Is overestimation of body size associated with neuropsychological weaknesses in anorexia nervosa?

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Abstract

Background: Recent research indicates some evidence of neuropsychological weaknesses in visuospatial memory, central coherence and set-shifting in adults with anorexia nervosa (AN). The growing interest in neuropsychological functioning of patients with AN is based upon the assumption that neuropsychological weaknesses contribute to the clinical features of the illness. However, due to a paucity of research on the connection between neuropsychological difficulties and the clinical features of AN, this link remains hypothetical. The main objective of this study was to explore the association between specific areas of neuropsychological functioning and body size estimation in patients with AN and healthy controls. **Methods:** The sample consisted of 36 females diagnosed with anorexia nervosa and 34 healthy female controls. Participants were administered the Continuous Visual Memory Test (CVMT) and the recall trials of Rey Complex Figure Test (RCFT) to assess visual memory. Central coherence was assessed using the copy trial of RCFT, and the Wisconsin Card Sorting Test (WCST) was used to assess set-shifting. Body size estimation was assessed with a computerized morphing program. **Results:** The analyses showed no significant correlations between any of the neuropsychological measures and body size estimation. **Conclusion:** The results suggest that there is no association between these areas of neuropsychological difficulties and body size estimation among patients with AN.

Keywords: Anorexia Nervosa, body size estimation, visuospatial memory, central coherence, set-shifting.

Is overestimation of body size associated with neuropsychological weaknesses in anorexia nervosa?

Body image disturbance is a core feature of anorexia nervosa (AN) (American Psychiatric Association, 2013). A better understanding of body image disturbance could represent an important contribution to the prevention and treatment of AN. To date, however, researchers have not been able to fully understand the processes involved in the development and maintenance of body image disturbance (Auchus, Kose & Allen, 1993).

The notion that patients with AN overestimate their body size arises from the clinical experience that these patients often report feeling fat, despite maintaining a significantly low weight (Garner, 2002). A large amount of research has been conducted to explore this phenomenon empirically (Farrell, Lee & Sharfan, 2005). Reviews conclude that at a group level, patients with AN overestimate the size of their body to a significantly greater extent than healthy controls (Cash & Deagle, 1997; Farrell et al., 2005).

Several studies have found evidence of specific neuropsychological deficits or weaknesses in a proportion of adults with AN (Reville, O'Connor & Frampton, 2016), such as visuospatial memory (e.g. Stedal, Frampton, Landro, & Lask, 2012; Stedal, Rose, Frampton, Landro, & Lask, 2012; Weider, Sæbø, Lydersen & Hestad, 2015; Zakzanis, Campbell, & Polsinelli, 2010), central coherence (e.g. Aloï et al., 2015; Lang, Lopez, Stahl, Tchanturia, & Treasure, 2014; Stedal et al., 2012), and set-shifting (e.g. Danner et al., 2012; Lounes, Khan & Tchanturia, 2011; Roberts, Tchanturia & Treasure, 2010; Tchanturia et al., 2012). It should be noted, that most of this research has been performed with adults. The research on cognitive abilities in adolescents with AN is still limited. However, the emerging trend has been that the cognitive difficulties apparent in adults with AN, in particular set-shifting difficulties, is less pronounced in children and adolescents (Allen et al., 2016; Lang, Stahl, Espie, Treasure & Tchanturia, 2014; Lang et al., 2015)

The growing interest in neuropsychological functioning of patients with AN is based upon the assumption that neuropsychological weaknesses contribute to the clinical features of AN. However, as pointed out by Talbot, Hay, Buckett and Touyz (2014), surprisingly few studies have directly explored the relationship between neuropsychological functioning and behavioural and psychological aspects of AN.

Most of the studies that have demonstrated overestimation of body size in patients with AN have used methods in which overestimation is based on memory or visual imagery of one's own body. Consequently, it seems logical to investigate whether difficulties with visual memory might influence the ability to estimate own body size. To our knowledge, two published studies have explored this possible connection. Thompson and Spana (1991) found a small but significant association between visual memory and overestimation of body size. Auchus et al. (1993) did not find a significant association between body size estimation and the visuospatial tests. However, they did find an association between overestimation of body size and poor mental imagery as measured by a self-report questionnaire. Both studies included non-clinical samples, and no studies have investigated the connection between visuospatial memory and body size estimation in currently ill patients with AN.

