set-shifting even on a single block of 100 trials, therefore, in this study no practice trial and only one block of 100 trials was administered.

Shift costs were measured by the mean difference in RTs and accuracy between shift and stay trials: a higher shift cost indicated greater difficulty in changing response from one type of question to another.

Gamble task. This novel task involved a representation of two decks of cards on a computer screen with the total money lost or won displayed in the centre of the screen (£0 at the start of the task). On each trial, participants chose from one of two decks of cards, and were informed whether they had won or lost money. Participants were instructed that at any one time one of the decks yielded more wins than losses and the other deck ensured that they lost money most of the time. They were advised that on several occasions during the task the position of the winning deck changed (i.e., the winning deck became the losing deck and vice versa), so that participants had to adjust their choices as the decks changed. Even the winning deck resulted in

losses some of the time, but participants were asked to determine which deck allowed them to win the most money overall.

Participants were presented with written instructions for the task (Appendix H), and verbal clarification if needed. More switches from the winning deck were hypothesised to indicate lower levels of persistence.

Local-global processing task. In this study a computerised local-global switching task was used to measure central coherence. This was based on a task described by White, O'Reilly and Frith (2009) used to measure central coherence in adults and children with ASD. The stimuli were five letters (E, H, P, S and U) presented either as a single large 'global' letter or as several smaller 'local' letters. Each trial consisted of two consecutive letters presented on screen, after which participants were asked to identify which letters had appeared by pressing the corresponding keyboard letter.

Participants completed four blocks of trials in the following order; two global letters in each trial (GG), two local letters in each trial (LL), a global then a local letter (GL), and a local then a global letter (LG). Each block consisted of 5 slow practice trials followed by 25 trials. After each trial participants received feedback on the correct answer. For more details on the procedure involved see White et al. (2009).

All task instructions appeared on the computer screen. The proportion of correct trials for both the first and the second letter in each block of trials was calculated. Less correct responses on trials requiring a switch from local to global

letters than on trials requiring a switch from global to local letters is indicative of a weakness in global processing, or weak central coherence.

Group embedded figures task. The GEFT (Witkin et al., 1971) is a pencil-and-paper task used here as a measure of central coherence. The GEFT measures the time taken to find one of eight simple shapes in 18 complex figures. In this study, the reliance on memory was eliminated as a picture of the simple shapes was displayed beside the complex design. A similar methodology was used by Lopez et al. (2008b) to examine central coherence in participants with AN. A score between 0 and 60 is allocated for each trial, and any 'false claims', where the participant erroneously thinks they have found the shape, are noted. In order to locate the simple shapes quickly, participants have to try and ignore the global complex design and focus only on the local simple shape. Participants who locate the shapes quickly and make fewer mistakes are thought to have strong local processing. The GEFT has acceptable levels of reliability in adult samples (Witkin, et al., 1971).

Procedure

The study used a within-subjects repeated measures design to compare individuals' scores on tests of persistence, set-shifting, and central coherence at two time points; when participants had fasted for 18 hours, and when they were satiated. The order of the fasting and nonfasting trials was randomised. In most cases, there was a one-to-two week break between sessions, although in certain cases a longer break was unavoidable ($M_{time\ between\ sessions}$ = 10.82 days, *SD* = 3.98, range 5-21).

All participants gave written consent to participate (Appendix I). Participants were advised to eat an early evening meal and fast overnight; most participants were

tested around lunchtime. They were encouraged to be open with the researcher about whether they had fasted as instructed. Bolton and colleagues (in preparation) report that ketone levels are not a reliable measure of fasting. However, although no urine samples were actually taken, in order to encourage adherence to fasting, participants were informed that a subsample would be randomly selected to give a urine sample to check ketone levels.

Participants were tested individually at UCL. Each participant attended two sessions, which were differed only slightly from one another. At *every* session participants were asked to complete self-report measures of anxiety and depression and the PPPQ-22, followed by five experimental tasks in the following order; GEFT, gambling task; rule-change task; Brixton task; local-global processing task. The administration of all tasks was identical at each session. At the *satiated* session, participants completed the EDE-Q6 and their height and weight was measured. Each testing session lasted about an hour. At the end of the second session, participants were paid, debriefed and thanked for their participation.

Results

Participant Characteristics

The mean age of participants was 23.22 years (*SD* = 3.81, range 18-29) and the mean BMI was 22.29 kg/ m^2 (*SD* = 3.45, range 16.4-32.2). Two participants had a BMI < 17.5 kg/m^2, below the clinical cut-off for AN (American Psychiatric Association, 1994). Age and BMI did not correlate significantly with one another, $r(58) = .13$, $p = .33$. All participants in the sample were educated to university level. No information on ethnic background was gathered. Participants were instructed to fast for 18 hours, and all reported that they had done so.

Self-Report Measures

Mood diary. Fifty-eight participants (97%) returned the self-report diary measures at the fasting session. Paired sample t-tests compared mood, feelings of hunger, and food preoccupation at time 1 (T1, before fasting began) and time 5 (T5, arrival at the session). Participants were significantly more irritated (M_{T1}= 1.84, M_{T5}= 2.93, $t(57) = -5.42$, $p < .001$), more hungry (M_{T1} = 1.9, M_{T5}= 4.72, $t(57) = -10.81$, $p < .001$), more preoccupied with food (M_{T1} = 2.5, M_{T5} = 4.53, $t(57) = -6.50$, $p < .001$) and more likely to report low mood (M_{T1} = 2.19, M_{T5} = 3, $t(57) = -4.42$, $p < .001$) after fasting than before fasting began.

Self-report depression and anxiety. One participant was mildly depressed and one was moderately depressed at both the fasting and satiated session. The mean HADS depression score was 2.93 (*SD* = 2.21, range 0-11) at the fasting session and 2.73 (*SD* = 2.31, range 0-12) at the satiated session. Depression scores at both sessions were significantly correlated with one another, $r(58) = .63$, $p < .001$. Mean depression scores were within one standard deviation of published healthy population norms (*M* = 3.68, Crawford, Henry, Crombie, & Taylor, 2001). Depression scores were not correlated with either age or BMI, $p > .08$.

Thirteen participants were mildly anxious and seven were moderately anxious at the fasting session. Sixteen participants were mildly anxious and four were moderately anxious at the satiated session. The mean HADS anxiety score was 6.65 (*SD* = 3.18, range 0-15) at the fasting session and 6.15 (*SD* = 3.23, range 0-15) at the satiated session. Anxiety scores at both sessions were significantly correlated, $r(58) = .68$, $p < .001$. Mean anxiety scores were similar to published healthy population norms (*M* = 6.14), described by Crawford et al. (2001). Anxiety scores were

moderately negatively correlated with age at the fasting session, $r(58) = -.29$, $p = .03$, and BMI at the satiated session, $r(58) = -.29$, $p = .027$.

Self-report perseveration, persistence and perfectionism. All participants completed the PPPQ-22 at the satiated session and 56 participants completed it at the fasting session. At both sessions, all three subscales on the PPPQ-22 were significantly correlated with one another, $p < .04$. Paired sample t-tests indicate no significant differences between the subscale scores at the fasting and satiated sessions, $p > .31$. Neither age nor BMI were significantly correlated with any of the subscales at either session.

Table 1 compares mean scores for each of the PPPQ-22 scales at the satiated session with results from previous studies with healthy participants (Bolton et al., in preparation; Waller et al., under consideration). Persistence scores are similar across these studies; perfectionism and perseveration scores are marginally higher in the current study but remain within one standard deviation of results from the other studies.

Table 1

Mean PPPQ-22 scores in current sample compared with mean scores from Waller et al. (under consideration) and Bolton et al. (in preparation)

Measure	Current sample	Bolton et al. (in preparation)	Waller et al. (under consideration)
	N = 60	N = 60	N= 91
Perfectionism	3.47 (*SD* = 0.7)	3.3 *(SD = 0.67)*	3.28 (*SD* = 0.64)
Perseveration	2.71 (*SD* = 0.71)	2.44 *(SD = 0.64)*	2.36 (*SD* = 0.60)
Persistence	3.52 (*SD* = 0.68)	3.38 *(SD = 0.59)*	3.42 (*SD* = 0.57)

Self-report ED symptoms. All subscales of the EDE-Q6 were correlated with one another, $r(58) > .65$, $p < .001$. Table 2 shows a comparison of mean subscale scores from this study with mean scores from two healthy female community samples (Bolton et al., in preparation; Mond, Hay, Rogers & Owen, 2005). Although participants in the current study had slightly higher eating concern scores, all subscale and global scores are within one standard deviation of scores from both Bolton et al. (in preparation) and Mond et al. (2005).

BMI was not correlated with any EDE-Q6 subscale. Age was moderately negatively correlated with shape concern, $r(58) = -.31$, $p = .016$, eating concern, $r(58) = -.30$, $p = .019$, and EDE-Q global score, $r(58) = -.30$, $p = .022$.

Correlations between HADS and PPPQ-22. PPPQ-22 perseveration scores were significantly correlated with HADS anxiety scores at the fasting, $r(58) = .38$, $p = .003$, and satiated sessions, $r(58) = .32$, $p = .01$. Perseveration scores were also significantly correlated with HADS depression scores at the fasting session, $r(58) = .26$, $p = .04$. Neither perfectionism nor persistence was significantly related to HADS anxiety or depression scores.

