Neuropsychological profile in the overweight population: an exploratory study of set-shifting and central coherence

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Biases in information processing styles, as measured by neuropsychological tasks, have been reported in the eating disorder literature. In particular, an inflexible, rigid processing style (poor set-shifting) and a bias toward detail to the exclusion of the bigger picture (weak central coherence) have been observed. This report investigates these traits in the overweight population, by comparing the neuropsychological profile of 50 normal-weight and ten overweight members of the general population. Small-to-negligible effect sizes are seen for the set-shifting tasks; however, a mixed profile with moderate-to-strong effect sizes is seen for tasks measuring detail focus. This exploratory study provides an intriguing introduction to neuropsychological profiles in the overweight population. Further exploration of these traits within the overweight/obese population is recommended.

The neuropsychological profile of people with the eating disorders anorexia nervosa (AN) and bulimia nervosa (BN) has received increasing interest over the past few years. The obvious lack of effective treatments, particularly for AN, has meant that eating-disorder researchers are broadening their focus to examine the more underlying aspects of this treatment-resistant group.

Set-shifting, the ability to move back and forth between different tasks or mental sets [1], is often impaired in the eating disorders [2,3]. This rigid style has been found in both the acute and recovered phases of anorexia [4,5], as well as in healthy family members [6] (for a systematic review of the set-shifting literature in eating disorders, see [7]). This rigidity can help explain why we often observe ritual-like behaviors in AN centered around food and eating, for example being 'stuck' in a binge–purge pattern, and an inability to look at their situation from a different perspective. In addition to impaired set-shifting, a detail-focused processing style has also been observed in eating disorders [8,9]. This style is well observed in the autistic spectrum disorders, where it is termed weak central coherence [10]. A bias towards the detail can mean that the 'gist' of a given situation (global picture) can become lost, as one focuses all of their energy on inspecting the smaller details in isolation from their context. This detail focus can be seen in the devotion to calorie counting in AN, to the detriment of global nutritional health. A novel pretreatment designed to address these two anomalies, namely cognitive remediation therapy, is producing positive results in the AN inpatient population [11,12].

As yet, these aspects of information processing have not been addressed in the overweight or obese population. While more general cognitive ability has been investigated to some degree, this is most often explored in the elderly population, where differences between normal and overweight groups are complicated by the presence of neurodegenerative disorders such as Alzheimer's disease or other medical conditions [13,14]. Few studies investigating the relationship between weight and cognitive functioning in younger populations are found; however, those present suggest poorer cognitive functioning with higher BMI (kg/m^2) [15].

With biases in these specific aspects of information processing style seen both in underweight (AN) and normal weight (BN) eating-disorder populations, might they also extend to the overweight (binge-eating disorder [BED]) end of the spectrum? If so, this could provide rationale for a new treatment approach in this population, given the effectiveness of such an approach in AN. We present preliminary findings from an exploratory study of healthy-weight and overweight volunteers in the normal population to investigate whether these traits merit further investigation amongst the clinically overweight/obese/BED population.

Method

Participants

Participants were 50 healthy-weight (BMI: 17.3–24.9 kg/m^2) and ten overweight (BMI: 25.7–30.1 kg/m^2) female controls, recruited via a circular e-mail sent to all King's College

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London staff and students. These participants were recruited as part of a larger study into the neuropsychology of eating-disorders. All participants were screened for eating disorder pathology, using the Eating Attitudes Test-26 [16], and family mental illness. If they met these criteria, all participants aged 18–55 years were included.