Several theoretical papers have proposed a connection between body image disturbance in AN and a detailed-oriented processing style (i.e., weak central coherence) (e.g. Madsen, Bohon & Feusner, 2013; Urgesi et al., 2012). It has been suggested that an over-attention to detail, reduced attention to global features, and a tendency to disproportionately focus on body areas of greatest dissatisfaction, might partly contribute to the abnormal body experience in AN (Madsen et al., 2013). A study by Griffiths, Murray and Touyz (2013) explored the association between central coherence and body image disturbance in men with muscle dysmorphia, often referred to as the “male version of AN” characterized by an extreme occupation with muscularity rather than thinness. Interestingly, findings showed that weak central coherence was uniquely and positively correlated to degree of body image disturbance (Griffiths et al., 2013). To date, no studies have explored the association between central coherence and body size estimation in females with AN.

Poor set-shifting abilities entail difficulties in changing one's responses according to environmental contingencies (Baldock & Tchanturia, 2007). Accordingly, one could hypothesize that poor abilities in set-shifting would result in a more persistent negative body image, leading to larger errors in estimation of body size. Griffiths et al. (2013) explored the association between set-shifting and body image disturbance in men with muscle dysmorphia. Similar to findings for central coherence, the analyses showed that set-shifting difficulties were associated with degree of body image disturbance. The relationship between set-shifting difficulties and body size estimation in patients with AN has not yet been investigated.

AIMS:

The aim of this study was to investigate the associations between body size estimation and visuospatial memory, central coherence and set-shifting in patients with AN versus healthy controls.

METHODS:

Sample:

The sample consisted of 36 females diagnosed with AN and 34 healthy females, aged between 14 and 29 years. Diagnoses were made based on the diagnostic criteria from the *Diagnostic and Statistical Manual of Mental Disorders, 4th edition* (American Psychiatric Association, 2000), using the diagnostic items of the *Eating Disorder Examination* (EDE 12.0D) (Cooper & Fairburn, 1987). Amenorrhea was not included as a diagnostic criterion, and has been removed from DSM-5 (American Psychiatric Association, 2013). Ten patients were included who initially fulfilled the full criteria for AN, but exceeded the DSM-IV weight threshold for AN at the time of assessment due to weight restoration during hospital admission. Patients were recruited from five units specializing in treatment of eating disorders in Norway. Control participants were recruited from local schools and universities in Oslo, Norway. All controls were screened for eating disorder psychopathology (EDE-Q), depression (BDI-II) and anxiety (STAI). Three controls were excluded due to a global EDE-Q score above the cut off (2.77) (Mond, Hay, Rodgers & Owen, 2006). None of the remaining controls scored above clinical cut-off on BDI or STAI.

The study received approval from the local Data Protection Committee at Oslo University Hospital and the Regional Ethical Committee for Medical Research. Written informed consent was obtained from all participants. For participants younger than 16 years, written informed consent was also obtained from parents.

Measures:

Weight for height ratio is a calculation of body mass adjusted for height, gender and age (Cole, Donnet, & Stanfield, 1981). The patients' weights and heights were collected by clinical staff and reported to the researchers with the patients' consent. In the control group, the researchers measured weight and height as part of the assessment.

Eating Disorder Examination, edition 12 (EDE) (diagnostic items) is a semi-structured interview developed by Cooper and Fairburn (Cooper & Fairburn, 1987) to assess eating disorder psychopathology. Both the original form and the Norwegian translation have demonstrated good psychometric properties (Cooper, Cooper & Fairburn, 1989; Reas, Wisting, Kapstad & Lask, 2011).

State-Trait Anxiety Inventory (STAI) is a questionnaire assessing anxiety (Spielberger & Sydeman, 1994). Contrary to other measures of anxiety, the STAI distinguishes between current anxiety (state-anxiety) and general level of anxiety (trait-anxiety). In this study, only the trait-anxiety scale is included. Both the original version of STAI and the Norwegian translation have demonstrated good psychometric properties (Håseth, Hagtvet, & Spielberger, 1990; Spielberger & Sydeman, 1994).