Correlations between HADS and EDE-Q6. There were several significant correlations between HADS scores and EDE-Q6 subscale scores (see Table 3). The restraint subscale was the only subscale not related to either HADS subscale.

Correlations between EDE-Q and PPPQ-22. There were no significant correlations between PPPQ-22 subscale scores and EDE-Q6 subscale scores, $r(58) < .17$.

Table 2

Mean (standard deviation) EDE-Q6 scores in current sample and healthy population norms

Measure	Current sample	Nonclinical Group (Bolton et al., in preparation)	Nonclinical group (Mond et al., 2005)
	N = 60	N= 60	N = 5,255
Restraint	1.34 (*SD* = 1.28)	1.22 *(SD = 1.18)*	1.3 (*SD* = 1.4)
Eating concern	1.06 (*SD* = 1.10)	0.85 *(SD = 1.06)*	.76 (*SD* = 1.06)
Weight concern	1.77 (*SD* = 1.55)	1.78 *(SD = 1.49)*	1.79 (*SD* = 1.51)
Shape concern	2.13 (*SD* = 1.50)	1.99 *(SD = 1.47)*	2.23 (*SD* = 1.65)
Global score	1.57 (*SD* = 1.22)	1.46(*SD* = 1.17)	1.52 (*SD* = 1.25)

Table 3

Correlations between EDE-Q6 and HADS scores in the current study

	HADS anxiety		HADS depression	
N =60	Fasting	Satiated	Fasting	Satiated
EDE restraint	*r* = .20	*r* = .07	*r* = .09	*r* = .23
EDE eating concern	*r* = .41**	*r* = .15	*r* = .26*	*r* = .29*
EDE shape concern	*r* = .37**	*r* = .28*	*r* = .15	*r* = .31*
EDE weight concern	*r* = .29*	*r* = .21	*r* = .09	*r* = .32*
EDE global	*r* = .35**	*r* = .20	*r* = .16	*r* = .32*

**correlation is significant at the p < .05 level (2-tailed)*

***correlation is significant at the p < .01 level (2-tailed)*

Experimental Tasks

Scores on the local-global processing task and the GEFT were not normally distributed; Kolmogorov Smirnoff $p < 0.05$. It has been argued that ANOVA is relatively unaffected by violations of normality (Harwell, Rubinstein, Hayes, & Olds, 1992). A recent Monte Carlo simulation study reported that non normally-distributed data did not bias ANOVA results in simulated data (Schmider, Ziegler, Danay, Beyer, & Bühner, 2010). As nonparametric alternatives to ANOVA are associated with a reduction in precision and loss of statistical power, it was decided, in common with other recently published research (e.g. Fisher, 2011), to use ANOVA even in cases where the criterion of normally-distributed data was not met.

For each task participants with scores greater than three standard deviations from the group mean on any measure were excluded as these scores indicate extreme outliers. Thus, the number of participants included in the analysis for each experimental task varied.

Practice effects. The order of fasting and satiated sessions was entered into each analysis of variance as a between-subjects factor in order to explore the effect of practice on test performance. There was a significant main effect of practice in each of the experimental tasks, except on the gamble task. On all other tasks, participants performed faster or with fewer errors at their second session, regardless of fasting condition. As the order of fasting sessions was counterbalanced to control for these effects, they are not discussed in more detail here.

The Brixton task. The number of errors each participant made was taken as a measure of set-shifting. Data for 58 participants was analysed. Participants made an average of 9.60 errors (*SD* = 3.94) in the fasting session and 10.41 errors (*SD* = 3.68)

in the satiated condition. A repeated measures ANOVA explored the effect of fasting on performance. Participants made slightly fewer errors when they had been fasting than in the satiated condition, although this trend was not statistically significant, $F(1, 56) = 3.65$, $p = .061$.

Rule-change task. Participants' RT was used as a measure of task performance for the rule-change task. Only correct trials with RT between 150 – 3000 ms were included in the analysis in order to eliminate trials on which participants were inattentive or responded prematurely. Data for 58 participants was analysed.

As the focus of the analysis was on the cost of shifting response rather than the content of the questions, the data was collapsed to yield four average scores for each individual; fasting shift average RT ($M = 1451.7$, $SD = 281$, range 701-2355ms), fasting stay average RT ($M = 1182.16$, $SD = 206$, range 648- 1788ms), satiated shift average RT ($M = 1487.55$, $SD = 299$, range 888- 1974 ms), satiated stay average RT ($M = 1257.8$, $SD = 270$, range 710 – 1867 ms).

A 2 x 2 (condition [fasting, satiated] x trial-type [stay, shift]) repeated measures ANOVA explored the effects of fasting on RTs. Participants overall responded faster when fasting than when satiated, $F(1, 56) = 6.23$, $p = .016$. There was also a main effect of trial-type, $F(1, 56) = 284.8$, $p < .001$, indicating that participants had longer RTs on shift trials than on stay trials. There was a marginally significant Fasting x Trial-type interaction, $F(1, 56) = 3.96$, $p = .052$, indicating that there was a larger difference in RTs between stay and shift trials in the fasting than in the satiated condition.

Participants' accuracy was also taken as a measure of task performance. Data for 57 participants was analysed for accuracy on the rule-change task. Once again the data was collapsed to yield four average scores for each individual; fasting shift average accuracy (M = 91.66, SD = 6.58, range 73-100), fasting stay average accuracy (M = 95.16, SD = 4.1, range 81-100), satiated shift average accuracy (M = 90.71, SD = 7.56, range 65-100), satiated stay average accuracy (M = 95.58, SD = 3.56, range 85-100).

A repeated measures ANOVA explored the effects of fasting on accuracy levels; there was no main effect of fasting, $F(1, 55) = 0.12$, $p = .74$, and no interaction between fasting and trial-type, $F(1, 55) = 1.05$, $p = .31$. There was a significant main effect of trial-type, $F(1,55) = 38.569$, $p > .001$; participants were significantly less accurate in responding to shift trials than stay trials.

Additional analyses. Additional correlational analyses explored the relationship between RT on the rule-change task and other variables of interest. A new variable, Fasting x Shifting interaction, representing the difference between shift costs in the fasting versus satiated condition was calculated using the formula:

(fasting shift average RT – fasting stay average RT) – (satiated shift average RT – satiated stay average RT)

There were no significant correlations between this variable and anxiety, depression, perseveration, ED symptoms, age, or BMI.

Local-global processing task. The proportion of correct responses for each type of trial was used as a measure of performance in this task. Only trials with a correct response to the first letter were included in the analysis of accuracy for the

second letter, as in White et al. (2009). In this task, data for 58 participants was analysed.

For each trial-type participants were presented with two letters, for example, in the global-global condition, letter 1 was a global letter and letter 2 was a global letter, whereas in the global-local condition, letter 1 was a global letter and letter 2 was a local letter. The mean scores for letter 1 and letter 2 in each trial type are presented in Table 4.

A 2 x 4 x 2 (Condition [fasting, satiated] x Trial-type [global-global, local-local, global-local, local-global] x Letter order [letter 1, letter 2]) analysis of variance examined the effect of fasting, trial-type and letter order on performance. Fasting did not have an overall effect on the proportion of correct responses, $F(1, 56) = 0.07$, $p = .79$. There was a significant main effect of trial-type; participants performed better on some trial-types than on others, $F(3, 54) = 107.01$, $p < .001$. Inspection of group means suggest that participants did better on trials when there was no switching between processing levels (i.e., global-global or local-local). There was a significant Condition x Trial-type x Letter order interaction, $F(3, 54) = 3.848$, $p = .014$, indicating that fasting affected performance in a way that differed across trial-type and letter order. Figure 1 shows the mean proportion of correct responses in the different trial-types. In blocks of trials where participants are asked to switch between processing levels (GL and LG conditions), those who are fasting are better than those who are satiated on trials requiring responses to local stimuli (GL2 and LG1). The reverse pattern is seen on trials requiring responses to global stimuli (GL1 and LG2). However, this pattern is not seen in blocks of trials where participants do not need to switch between local and global stimuli (GG and LL conditions).