Materials

Self-report measures were used to gather demographic information (Table 1). The Neuropsychology battery consisted of eight tasks. Set-shifting tasks were:

- Wisconsin Card-Sorting Test (WCST; perseverative errors).
- Computerized Trail-Making Test (TMT)
- Computerized Brixton Task
- CatBat Task
- Haptic Illusion Task

For a full description of set-shifting tasks, see [7]. Detail-focused tasks were:

- Rey–Osterrieth Complex Figure (RCFT; copy and 20-min recall) [17]
- The Group Embedded Figures Task (GEFT) [18]

Procedure

Participants first completed a set of questionnaires, and were then invited to a 1-h neuropsychological assessment session. A Masters-level researcher, trained in the relevant neuropsychological tasks, ran the assessment in a small experimental room. Participants were debriefed on completion, and remunerated to thank them for their time. Data were analyzed using SPSS 11.0.4.

Results

See Table 1 for demographic information on healthy-weight and overweight participants. All cases assessed were included in the analysis, and no data-transformation methods were used. A one-way ANOVA was used for demographic comparisons. No significant differences were observed for self-report depression, anxiety or obsessionality scores (as measured by obsessive–compulsive inventory-revised [OCI-R]); however, there was a significant age difference and a disproportionate ethnicity balance (white European vs other [e.g., Asian, Indian]).

Given the small and unequal sample sizes across groups, effect sizes (Cohen's d) [101] were used to compare neuropsychological outcome. Effect size analysis allows for the disproportionate sample size, as well as being an appropriate calculation to use in exploratory research, such as the current paper. As can be seen in Figure 1, negligible-to-small effect sizes are consistently observed across set-shifting tasks (TMT, Brixton, Haptic, CatBat and WCST). This indicates that healthy-weight controls and overweight controls did not differ dramatically on the measures of set-shifting ability.

Conversely, medium-to-large effect sizes are seen on both central-coherence tasks, although in opposite directions. For the RCFT (Copy), the overweight population is both less accurate and more piecemeal in their drawing than the healthy-weight group. However, when completing the GEFT, the overweight group are slower and produce more time-out errors than the healthy-weight population, indicating a more global processing style.

Discussion

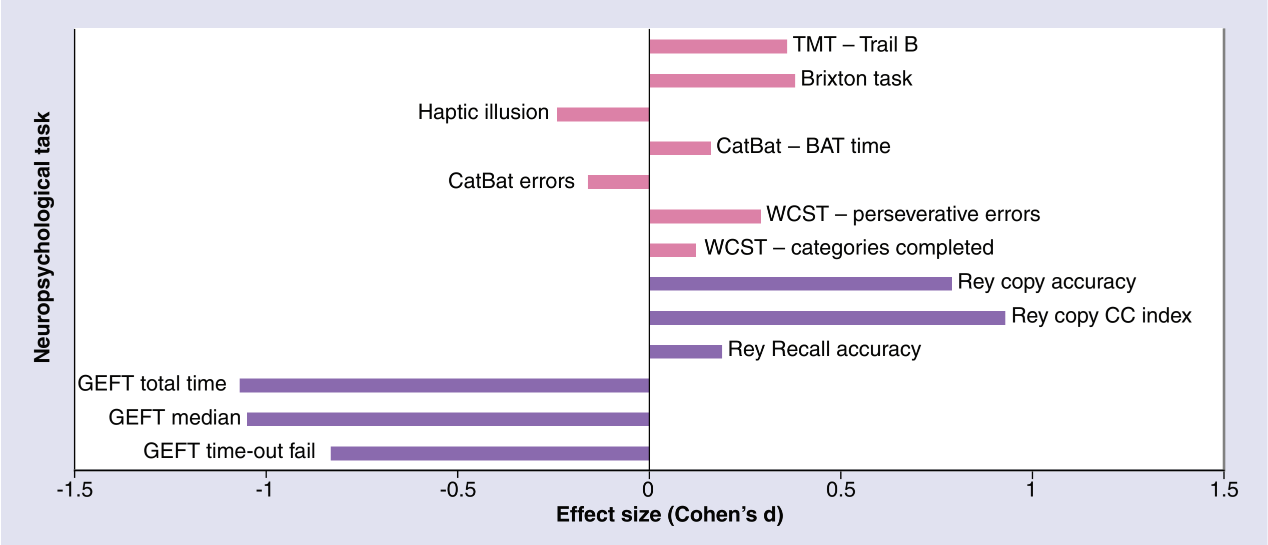
We present experimental data to explore both rigid and detail focused information processing

Table 1. Demographic details for healthy-weight and overweight participants.