Beck Depression Inventory (BDI-II) is a well-established questionnaire developed to assess severity of depressive symptoms (Beck, Ward, Mendelsen, Mock, & Erbaugh, 1961; Spielberger & Sydeman, 1994). Both the original version of BDI-II and the Norwegian translation have demonstrated good psychometric properties (Beck, Steer, & Brown, 2005; Dozois, Dobson, & Ahnberg, 1998).

Body size estimation (BSE). To assess body size estimation, we used a *Computerized Body Size Estimation Morphing Program*, previously used in a study by Sand, Lask, Hoie and Stormark (2011). A full-body picture of the participant was projected onto the wall, either wider or narrower than actual size. Participants were then asked to adjust the width of the projection so that the size corresponded to what they perceived as their actual body size. The task was repeated twice, once with the picture initially wider than actual size, and then narrower. The degree of distortion was the same in each direction and for all participants. The data reported from the task are the mean values between these two conditions. Standardized instructions were used for all participants.

Rey Complex Figure Test (RCFT) was administered to assess visuospatial construction, visual memory (Meyers & Meyers, 1995; Osterrieth, 1944) and central coherence (Lopez et al., 2008). We used the scoring instructions developed by Meyers and Meyers (1995, adapted from Osterrieth, 1944) to assess visuospatial construction, immediate visual memory

and delayed visual memory. To assess central coherence, the scoring system developed by Lopez et al. (2008) was used.

Continuous Visual Memory Test (CVMT) was administered to assess visual memory (Trahan & Larrabee, 1999).

Wisconsin Card Sorting Test (WCST-64) computer version 2: Research edition. To assess set-shifting, we administered the computer version of the Wisconsin Card Sorting Test (WCST-64) (Heaton, Chelune, Talley, Kay, & Curtiss, 1993).

Statistical analyses:

Differences in continuous variables between patients and controls were tested with Student t-tests for normally distributed data and Mann – Whitney U test for non-normally distributed data. Categorical variables were tested with Chi-square test for contingency tables. Pearson or Spearman's correlation coefficients were used to analyze the association between continuous variables to identify possible confounding variables and to explore the direction and strength of associations between neuropsychological measures and body size estimation. Cohen's d was calculated using the following formula $d = (M_2 - M_1)/s$, where M refers to the mean value and s is the pooled standard deviation. Small effect sizes were defined as .20, medium as .50 and large as .80 and higher. A significance level of 5 % was used. All statistical analyses were done using the PASW Statistics software version 18.0 (IBM SPSS Inc., Chicago, IL).

Power calculations:

The power calculations were performed a posteriori, using the primary endpoints. The mean difference for body size estimation between patients and controls was used as the primary endpoint. In this study, the estimated mean difference of memory was 0.16 with a standard deviation of 0.18 in a sample of 36 patients and 34 controls. Thus, with a type I error of 5%, we could reject the null hypothesis that the population means of the patients and control groups were equal with a power of 95 %.

RESULTS:

Sample characteristics:

The sample characteristics are presented in Table 1.

INSERT TABLE 1

Neuropsychological measures:

Results showed a significant difference between patients and controls for WCST *total correct* and *total errors*, with patients scoring significantly poorer than healthy controls. For the remaining measures, no significant differences were found between groups (see Table 2). As previous research have indicated less set-shifting difficulties in the younger AN-population, we explored the correlation between age and set-shifting scores. The perseverative scores of WCST were in fact significantly and negatively correlated with age in the patient group (perseverative responses: $r = -.412$, $p = .014$, perseverative errors: $r = -.376$, $p = .026$).

However, this was also the case for the control group (perseverative responses: $r = -.430$, $p = .011$, perseverative errors: $r = -.366$, $p = .033$). Age did not affect the differences between patients and controls on the set-shifting measure (WCST), probably due to similar age-related trends in both groups.

INSERT TABLE 2

Body size estimation:

Results showed that patients overestimated their body size to a significantly greater degree than healthy controls in both conditions ($p < 0.001$) (see Table 2).

Controlling for possible confounders:

To identify possible confounders, we explored variables that have been shown to affect performance on neuropsychological tests in previous studies (weight for height ratio, depression and anxiety). Only those with significant relationships with both exposure (patients vs. controls) and outcome (WCST total correct and WCST total errors) were considered as possible confounders and included in the analysis. Among the variables included in the analysis we were not able to identify any possible confounders. Consequently, no further adjustments were performed.