Table 4

Mean (standard deviation) proportion of correct responses for each trial-type on the local-global processing task

N = 58	Fasting	Satiated	Level of processing
Global-Global letter 1	.79 (*SD* = .17)	.77 (*SD* = .16)	Global
Global-Global letter 2	.81 (*SD* = .16)	.82 (*SD* = .14)	Global
Local-Local letter 1	.76 (*SD* = .16)	.79 (*SD* = .14)	Local
Local-Local letter 2	.73 (*SD* = .16)	.74 (*SD* = .15)	Local
Global-Local letter 1	.76(*SD* = .17)	.78 (*SD* = .14)	Global
Global-Local letter 2	.50 (*SD* = .19)	.47 (*SD* = .19)	Local
Local-Global letter 1	.68 (*SD* = .19)	.65 (*SD* = .20)	Local
Local-Global letter 2	.56 (*SD* = .25)	.59 (*SD* = .24)	Global

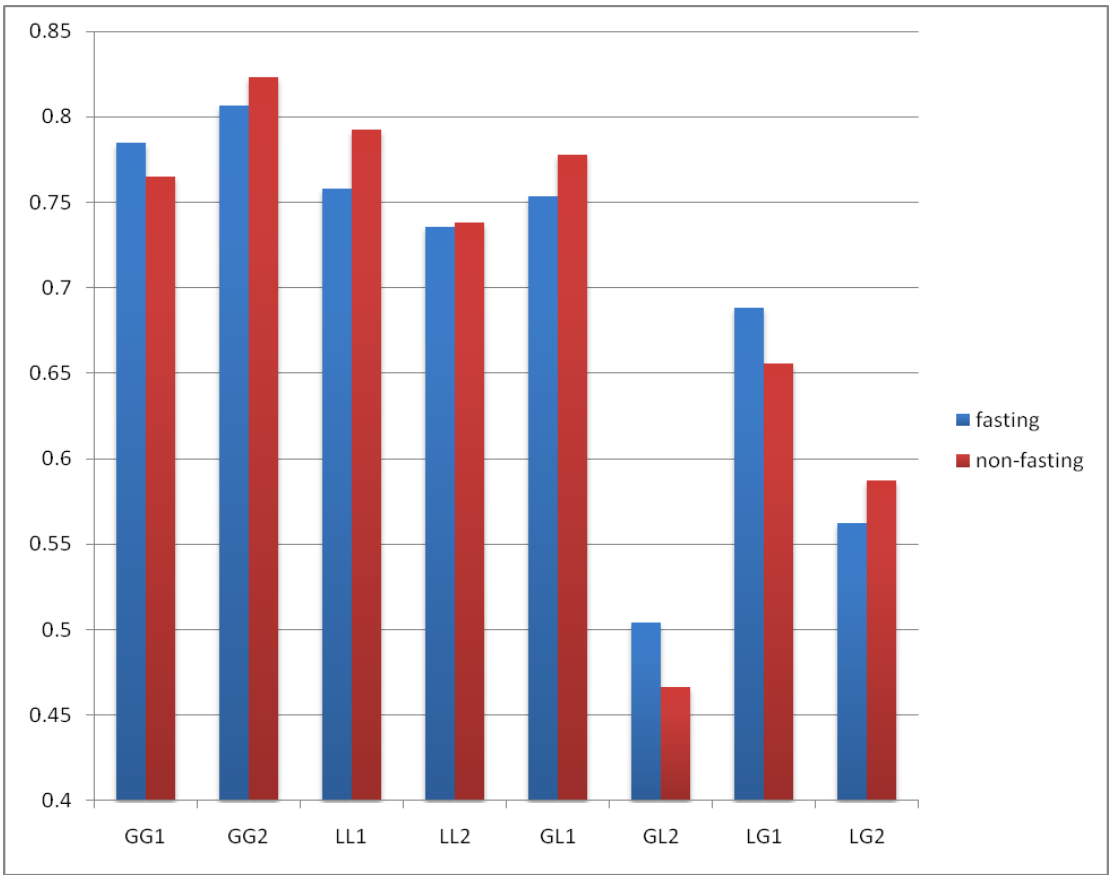

Figure 1. Mean proportion of correct responses across different trial-types on the local-global processing task.

This interaction was explored further using two separate analyses of variance to examine responses to Letter 1 and Letter 2 in each trial-type. The Letter 1 analysis examined the effect of fasting on response accuracy for the first letter in global-local and local-global trials with a 2 x 2 (Condition [fasting, satiated] x Trial-type [global-local, local-global]) ANOVA. The Letter 2 analysis examined the effect of fasting on response accuracy for the second letter in global-local and local-global trials using a 2 x 2 (Condition[fasting, satiated] x Trial-type [global-local, local-global]) ANOVA. For Letter 1 there was a significant Fasting x Trial-type interaction $F(1, 56) = 6.92$, $p = .011$; this interaction was approaching significance for Letter 2 $F(1, 56) = 3.60$, $p = .063$. Taken together, these results suggest that fasting is associated with a bias towards local processing and impaired global processing when the task involves switching between local and global perspectives.

Additional analyses. Additional analyses examined the relationship between performance on this task and other variables hypothesised to impact on local-global processing. A new variable called Processing Switch, representing the Condition x Trial-type x Letter order interaction was calculated using the formula: satiated (GL1 – LG1 – GL2 + LG2) – fasting (GL1 – LG1 – GL2 + LG2). There were no significant correlations between Processing Switch and any variables of interest, including perseveration, EDE-Q6 scores, age, or BMI.

Gamble task. Performance on this task was assessed by measuring the proportion of times participants switched or stayed with a deck. By definition, the total number of times participants switched decks was perfectly negatively correlated with the total number of times participants stayed with a deck ($r = -1$, $p < 0.001$);

therefore only data on staying with a deck and the number of times the winning deck was chosen were included in this analysis. Data for 55 participants were analysed.

Participants chose the winning deck an average of 63.75 of 100 trials (*SD* = 7.84, range = 42-77) in the fasting condition, and 62.58 times (*SD* = 8.32, range = 44-82) in the satiated condition. A paired samples t-test indicated that this was not a significant difference, $t(54) = 0.78$, $p = .44$.

A 2 x 2 (Condition [fasting, satiated] x Deck [stay with winning deck, stay with losing deck]) analysis of variance examined the effect of fasting on deck preferences. Across both fasting and satiated trials, participants were significantly more likely to stay with the winning deck than they were to stay with the losing deck, $F(1,53) = 235.67$, $p < .001$. Participants were marginally less likely to stay with a deck (either the winning or losing deck) when fasting compared with when satiated, $F(1, 53) = 2.84$, $p = .098$.

GEFT. The median time taken to complete this task and the number of false claims to have correctly found the figure were taken as measures of task performance. Data for 56 participants were analysed. The average time taken to complete a figure was 11.97s (*SD* = 5.95, range 3- 28s) in the fasting condition, and 13.7s (*SD* = 6.30, range 3- 27s) in the satiated condition. The mean number of false claims was 1.86 (*SD* = 1.38, range 0- 5) in the fasting condition and 2.63 (*SD* = 2.01, range 0- 8) in the satiated condition.

Two separate general linear models were used to analyse the effects of fasting on completion times and the number of false claims. There was no main effect of fasting on completion times, $F(1,54) = 2.98$, $p = .090$, although there was a

nonsignificant trend for those in the fasting condition to have slightly faster completion times than those in satiated condition. Participants made significantly fewer false claims when fasting than when satiated, $F(1,54) = 5.42$, $p = .024$.

Additional analyses. As the local-global processing task and the GEFT are both hypothesised to measure central coherence, additional analyses explored their relationship to one another in this study. There were no significant correlations between the Processing Switch variable from the local-global processing task and GEFT median completion times in either the fasting or satiated conditions.

Intercorrelations between tasks. A variable to represent the effect of fasting on switching decks in the gamble task was calculated using the formula: (fasting stay with winning deck) - (satiated stay with losing deck). A variable to represent the effect of fasting on the number of errors in the Brixton task was calculated using the formula: (fasting number of errors) – (satiated number of errors).

Correlational analyses explored the relationships between these two new variables, the variables representing switching on the local-global processing task (Processing Switch) and the rule-change task (Fasting x Shifting interaction), and the difference in GEFT completion times between fasting and satiated conditions. There were no significant correlations between any of these variables, $r(47) < .185$.

Discussion

Summary of Main Findings

This study aimed to explore the effect of short-term fasting on tasks measuring set-shifting, persistence, and central coherence. Consistent with the findings of Bolton and colleagues (in preparation), on the rule-change task there was

a greater cost of switching rules in the fasting compared with the satiated condition. Short-term fasting was also associated with improved local processing and impaired global processing, indicative of weaker central coherence, on a local-global processing task. Results from the persistence task are more difficult to interpret.

Review of Specific Hypotheses

i. In the rule-change task, participants will have slower mean RTs on shift trials, compared to stay trials.

As expected RTs were significantly slower on shift compared with stay trials.

ii. In the rule-change task, fasting will increase RTs for both stay and shift trials. In particular on trials requiring a shift, fasting will lead to longer RTs, i.e. fasting will exacerbate shift costs.

This hypothesis was partly supported. There was a significant Fasting x Trial-type interaction, suggesting there was a larger cost of shifting rules in the fasting than in the satiated condition. However, fasting was associated with faster RTs for both stay and shift trials, which was the opposite effect to that predicted.

iii. In the Brixton task, fasting will impair set-shifting and participants will make more errors when they are fasting.

This hypothesis was not supported. In fact, there was a nonsignificant trend for fewer errors when fasting than when satiated.

iv. In the local-global processing task, participants will identify fewer letters when asked to switch from a global to a local letter or vice versa than when there is no switch required.

Consistent with predictions, when participants were required to switch processing levels they identified fewer correct letters than when there was no switch in processing level.

v. On the local-global processing task fasting will be associated with improved performance when processing local letters and impaired performance when processing global letters.

This hypothesis was partly supported. Fasting did not affect performance on trials where no switching was required, i.e. global-global or local-local trials. However, on switching trials, participants who were fasting had superior local processing and impaired global processing compared to when satiated.

vi. In the gamble task, fasting will be associated with less persistence, i.e., participants will stay with the winning deck less in the fasting condition.

This hypothesis was not supported. Participants were somewhat less likely to stay with both winning and losing decks when fasting than when satiated, although this was a nonsignificant trend.

vii. In the GEFT, fasting will be associated with faster median completion times, and fewer false claims to have found the figure, suggesting a local processing bias.

This hypothesis was partly supported. There was a nonsignificant trend for those fasting to have shorter completion times than when satiated. Participants made significantly fewer false claims when fasting than when satiated.

viii. As all experimental tasks have been used or designed to assess different aspects of cognitive performance associated with AN, performance on these tasks will be intercorrelated. In particular, as both the local-global processing task and the GEFT have previously been used as measures of central coherence there will be a strong relationship between performance on these tasks.

This hypothesis was not supported. There were no significant correlations between experimental tasks. South, Ozonoff and McMahon (2007) similarly reported no correlations between measures of central coherence and behavioural rigidity in their study comparing typically developing children and children with autism.

ix. In line with previous research (Bolton et al., in preparation), PPPQ-22 perseveration will be correlated with EDE-Q6 scores and with experimental tasks measuring set-shifting, i.e., the rule-change task and the Brixton task.

Contrary to the findings of Bolton et al. and Waller et al. (under consideration), there were no correlations between PPPQ-perseveration and EDE-Q6 scores in this study. Self-reported perseveration was not correlated with any of the variables representing the effect of fasting on set-shifting performance.

x. Short-term fasting will increase rates of self-reported perseveration and decrease self-reported persistence on the PPPQ-22.

Although fasting seemed to impair set-shifting performance, there was no effect of fasting on self-reported persistence or perseveration.

Central Coherence

ED research suggests that weak central coherence may be associated with AN (Lopez et al., 2008b; Treasure, 2007). However, as starvation is inevitably correlated with the presence of AN, it has been hard to disentangle whether such a bias is due to the AN itself or the effect of starvation. Findings from the current study suggest that short-term starvation is associated with impairments in central coherence. These findings suggest that even if individuals do not show impairments in information processing premorbidly that short-term starvation could create such impairments. Regardless of whether these processing biases are caused or merely exacerbated by the effects of starvation, as they are likely to lead to cognitive inflexibility, weak central coherence may also be an important maintaining factor in AN.

Lopez et al. (2008b) report that those recovered from AN and at a healthy weight had an intermediate central coherence profile- between those with current AN and healthy controls. The current study suggests that at least part of the differences seen between current and recovered AN could be accounted for by the effects of food deprivation on cognitive functioning. It is also possible that long-term undernourishment could have lasting effects on cognitive processing which may leave those recovered from AN with persistent symptoms of weak central coherence.

Set-Shifting and Perseveration

Bolton et al. (in preparation) used a variant of the rule-change task used in this study. The current study did not replicate their finding of overall performance being slowed by fasting. However, their finding that fasting had a bigger effect on shift than on stay trials was replicated in the current study. From the current study, it would appear that while fasting does not impair overall task performance, it does

impair individuals' ability to shift their mental set. This suggests that the effect of fasting on shift costs is not secondary to an overall impairment in task performance.

Slight differences in the tasks used may account for the different findings. In the current study, the task was made up of one block of 100 trials rather than four blocks of 100 trials used by Bolton et al. (in preparation). Whereas the current study included only neutral stimuli, Bolton et al. used pictures of food and nonfood items. It is possible that although no direct effect of the food pictures on performance was reported by Bolton et al., that food pictures distracted fasting participants (e.g., by reminding them of their hunger), leading to slower RTs. However, importantly, both studies are consistent in reporting a specific effect of fasting on shift cost.

Research in AN suggests that set-shifting difficulties may represent an endophenotype of AN (Holliday et al., 2005; Roberts et al., 2007; Treasure, 2007). However, findings from the current study and from Bolton and colleagues (in preparation) suggest that at least some of the difficulties in set-shifting reported in AN could be accounted for by the effects of fasting on cognitive performance. It remains unclear whether set-shifting difficulties in response to fasting reported in this study are pre-existing vulnerabilities triggered by fasting, or direct side-effects of fasting.

Persistence

Fasting participants switched decks more often than when they were satiated on the gamble task, perhaps suggesting they were less willing to be persistent when hungry. This trend is interesting, given that Serpell et al. (2009) suggest that low levels of self-reported persistence may be associated with poorer mental health. In

another study (Waller et al., under consideration) PPPQ-persistence was lower in an ED group than in a nonclinical comparison group. However, in the current study, there was no relationship between PPPQ-22 and EDE-Q subscales. There was also no effect of fasting on PPPQ-22 scores.

Intercorrelations between Questionnaires

Self-reported ED symptomatology was associated with anxiety and depression scores in this study. This finding is line with previous studies (Bolton et al. in preparation; Lipsey, Barton, Hulley, & Hill, 2006). Indeed clinically, co-morbid anxiety and depression are common in those with anorexia and other EDs (Bulik, 2002; Kaye, Bulik, Thornton, Barbarich, & Masters, 2004).

Serpell et al. (2009) showed that PPPQ-22 perseveration was associated with several subscales from the Brief Symptom Inventory, and was a good predictor of psychopathology. In this study, although PPPQ-22 perseveration was correlated with anxiety and depression scores it was not correlated with EDE-Q6 scores. Interestingly, although mean perseveration and EDE-Q6 scores were similar to those in Bolton et al. (in preparation), the correlations between perseveration and EDE-Q scores reported in their study were not replicated in this study. It would seem that perseveration is related to some aspects of mood, but its relationship to eating pathology specifically remains unclear.

In addition, neither perseveration nor EDE-Q Global scores were associated with performance on any of the experimental tasks. This suggests that any effects of fasting reported in this study exist independently of eating disorder symptomatology and self-reported perseveration.

Alternative Explanation of the Findings

In the local-global processing task, it is possible the findings are not related to the direct effect of starvation on information processing but could be explained by the fact that those in the fasting condition were preoccupied with their hunger. This in turn could have influenced their performance on tasks requiring more attention. However, the differential pattern between local and global processing on this task would be difficult to account for using this explanation. In addition, a hypothesis that hunger distracts participants and impairs performance also does not account for the significantly faster RTs on the rule-change task or the nonsignificant trend to complete the GEFT more quickly when fasting.

Another explanation of the findings might be that the experimental tasks may be assessing a variety of executive functions, not central coherence or set-shifting alone. For example, it is possible that the local-global processing task also involved aspects of attention, perception, and perhaps working memory, any of which could be affected by hunger, and in turn could account for the findings. Nonetheless, the local-global task does attempt to control for attention by excluding trials where participants do not answer the first letter correctly. It also attempts to minimise the load on working memory by using only two letters at a time, and choosing from only five letters. More research is needed in the future comparing these tasks with other measures of executive function, to tease out exactly what each task is measuring.

Limitations of the Current Study

Limitations of the design. This study relied on participant goodwill and honesty to abstain from food for 18 hours before the study. As urinalysis is an

insufficiently sensitive measure of short-term fasting (Bolton et al., in preparation), there was no way to verify whether participants had fasted as instructed. It is possible that some participants did not follow the fasting guidelines outlined, and this is likely to impact on the data. Nonetheless, significant differences between the fasting and satiated sessions suggest that enough participants did fast as instructed to demonstrate an effect. Indeed, it may be that if a subsample were not compliant then the effects of fasting on performance are underestimated in the current study.

In AN research it can be difficult to disentangle the effect of enduring endophenotypes from the effects of temporary states, such as hunger. Although the current study sought to explore the effects of hunger on cognitive performance in a nonclinical sample, it is important to consider that short-term fasting cannot replicate the effects of chronic undernourishment and hunger in AN. Chronic starvation leads to neurochemical, metabolic and structural brain changes in patients with AN (Kingston, Szmukler, Andrewes, Tress & Desmond, 1996; Nico et al., 2010; Sidiropoulos, 2007), which often remain after recovery (Klump, Bulik, Kaye, Treasure & Tyson, 2009). Fasting for eighteen hours does not lead to such changes. Furthermore, patients with AN often severely restrict their food intake rather than completely abstaining from food. Future research comparing AN patients with healthy controls who had been fasting for at least 18 hours may help us to understand further whether the changes in performance seen in this study are comparable in any way with the cognitive profile of AN patients.

Limitations of the sample. The current sample ranged in age from 18 to 30, in order to best represent the population affected by AN. No information on the ethnicity of participants was gathered in this study, although, all participants were

studying at UCL, where approximately 30% of students are from overseas (UCL, 2011). These factors limit the generalisability of these findings to well-educated, female populations.

As all participants volunteered to take part in this study, there may have been some selection bias, whereby those with experience of EDs were more likely to volunteer. Alternatively it could be that those with more impulsive bulimic-type eating symptoms excluded themselves as they would not feel able to fast. Although those with a lifetime history of ED were asked not to participate, the researcher had no way of screening for this. If participants had a history of ED or a relative with ED, this could be associated with weaker central coherence and impaired set-shifting compared with the general population (Holliday et al., 2005), which could partially account for the current findings (although not for differences between fasting and satiated sessions). However, EDE-Q6 subscale and global scores were comparable with a community sample (Mond et al., 2005), suggesting a fairly representative group. In addition, as all participants were paid for their participation (albeit a nominal amount) it is possible that they were as motivated by the financial reward as they were by any interest in EDs.