Association between body size estimation and neuropsychological variables:

To investigate the association between body size estimation and neuropsychology, analyses were performed separately for patients and controls. No significant correlations were found

between any of the neuropsychological measures and body size estimation. Repeating the analysis with the two groups combined did not change the results in any significant way (Table 3).

INSERT TABLE 3

DISCUSSION:

This study showed no significant correlation between visuospatial memory, central coherence and set-shifting and overestimation of body size in patients with AN and healthy controls. Thus, our hypothesis of a link between neuropsychological difficulties and overestimation of body size was not supported by the data. Accordingly, we have to consider that this link might not exist. On the other hand, there are several possible explanations that should be considered prior to drawing conclusions on the matter.

In contrast to the majority of previous research, we found very few statistically significant differences between patients and controls on most of the neuropsychological measures. It is feasible that a stronger association between body image and neuropsychological functions would be found in a sample of patients with more pronounced neuropsychological difficulties. Some have suggested that there might be a subgroup of patients with AN with very severe deficits in neuropsychological functioning. This hypothesis was supported by a recently published cluster analysis in which patients were distributed across three clusters of neuropsychological functioning (Renwick et al., 2015). Only one of the three clusters identified showed overall poor performance on neuropsychological tasks (Renwick et al., 2015). Taking this into account, it is possible that our sample, for some reason, included fewer AN patients with more severe neuropsychological deficits.

Furthermore, there is a possibility that the neuropsychological results were affected by the wide age range of participants (from 14 years up to 29 years). Recent research has indicated that neuropsychological weaknesses in adolescents with AN are less pronounced than in adults with AN (e.g. Bühren et al., 2012; Lang et al., 2014; Rose, Frampton & Lask, 2014).

Even though we found significant differences between patients and controls on some of the WCST subscales, we did not find significant group differences on the subscales which are assumed to be the strongest indicators of set-shifting difficulties, i.e. perseverative scores.

This finding diverges from several other studies (e.g. Abbate-Daga et al., 2011; McAnarney et al., 2011; Roberts et al., 2010; Steinglass, Walsh & Stern, 2006; Westwood, Stahl, Mandy & Tchanturia, 2016). One possible explanation is that prior research predominantly used the standard version of WCST, whereas we used the short form (WCST-64). This was done to minimize any potential concentration difficulties due to low weight in the patient group, and data from several studies support the comparability between the standard version and the 64-item version of WCST (Greve, 2001). However, as comparability between WCST versions has not been directly explored in an eating disorder population, we cannot rule out the possibility that this methodological difference affected our results.

Another limitation of this study that needs mentioning is the lack of inter-rater data for the RCFT. This is especially relevant for the central coherence scoring system, as it is relatively new, and hence inter-rater reliability cannot be taken for granted when there are multiple administrators. In consequence we cannot be certain that inter-rater differences between the two administrators did not biased the results in some way.

Two recent studies looking at the association between perceptual abnormalities and body size estimation has not been able to establish such a link (Koskina, Mountford & Tchanturia, 2016; Waldman, Loomes, Mountford & Tchanturia, 2013). This could explain the lack of association between visuospatial memory and overestimation of body size in our study, as we would not expect to find such an association if perceptual abnormalities are not the source of body size estimation errors in the first place. However, the findings from these studies cannot account for the lack of association between body size estimation and central coherence or set-shifting, as this relationship is suggested to be mediated by body attitudes/experience rather than basic perceptual abnormalities.

In conclusion, our findings did not support the hypothesis of an association between visuospatial memory, set-shifting, central coherence and body size estimation in adults with AN.