Limitations of statistical methods. As this study was exploratory in nature, multiple comparisons were necessary in order to explore any possible interrelations between tasks or between tasks and self-report data. Multiple correlations increase the likelihood of finding a statistically significant result by chance (Type I error). Future research may wish to replicate the current findings, using larger sample sizes to allow the use of more rigorous statistical analyses.

Clinical and Theoretical Implications of the Findings

Given the impact of even short-term fasting on central coherence and set-shifting, it is important to consider the way in which the effects of starvation might be incorporated into a model of AN, to explain aetiology and maintenance. These findings suggest that food restriction interacts with local and global information processing in some way, either by exacerbating an inherent tendency towards weak central coherence, or by eliciting weak central coherence in those that under normal circumstances do not display impaired global and enhanced local processing.

It is possible that some people have weak central coherence and impairments in perseveration and thus are at risk for AN; for these individuals once AN takes hold, starvation may exacerbate these tendencies. For others who do not have these impairments in information processing pre-morbidly, starvation might trigger these tendencies, and thus may play a role in maintaining an inflexible approach, which in turn maintains AN. Findings from the current study may be relevant to understanding why AN is occasionally precipitated by unintentional weight loss (Brandenburg & Anderson, 2007). If supported by further studies, these findings also suggest that initial weight restoration alone could ameliorate some of the (cognitive) symptoms of AN (cognitive rigidity). They may be relevant in understanding why very underweight patients with AN often find it difficult to fully engage in psychological therapy (Wilsdon & Wade, 2006). They may also support the view of some clinicians that treatment of very underweight patients should focus initially on weight restoration before addressing tasks requiring more integrative processing and flexible thinking, for example goal-setting, cognitions or emotions (e.g. Maudsley Family Therapy).

Cognitive remediation therapy (CRT) was developed to improve working memory, planning skills and flexibility in individuals with schizophrenia (Wykes et al., 2007). Tchanturia et al. (2008) report that ten sessions of an adapted version of CRT targeting cognitive flexibility in inpatients with chronic AN improved performance on tasks of set-shifting and central coherence. This pilot study also reported significant concurrent improvements in BMI, although as there was no control group, and patients received other interventions as part of their treatment, it is not possible to establish whether changes in BMI or cognitive performance were directly related to the intervention.

Merwin et al. (2011) conceptualise psychological inflexibility as being related to *rule-based insensitivity*, where under certain conditions some individuals fail to adjust their behaviour to match the demands of the environment due to an overreliance on verbal rules. This rule-based sensitivity is similar to recent conceptualisations of perseveration as a tendency to continue with an activity, even if this activity is no longer producing the intended results (Serpell et al., 2009). Interestingly, Merwin et al. (2011) report that psychological inflexibility (as measured by psychological acceptance) is more pronounced in patients with acute AN than in those recovered from AN, in whom it is more pronounced than healthy controls. They suggest that this inflexibility could be increased using mindfulness and acceptance techniques to help those with AN tolerate uncertainty and behave in ways guided by environmental feedback rather than verbal rules.

In a preliminary study, Merwin et al. (2011) report that psychological flexibility improved in parallel with symptom remission. Findings from the current study suggest that even short-term fasting can affect cognitive flexibility in a

nonclinical group. This suggests that any model of cognitive flexibility may also need to account for the effects of short-term fasting. The effect of fasting on psychological flexibility is not yet known, although both psychological and cognitive flexibility show similar patterns of intensity in those with current AN, in those recovered from AN, and healthy controls, suggesting a possible overlap between these concepts. Future research will usefully investigate the impact of starvation on psychological flexibility, perhaps by comparing flexibility in those with current AN with healthy controls who have been fasting. Such research could elucidate the role of food deprivation on psychological flexibility, and increase our understanding of how models of cognitive and psychological flexibility might overlap. Although findings from the current study are very tentative, there is an indication that refeeding alone *could* ameliorate some of the core symptoms of AN without the need for specialist treatments targeting flexibility. Future research should focus on the role of starvation in flexibility, before developing specific psychological interventions designed to reduce rigidity.

Future Research Directions

This study suggests some interesting avenues for further research. Future research exploring cognitive traits in AN should attempt to control for the effects of food deprivation on performance, in both nonclinical and ED populations. Research using some of the experimental tasks from the current study with a sample of those with AN and healthy controls who had been fasting could explore whether short-term starvation and chronic starvation in AN are comparable in any way. If it was considered ethical, it might also be useful to ask those recovered from AN to fast before testing their cognitive performance, in an attempt to better our understanding

of cognitive inflexibility as a trait, or as a more short-term state. A naturalistic comparison of individuals with AN in inpatient and outpatient settings on measures of set-shifting and central coherence would also be worthwhile. Those in inpatient settings are commonly eating regularly and gaining weight, whilst outpatients may not be, allowing some comparisons to be made between the effects of chronic and acute starvation in those with similar BMIs.

The current study suggests a trend towards weaker central coherence and set-shifting difficulties even after short-term fasting in a nonclinical sample. As stated earlier, it is unclear whether fasting exacerbates an existing vulnerability or whether this cognitive rigidity is a direct effect of fasting. Retrospective studies, for example, Brecelj Anderluh et al. (2003), suggest that behaviours indicative of cognitive rigidity, such as obsessive-compulsive behaviours, predate ED onset. Ultimately, longitudinal studies will be needed to tease apart the effects of states and traits on vulnerability to AN. Longitudinal studies could explore whether an endophenotype of set-shifting difficulties and weak central coherence existed before the onset of AN, or whether the persistence of these symptoms after recovery could be accounted for by structural changes to the brain as a result of chronic undernourishment.

Conclusion

Previous studies exploring the effect of AN on cognitive performance have been unable to separate the effect of starvation on performance from the illness itself. This study sought to explore the effects of short-term fasting on performance on a range of neuropsychological constructs hypothesised to be related to AN using a nonclinical sample. It also sought to replicate the finding that fasting exacerbates set-shifting difficulties in a nonclinical sample (Bolton et al., in preparation). This study

replicated the finding that fasting impairs the ability to shift mental set using a novel rule-change task. Fasting was also associated with a bias towards local processing and impaired global processing in a computerised task. Taken together, it would seem that even short-term fasting can impact cognitive performance in a nonclinical group.

Findings from the current study support the idea that fasting is associated with difficulties shifting set and weaker central coherence. We suggest that any proposal of set-shifting difficulties or weak central coherence as possible endophenotypes of AN should be treated with caution until the impact of starvation is clarified.

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Part 3: Critical Appraisal

This review aims to critically reflect on the research project described in the empirical paper, beginning with a discussion of the background to this research. The experimental tasks used in this research and some of the limitations of these will be discussed further. The use of a nonclinical sample in clinically-relevant research will also be considered.

Background to the Research

The current research is a part replication and extension of research by Bolton, Burgess, Gilbert, and Serpell (in preparation), who reported that short-term fasting impairs set-shifting on a novel rule-change task. As Bolton and colleagues had already reported on the effect of short-term fasting in a nonclinical sample, when designing this study I considered the merits of comparing set-shifting performance in those with current AN with healthy controls who had been fasting. Research comparing those with current AN with healthy controls who had been fasting on tasks measuring cognitive flexibility will add valuable information to our current understanding of possible endophenotypes for AN. Although such clinical research is still needed, Lucy Serpell and I decided that an initial replication and extension of Bolton and colleague's study would be a useful first step in this research process. Therefore, this study was designed to replicate Bolton and colleagues' findings of impaired set-shifting after short-term fasting on a rule-change task. It also sought to investigate the concept of set-shifting more broadly by including another measure of set-shifting, and to explore the effect of short-term fasting on tasks measuring central coherence and persistence.

Summary of Findings

This study replicated Bolton and colleagues' (in preparation) finding that fasting impairs set-shifting using a novel rule-change task. Fasting was also associated with a bias towards local processing and impaired global processing in a computerised task, and a bias towards local processing on the Group Embedded Figures Test (GEFT; Witkin, Oltman, Raskin & Karp, 1971). This information processing style is indicative of weaker central coherence. These results suggest that even short-term fasting can impact performance on information processing and cognitive flexibility tasks in a nonclinical group.

Using a Nonclinical Sample

One of the challenges of clinically-related research with a nonclinical sample is establishing the relevance or utility of your findings to understanding a clinical population. In this study, I tried to recruit a sample that would be representative of those most at risk for eating disorders, i.e. young females. However, all participants were university students living in London, which limits the generalisability of any findings to similarly educated groups. Future research may want to recruit a more educationally and socio-economically diverse sample. I purposefully did not exclude non-native English speakers, in order to recruit a more diverse sample, although I did exclude those who were not fluent English speakers. Perhaps including non-native speakers had an effect on task performance, particularly on the rule-change task which relied on understanding and responding to a written question. However, any language-related difficulties would not account for the specific effect of fasting on performance reported in this task. In addition, although non-native English speakers were included in this study, all participants were studying at UCL; UCL requires all

international students to undertake and pass English language examinations that demonstrate a high level of proficiency in spoken and written English.

Although recruitment excluded those with certain health conditions, and with a history of eating disorders, I did not explicitly ask about previous eating disorders in the testing session. With hindsight, as lifetime history of an eating disorder or the presence of an eating disorder in a first degree relative may both be relevant to findings in this study, perhaps I should have included some specific questions addressing this in the protocol. This information may also have been a useful way to explore any self-selection bias in this sample. However, Moss and Von Ronson (2006) report no self-selection bias in eating disorder research; those volunteering to participate in eating disorder research had similar eating pathology scores to volunteers for an unrelated research study.

Apart from recruiting a representative sample, using a nonclinical sample raised issues for me as research-practitioner. About a third of the sample reported mild to moderate anxiety at one of the sessions; a smaller proportion were mildly or moderately depressed, and at least one participant had very high levels of self-reported eating pathology. As all information gathered was anonymised, there was no way of identifying who these individuals were, in order to signpost them to mental health services. Although this is standard research practice, this approach is notably different from the more therapeutic stance I take in my clinical work. Perhaps if I had been conducting research with a clinically recruited sample, I might have been more likely to consider these issues in the planning stages of the research project. I will consider these issues more carefully, perhaps in discussions with my research supervisor, when I am next designing a research project. One possibility is that I

could have given all participants a list of student counselling services or eating disorder services when debriefing them.

Limitations of the Experimental Tasks

Measuring perseveration and set-shifting. As this study was a part-replication of Bolton et al.'s research (in preparation), the rule-change task and the PPPQ-22 (Serpell, Waller, Fearon, & Meyer, 2009) were both used as measures of set-shifting and perseveration. In order to more easily compare the findings from this study with other research on set-shifting in eating disorders, I decided to include a second measure of set-shifting. The Brixton task has previously been used in eating disorder research as a measure of set-shifting (Holliday, Tchanturia, Landau, Collier & Treasure, 2005; Roberts, Tchanturia, Stahl, Southgate, & Treasure, 2007). The Brixton task is easy to administer and could be included in a battery of computerised task. However, a meta-analysis of measures of set-shifting in eating disorder research suggest that the Brixton task may not be very sensitive to set-shifting difficulties in those with eating disorders, except when participants are very unwell (Roberts et al., 2007). Future research exploring the associations between fasting and set-shifting could perhaps include a more sensitive measure of set-shifting, for example the Haptic Illusion task (Uznadze, 1966, as cited in Roberts et al., 2007) or the CatBat task (Eliava, 1964, as cited in Roberts et al., 2007).

Measuring persistence. Serpell and colleagues (2009) were among the first to suggest that persistence may in some way be related to the constructs of perfectionism and perseveration which have already been associated with eating disorders (Shafran, 2002; Tchanturia et al., 2004; Wilsdon & Wade, 2006). Serpell et al. suggest that persistence is an adaptive trait, and can be protective against a range

of psychopathology in a nonclinical sample. Waller and colleagues (Waller et al., under consideration) report that those with eating disorders have low levels of self-reported persistence. It was therefore decided to include a task measuring persistence in the current study, in order to investigate the relationship between persistence and set-shifting or perseveration, as well as the impact that short-term fasting had on persistence.

Previous research has used a mirror tracing task and an anagram persistence task as measures of persistence (Brandon et al., 2003; Quinn, Brandon & Copeland, 1996). Although the mirror tracing task has shown some power in predicting smoking cessation outcomes, it is a measure of motor persistence, and has been criticised as it invokes frustration in participants and may more accurately tap into frustration tolerance than persistence (Brandon et al., 2003). The anagram persistence task has also been used as a measure of persistence, although Brandon and colleagues (2003) report that this may be a less robust measure of persistence. They criticised the anagram task for being language-focussed and requiring a high level of intellectual effort, which may unfairly disadvantage those not familiar with vocabulary-based tasks. In addition, this task also evokes a high level of frustration in participants as they are presented with a number of anagrams they are unable to solve (Brandon et al.; Quinn et al. 1996). Therefore, it was decided by our research team that it was necessary to design a novel task to assess persistence.

In this study, the gamble task was used as this measure. It was hypothesised that participants would be less persistent when fasting, leading them to switch from the winning deck more frequently when fasting than when satiated. This specific hypothesis was not supported in the current study; there was a nonsignificant trend

for participants to switch decks (both from the winning and the losing deck) more frequently when fasting compared to when they were satiated. This finding is somewhat difficult to interpret. As with any new task, it is unclear exactly which aspects of executive functioning are being measured and whether performance on the gamble task was associated with persistence or with some other aspect of the task, for example impulsivity or attention. Future research validating this task by comparing it with other measures of executive functioning may be able to clarify some of these questions.

In addition, the difference in the number of times participants switched decks in the fasting and satiated condition was not correlated with the persistence subscale of the PPPQ-22. Neither was performance on the set-shifting tasks correlated with PPPQ-22 perseveration scores, perhaps indicating that self-report information about these domains may not be comparable with task performance. Lounes, Khan and Tchanturia (2011) similarly report no correlation between self-reported cognitive flexibility and performance on a task measuring flexibility (the Brixton task) in both healthy controls and those with AN.

Measuring central coherence. The GEFT was used in this study as one measure of central coherence, assessing local information processing. There was a marginally significant trend for those in the fasting condition to complete the task more quickly, and participants made significantly fewer false claims to have found the figure when fasting. However, several participants reported finding this task much easier at their second session, and consistent with this, there was a significant effect of practice on this task. Although the order of fasting and satiated sessions were counterbalanced to control for practice effects, the GEFT may have been a

more robust test of local processing if the practice effects had not been so strong. The GEFT was also very time-consuming to administer in each session, particularly as some participants appeared to find it quite challenging. The GEFT is divided into two parts; each with nine items. Perhaps in future repeated-measures research, participants could complete different sections of the GEFT at each testing session in order to account for practice effects. This would also shorten research sessions.

The local-global processing task has not previously been used in eating disorder research. It was designed for use with individuals with autistic spectrum disorder (White, O'Reilly & Frith, 2009). As this task had not previously been used with a nonclinical sample, pilot testing was necessary in order to ensure that there was individual variation within the sample, and that participants were not scoring at the ceiling of this task. The relationship between central coherence in eating disorders and ASD remains unclear, although some researchers have suggested that AN should be considered part of the autistic spectrum (Gillberg et al., 2010; Odent, 2010; Oldershaw, Treasure, Hambrook, Tchanturia, & Schmidt, 2011). In the current study, information processing indicative of weaker central coherence was seen in those who had been fasting, suggesting that this task may be a useful measure of central coherence. Unlike many other currently used assessment tools, for example the Homograph Reading Test (Happé, 1997) or the Rey-Osterreith Complex Figure Test (Osterreith, 1944, as cited in Lopez, Tchanturia, Stahl, & Treasure, 2008), the local-global processing task can be administered electronically without the need for any training in administration or scoring. In addition, unlike other measures of central coherence, which typically assess either local or global information processing, this task assesses both aspects of central coherence, and it is this

interaction between global and local processing which is key to the concept of central coherence.

In this study both the GEFT and the local-global processing task were used to assess central coherence. Although there was no correlation between performance on the GEFT and the local-global processing task, a similar pattern was seen after fasting in both tasks. There was a nonsignificant trend for fasting participants to complete the GEFT more quickly and with fewer errors than when satiated, indicating a bias in local processing, and on the local-global processing task, fasting was also associated with a bias towards local processing, as well as impaired global processing. Future eating disorder research could usefully compare performance on the local-global processing task with performance on other established measures of central coherence such as the Rey-Osterreith Complex Figure Test (Osterreith, 1944, as cited in Lopez et al., 2008) and the Homograph Reading Test (Happé, 1997). This research could perhaps use a composite variable of central coherence (for example, weak/ average/ superior central coherence) similar to that used by Roberts, Tchanturia and Treasure (2010), to identify inter-relationships between these tasks, and to investigate whether there is a central coherence 'signature' associated with starvation.

Designing the Research Protocol

One challenge that I faced when designing this study was deciding how much to include in each testing session. As Bolton et al. (in preparation) had recruited 60 participants for their study, I sought to replicate this sample size, while extending the concepts examined. I attempted to balance including as many tasks as possible in each session in order to maximise the research opportunity, against the practicalities

of organising and carrying out 120 one-hour testing sessions. Looking back I wonder if I may have overextended myself in committing to this amount of testing over a period of three months; perhaps I should have sought out a voluntary research assistant to share at least part of this load, or spread recruitment over a longer period. Alternatively I could have streamlined the sessions to make them shorter. As mentioned earlier, I could have administered only one part of the GEFT at each session. I could also have asked participants to complete the self-report questionnaires before coming to the testing sessions, perhaps using an online tool, in order to make testing sessions less time-consuming. However, this may have impacted on the accuracy and completion rates of the self-report measures. In addition, ensuring that participants completed these tasks at around the same time as attending the session would have been logistically difficult. Nonetheless, these issues may be worth considering for future research, in order that both research participants' and researcher's time is most efficiently utilised.

The Impact of the Research on my Clinical Work

The process of completing this research has been both challenging and rewarding for me. As well as experiences of completing a research project from start to finish, I think this research has also impacted on my clinical work. I am more aware than before to consider with clients the importance of regular meals, and the impact of even short-term food deprivation on mood and cognitive performance. This has been particularly relevant in my clinical work with individuals with chronic depression, who seem to find it difficult to prioritise regular meals and often report going for long periods without eating. I have used findings from relevant research to psychoeducate clients about the impact of hunger on mood and cognitive

performance, and I am also more aware of checking in with clients at the start of a therapy session about when they have last eaten, so that we can adapt the content of our session to focus on these issues of self-care if necessary.