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TABLE 1: Sample characteristics

	Patients m (sd)	Controls m (sd)	P-value	Cohens' d
Age	18.75 (3.94) (n = 36)	18.68 (2.87) (n = 34)	.93	0.02
> 18 years	n = 16	n = 16		
< 17 years	n = 20	n = 18		
Weight for height	80.89 (8.46) (n = 35)	101.47 (13.29) (n = 33)	<.001	-1.85
STAI-trait anxiety	62.73 (8.44) (n = 33)	36.49 (8.17) (n = 34)	<.001	3.16
BDI-II	31.59 (11.50) (n = 32)	6.30 (4.36) (n = 34)	<.001	2.91
EDE-Q total	3.59 (1.24) (n = 33)	0.81 (.61) (n = 33)	<.001	2.84

Abbreviations: STAI (State-trait anxiety inventory), BDI-II (Beck depression inventory-II), EDE-Q (Eating Disorder Examination – questionnaire version)

TABLE 2: Neuropsychological tests & body size estimation

	Patients m (sd)	Controls m (sd)	Mean diff. (95% CI)	p- value	Cohens d
WISC/WAIS	11.20 (2.86)	12.00 (2.00)	-0.80	.20	-0.32
- matrix reasoning	(n = 35)	(n = 30)	(-2.04 – 0.44)		
WISC/WAIS	10.34 (1.64)	10.67 (2.23)	-0.32	.52	-0.17
- vocabulary	(n = 335)	(n = 30)	(-1.31 – 0.67)		
WCST	46.74 (9.86)	51.41 (6.41)	-4.67	.02	-0.56
- total correct	(n = 35)	(n = 34)	(-9.68 – 0.66)		
WCST	50.43 (11.68)	55.91 (8.44)	-5.48	.03	-0.54
- total errors	(n = 35)	(n = 34)	(-10.39 – -0.57)		
WCST	52.31 (12.30)	56.62 (10.40)	-4.30	.12	-0.38
- perseverative responses	(n = 35)	(n = 34)	(-9.77 – 1.17)		
WCST	51.89 (12.29)	56.06 (10.05)	-4.17	.13	-0.37
- perseverative errors	(n = 35)	(n = 34)	(-9.56 – 1.22)		
RCFT	38.68 (13.78)	41.07 (11.20)	-2.39	.45	-0.19
- immediate recal	(n = 34)	(n = 28)	(-8.74 – 3.95)		
RCFT	40.43 (14.42)	41.18 (9.93)	-0.75	.81	-0.06
- delayed recal	(n = 35)	(n = 28)	(-6.90 – 5.40)		
RCFT	1.91 (0.64)	2.13 (0.61)	-0.32	.14	-0.35
- order of construction	(n = 35)	(n = 33)	(-0.53 – 0.76)		
RCFT	1.18 (0.35)	1.23 (0.40)	-0.23	.57	-0.13
- style	(n = 35)	(n = 33)	(-0.24 – 0.13)		
RCFT	1.18 (0.34)	1.26 (0.35)	-0.05	.29	-0.23
- central coherence index	(n = 35)	(n = 33)	(-0.25 – 0.08)		
CVMT	75.03 (5.24)	75.00 (10.08)	0.03	.99	0.00
- total score	(n = 34)	(n = 30)	(-3.92 – 3.98)		
BSE	1.41 (0.18)	1.25 (0.12)	0.16	<.001	1.05
	(n = 36)	(n = 34)	(0.08 – 0.23)		

Abbreviations: WISC (Wechslers intelligence scale for children), WAIS (Wechslers adult intelligence scale), WCST

(Wisconsin card sorting test), RCFT (Rey complex figure test), CVMT (Continuous visual memory test), BSE (body size estimation)

TABLE 3: Correlations between body size estimation and neuropsychological measures

	Patients (n = 35)		Controls (n = 34)	
	Body size estimation			
	r	p-value	r	p-value
Visuospatial memory				
• RCFT - imediat recal	-.032	.859	-.067	.734
• RCFT - delayed recal	-.036	.837	-.093	.638
• CVMT – total	-.044	.807	.054	.775
Central coherence				
• RCFT - order of construction	-.023	.894	.117	.515
• RCFT - style	.028	.875	-.222	.215
• RCFT - central coherence index	-.014	.937	-.061	.735
Set-shifting				
• WCST - total correct	-.134	.443	.073	.681
• WCST - total errors	-.103	.554	.015	.934
• WCST - perseverative scores	-.073	.677	.071	.690
• WCST - perseverative errors	-.083	.634	.045	.799

Abbreviations: RCFT (Rey complex figure test), CVMT (Continuous visual memory test), WCST (Wisconsin card sorting test)

The values reported are pearson correlation coefisient (r) and p-values.