Conclusion

This exploratory research recruited a nonclinical sample to investigate the effect of short-term fasting on thinking styles associated with AN. In this study, even short-term fasting was associated with greater difficulties shifting mental set, as well as greater difficulties ignoring detailed focused information in order to process the bigger picture. As a female, sample of university students was recruited these findings are limited to well-educated, young, female populations. The use of some novel tasks assessing central coherence, set-shifting, and persistence also limit the generalisability of these findings.

This research like any research design involved balancing certain limitations and shortcomings with others, in order to carry out the most useful piece of research possible. Despite its limitations, this was a well-powered within-subject research design, which controls for individual variations in performance. Directions for future research have already been outlined in the empirical paper; it is likely that future research in this area will attempt to control for some of the limitations in methodology described in this review, namely by using well-established or validated measures of set-shifting and central coherence whenever possible and by taking more steps to avoid practice effects if using the GEFT. The process of conducting this research has impacted on my work in clinical settings. As well as highlighting the pitfalls in designing such a piece of research, findings from the current study may have import implications for both future research and clinical practice.

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Appendix A

Poster used for Recruiting Participants

VOLUNTEERS NEEDED!

YOU WILL RECEIVE £15 FOR 2 HOURS OF YOUR TIME!

WE ARE CONDUCTING A RESEARCH STUDY INTO THE EFFECTS OF FASTING ON THINKING

If you are a healthy female aged between 18 & 30 and would like more information:

please contact Sarah Pender

pender.sarah@gmail.com

telephone/ text: 07923369848

Please note: This study has been approved by the UCL Research Ethics Committee

In order to take part in this study you must not have any medical conditions such as diabetes which may make fasting dangerous.

All data will be collected and stored in accordance with the Data Protection Act 1998.

Fasting study

Pender.sarah@gmail.com

Appendix B

Letter of Ethical Approval

UCL RESEARCH ETHICS COMMITTEE
GRADUATE SCHOOL OFFICE

Dr Lucy Serpell
Department of Clinical Health Psychology
4th floor, Torrington Place
University College London
London
WC1E 6BT

19 April 2010

Dear Dr Serpell

Notification of Ethical Approval:
Ethics Application: A comparison of individual's health performance on tasks measuring central coherence, set-shifting, persistence, and perseveration, and the effects of fasting on this performance

I am pleased to confirm that in my capacity as Chair of the UCL Research Ethics Committee I have approved your project for the duration of the study (i.e. until September 2011).

Approval is subject to the following conditions:

1. You must seek Chair's approval for proposed amendments to the research for which this approval has been given. Ethical approval is specific to this project and must not be treated as applicable to research of a similar nature. Each research project is reviewed separately and if there are significant changes to the research protocol you should seek confirmation of continued ethical approval by completing the 'Amendment Approval Request Form'.

The form identified above can be accessed by logging on to the ethics website homepage: http://www.grad.ucl.ac.uk/ethics/ and clicking on the button marked 'Key Responsibilities of the Researcher Following Approval'.

2. It is your responsibility to report to the Committee any unanticipated problems or adverse events involving risks to participants or others. Both non-serious and serious adverse events must be reported.

   Reporting Non-Serious Adverse Events.
   For non-serious adverse events you will need to inform Dr Angela Poulter, Ethics Committee Administrator (ethics@ucl.ac.uk), within ten days of an adverse incident occurring and provide a full written report that should include any amendments to the participant information sheet and study protocol. The Chair or Vice-Chair of the Ethics Committee will confirm that the incident is non-serious and report to the Committee at the next meeting. The final view of the Committee will be communicated to you.

   Reporting Serious Adverse Events
   The Ethics Committee should be notified of all serious adverse events via the Ethics Committee Administrator immediately the incident occurs. Where the adverse incident is unexpected and serious, the Chair or Vice-Chair will decide whether the study should be terminated pending the opinion of an independent expert. The adverse event will be considered at the next Committee meeting and a decision will be made on the need to change the information leaflet and/or study protocol.

On completion of the research you must submit a brief report (a maximum of two sides of A4) of your findings/concluding comments to the Committee, which includes in particular issues relating to the ethical implications of the research.

Yours sincerely

p.p. Angela Packwood

Sir John Birch
Chair of the UCL Research Ethics Committee

cc. Sarah Pender, UCL Division of Psychology & Language Sciences; Dr Sam Gilbert, Institute of Cognitive Neuroscience

UCL Research Ethics Committee, c/o The Graduate School, North Cloisters, Wilkins Building
University College London Gower Street London WC1E 6BT
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Appendix C

Information Sheet for Participants

Information Sheet for Participants in Research Studies

You will be given a copy of this information sheet.

Project title: The impact of fasting on thinking

This study has been approved by the UCL Research Ethics Committee [Project ID number]: 2337/001

Investigators: Sarah Pender, Dr Lucy Serpell, and Dr Sam Gilbert, c/o Dept of Clinical Health Psychology, 4th Floor, Torrington Place, London, WC1E 6BT

Contact: pender.sarah@gmail.com Phone: 07923369848

You are being invited to participate in this research project.

You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information.

Details of the Study

The study explores the relationship between different measures of thinking styles which may be involved in eating disorders. The aim of the study is to understand if any of these measures are related to one another, and to find out what effect short-term starvation has on people's performance on these tasks. This may help eating disorder researchers discover whether some of these thinking styles might put people at risk for developing eating disorders.

We are recruiting healthy female volunteers aged between 18 and 30.

If you agree to take part in the study we will meet with you at UCL or a place of your choosing on two separate occasions, about a week apart. Each testing session will last about an hour. At each session, we will ask you to complete some questionnaires, some computer tasks, and a paper and pencil drawing task. We will also measure your height and weight.

Before one session we will ask you to fast for about 18 hours. I have given you a separate handout with some more information and advice on fasting. Please read this carefully. We will also ask you to fill in a diary about your mood, how much you are thinking about food, and how hungry you are while fasting.

At each session we may ask you for a urine sample. This is to check the level of ketones in your urine and is an indicator of whether or not you have been fasting. Your urine will not be stored after the testing sessions or tested for anything except ketone levels. We will randomly select which participants are tested in this way.

You will receive £15 or two course credits for your participation in this study. We will give you this money/ credits at the end of the second testing session.

It is unlikely that you will experience any distress by taking part in this study, although you may wish to consider the potential effects that fasting might have on you in the short-term before agreeing to participate.

It is up to you to decide whether or not to take part. If you decide to take part you are still free to withdraw from the study at any time during the testing session and without giving a reason. This will not affect your rights in any way.

If you decide to take part in the study you will be given this information sheet to keep and we will ask you to sign a consent form. As participation is anonymous it will not be possible for us to withdraw your data once you have completed the study. No information about you will be disclosed to a third party.

All data will be collected and stored in accordance with the Data Protection Act 1998.

What is the purpose of the study?

The purpose of the study is to examine the effects of short-term starvation on people's performance on cognitive tests relating to eating disorders. We are also investigating if these different cognitive tests are related to one another.

Do I have to take part?

No you don't have to take part; it is up to you to decide whether or not to take part. I will describe the study and go through this information sheet with you. If you wish to participate then I will ask you to sign a consent form to show that you have agreed to take part, and I will give you a copy of this information sheet and your consent form to keep. If you decide to take part you are still free to withdraw from the study at any time without giving a reason.

What will happen to me if I take part?

If you agree to take part, I will invite you to UCL or a convenient location to fill in some questionnaires and complete a computer task, and a paper and pencil drawing. I will meet with you on two separate occasions, a week apart. On one of the testing sessions I will ask you to fast from about 8pm the evening before, and on the other session, I will ask you to eat as normal. Each testing occasion will last about an hour. I may ask you to give a urine sample after you have been fasting.

What would a urine test involve?

We will randomly select those participants who will be asked to give a urine sample. The urine test involves you going to the bathroom alone and urinating into a small pot. When you return to the testing room I will test your urine with a test strip, which will change colour depending on the level of ketones in your urine at the time of testing. Your urine will not be stored in any way – it will be disposed of immediately once it has been tested.

Is it safe to give a urine test?

Yes. It is completely safe and has been approved by the UCL ethics committee. Appropriate health and safety standards will be adhered to.

Will I be able to get medical advice on my urine test results?

No. We will not be able to offer you any medical advice on your urinary ketone level, or any other aspect of your health. The urine test is simply to measure your ketone level at the time of testing, and may not represent your usual urinary ketone level. We will not be doing any other tests on your urine. If you are worried about any aspect of your health you should consult your GP.

Why am I being asked to fast for one of the sessions?

This study is examining the effects of starvation on cognitive processes

Payment

You will be paid for your participation at the rate of £7.50 per hour, totalling £15 for the two sessions together. You will receive the £15 payment in cash at the end of your second testing session.

What are the possible disadvantages or risks of taking part?

It is possible that fasting may make you feel distressed, irritable or tired, and you will likely feel hungry. We recommend that you do not fast during a time where you might have to take an important exam, operate heavy machinery, or drive, as you might find it more difficult to concentrate. You will be provided with a snack at the end of the session when you have fasted. There are no long-term ill effects of this short-term fasting. We recommend that you follow the advice on the '*Instructions for Fasting'* information sheet.

What are the possible benefits of taking part?

The research is not intended to be of direct benefit to participants. However, I hope that you will find participating in the study interesting. The study should be of benefit to the profession of psychology and will help us to gain a better understanding of anorexia nervosa.

Will my taking part in the study be kept confidential?

Yes. My supervisors and I will follow ethical and legal practice and all information about you will be handled in confidence. I will be responsible for the safety and security of all data. A code number rather than your name will be used to label all data so that you cannot be identified. Only my supervisors and I will have access to the questionnaires and task results. The questionnaires will be kept in a locked cupboard at my home, and numbered data will be stored on a password-protected computer file.

What will happen to the results of the study?

The study is due to be completed by the end of September 2011. If you would like, I will send you a summary of the findings when the study is completed. I intend to publish the results of the study in my doctoral thesis and in at least one scientific journal. I may also present the results at a conference. You will not be identified in any report, publication or conference presentation.

Who is organising and funding the research?

The study is part of my doctoral thesis in clinical psychology at UCL. The project is in collaboration with my supervisors, Dr Lucy Serpell and Dr Sam Gilbert, both staff members at University College London. We have received a small amount of funding for the project from the Department of Clinical, Health and Educational Psychology at UCL and the Central Research Committee.

Who has reviewed the study?

The proposed research has been reviewed by an independent group of people called a Research Ethics Committee, to protect your safety, well-being, rights and dignity. This committee at UCL have agreed that the research project is ethically acceptable.

Thank you for taking the time to read this Participant Information Sheet. If you decide to take part in the study, you will be asked to sign the attached Consent Form and you will also be given a copy of this Participant Information Sheet and your signed Consent Form to keep.

Appendix D

Advice on Fasting

Advice on fasting

You are being asked to fast before the testing session. It is important that you follow the instructions for fasting in order to (i) ensure your safety, and (ii) make sure the study is valid.

Do not fast if you have diabetes, any other medical conditions, problems with your blood sugar, or if you ever have been advised not to fast by a medical professional. Do not fast if you have any reason to believe you might be pregnant.

Do not fast during a period where you will be driving, operating heavy machinery, taking part in any dangerous activities, or taking important exams.

While fasting, your blood sugar may drop, you may feel hungry, lower in mood, irritable, and it may seem harder to concentrate.

Instructions for fasting

- The day before the testing session, please eat as normal, then between _____ and _____hrs (18 hours before your testing session the following day), please begin fasting.
- While fasting, please do not eat any food at all and do not drink any caffeinated drinks, such as tea, coffee or fizzy/sugary drinks.
- Do not drink any alcohol while you are fasting.
- If you feel faint at all while you are fasting, it is important that you stop fasting immediately. **You must eat something if you begin to feel faint.**
- During the fasting period, make sure you drink a sufficient amount of water in order to avoid dehydration.

Appendix E

Self-report Diary Measures

Diary measures

Please use this diary to keep a record of your thoughts/feelings and hunger levels in the time leading up to the testing session. Circle the number that best describes how you feel for each of the 4 descriptors.

6 pm the evening before testing							
Irritability/restlessness	**1** Not at all	**2**	**3**	**4**	**5**	**6**	**7** Very much so
Mood	**1** Very good/high	**2**	**3**	**4**	**5**	**6**	**7** Very bad/low
Hunger	**1** Not at all	**2**	**3**	**4**	**5**	**6**	**7** Very much so
Food preoccupation	**1** Not thinking about food at all	**2**	**3**	**4**	**5**	**6**	**7** Thinking about food constantly

Bedtime							
Irritability/restlessness	**1** Not at all	**2**	**3**	**4**	**5**	**6**	**7** Very much so
Mood	**1** Very good/high	**2**	**3**	**4**	**5**	**6**	**7** Very bad/low
Hunger	**1** Not at all	**2**	**3**	**4**	**5**	**6**	**7** Very much so
Food preoccupation	**1** Not thinking about food at all	**2**	**3**	**4**	**5**	**6**	**7** Thinking about food constantly

On waking in the morning							
Irritability/restlessness	**1** Not at all	**2**	**3**	**4**	**5**	**6**	**7** Very much so
Mood	**1** Very good/high	**2**	**3**	**4**	**5**	**6**	**7** Very bad/low
Hunger	**1** Not at all	**2**	**3**	**4**	**5**	**6**	**7** Very much so
Food preoccupation	**1** Not thinking about food at all	**2**	**3**	**4**	**5**	**6**	**7** Thinking about food constantly

Mid morning (11am)							
Irritability/restlessness	**1** Not at all	**2**	**3**	**4**	**5**	**6**	**7** Very much so
Mood	**1** Very good/high	**2**	**3**	**4**	**5**	**6**	**7** Very bad/low
Hunger	**1** Not at all	**2**	**3**	**4**	**5**	**6**	**7** Very much so
Food preoccupation	**1** Not thinking about food at all	**2**	**3**	**4**	**5**	**6**	**7** Thinking about food constantly

Lunchtime (1pm)							
Irritability/restlessness	**1** Not at all	**2**	**3**	**4**	**5**	**6**	**7** Very much so
Mood	**1** Very good/high	**2**	**3**	**4**	**5**	**6**	**7** Very bad/low
Hunger	**1** Not at all	**2**	**3**	**4**	**5**	**6**	**7** Very much so
Food preoccupation	**1** Not thinking about food at all	**2**	**3**	**4**	**5**	**6**	**7** Thinking about food constantly

Arrival at testing session							
Irritability/restlessness	**1** Not at all	**2**	**3**	**4**	**5**	**6**	**7** Very much so
Mood	**1** Very good/high	**2**	**3**	**4**	**5**	**6**	**7** Very bad/low
Hunger	**1** Not at all	**2**	**3**	**4**	**5**	**6**	**7** Very much so
Food preoccupation	**1** Not thinking about food at all	**2**	**3**	**4**	**5**	**6**	**7** Thinking about food constantly

THANK YOU.
PLEASE RETURN THIS TO THE RESEARCHER AT TEST SESSION.

Appendix F

Verbal Instructions for the Brixton Task

The following screens all have the same basic designs on them. There are always ten positions, and one of them is always coloured blue [point to filled circle on screen]. However, the coloured one moves around according to various patterns that come and go without warning. These numbers [point to the numbers beneath the circles] are just here to refer to the position- there is nothing complicated or mathematical about this test.

Now as each new screen appears, your job is to pick up on the pattern as best as you can and choose by pointing and clicking with the mouse where you think the blue one is going to be on the next screen. It's not guess work- you can work it out. For instance, imagine the blue was here [6], and on the next screen it's here [7], and then it goes to 8, then to 9, you might reasonably expect it next to go to 10.

From time to time the pattern changes without warning and then it is your job to pick up on the new pattern as best as you can. Do you understand?

Give further assistance if necessary

Obviously the first time you have nothing to go on, so your first answer will have to be a guess- have a guess as to where the blue one will be next.

Appendix G

Written Instructions for the Rule-Change Task

Instructions for the rule-change task

- You will be presented with some pictures appearing on the computer screen.
- The number of pictures presented on screen will vary randomly from between 1 and 6.
- At the same time, on the bottom of the screen, a judgement question will appear in writing.
- The judgement question will be one of 4 options: odd, even, high or low.
- **Low** numbers are 1, 2, and 3. **High** numbers are 4, 5 and 6.
- **Odd** numbers are 1, 3 and 5. **Even** numbers are 2, 4, and 6.
- Your job is to judge the pictures according to the judgement question and answer *yes* or *no* in response, to say whether the pictures presented match the judgement question.
- The pictures will remain on screen until you make your choice.
- You are not being asked to judge the content of the pictures, just the number of pictures appearing each time.
- Please be as fast and as accurate as possible.

Please let the researcher know if anything is unclear or if you have any questions.

Appendix H

Written Instructions for the Gamble Task

In this task, there are two decks of cards, one on either side of the computer screen.

- At any one time, one of these decks is the winning deck and the other is the losing deck.
- Sometimes the winning deck is on the left hand side and sometimes it switches to being the deck on the right hand side.
- Your aim is to win as much money as possible, by figuring out which deck allows you to win the most money at any one time.
- The number in the middle of the screen tells you how much money you have won in total.
- The winning deck allows you to win money most of the time. Even with the winning deck you can lose money on some trials.
- Even with the losing deck you win money on some trials.

Appendix I

Participant Consent Form

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research. Please initial each box to indicate that you agree with the preceding statement and sign below.

Title of Project: The impact of fasting on thinking

This study has been approved by the UCL Research Ethics Committee [Project ID Number: 2337/001]

Thank you for your interest in taking part in this research. Before you agree to take part the person organising the research must explain the project to you.

I _____ confirm that I have read the Information Sheet for Participants, and that I have had an opportunity to ask the researcher any questions or raise any concerns about the project with her, and have had these answered satisfactorily. ☐

I understand what taking part in the study involves. ☐

I understand that participation is voluntary, and I am free to withdraw from the study at any time during the testing sessions, without giving a reason. ☐

I have read the information sheet about the effects of fasting and I understand that I am free to stop fasting at any point should I feel unwell or uncomfortable. I confirm that I will follow the guidelines for fasting and should I feel faint or sick while fasting I will eat something. ☐

Signed: _____

Date: _____