	Normal weight M(SD) (n = 50)	Overweight M(SD) (n = 10)	Comparison
White European	78%	40%	
Age (years)	23.06 (5.59)	27.7 (9.43)	t (58) = -2.11; p = 0.16
BMI* (kg/m^2)	21.53 (1.88)	27.97 (1.36)	t (58) = -10.28; p < 0.001
OCI-R	12.86 (10.10)	11.60 (7.59)	t (58) = 0.37; p = 0.66
HADS-Anxiety	5.92 (3.93)	6.20 (2.44)	t (58) = -0.24; p = 0.81
HADS-Depression	1.80 (2.08)	2.00 (1.70)	t (58) = -0.29; p = 0.78

Equal variances not assumed.
**p > 0.001.*
BMI: Body mass index; HADS: Hospital anxiety and depression scale; M: Mean; OCI-R: Obsessive-compulsive inventory-revised; SD: Standard deviation.

Figure 1. Effect sizes for neuropsychological tasks measuring set-shifting (pink) and central coherence (purple).



A positive effect size indicates that the overweight group displayed more rigidity or more detail focus compared with normal-weight participants.
GEFT: Group Embedded Figures Task; TMT: Trail-Making Test; WCST: Wisconsin Card-Sorting Test.

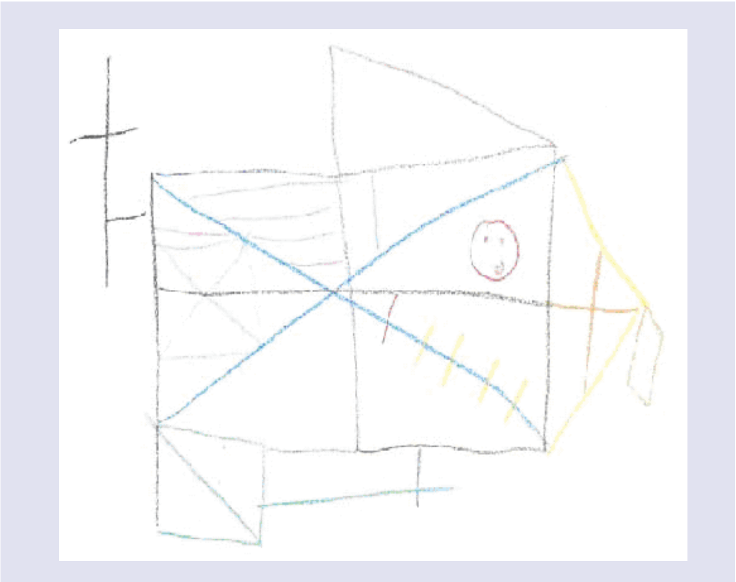
styles in the overweight population. While these biases have been observed in the clinical eating disorders AN and BN, it is as yet unclear whether these traits apply to the overweight/obese end of the eating-disorder spectrum. The results presented here offer tentative support for a detail-focused style in the overweight population. This support is provided by a lower central-coherence index (combining order of elements drawn [global or detailed], and style of drawing [continuous or fragmented]) on the RCFT in the overweight population, indicating a more detailed and fragmented drawing style. Based on this result, one would expect to see superiority in the overweight group when asked to locate a hidden shape (detail) within a more complex shape. However, slower rather than faster times are observed on the GEFT task with a large effect size, indicating that the overweight group were less able to focus in on the detail than healthy-weight controls when searching for these shapes.

It is interesting to note the lower accuracy score found for the RCFT in the overweight group. While a low central-coherence score (similar to that found here with the overweight group) has been found in the AN population, this is coupled with an accuracy score comparable with healthy controls. This means that even though people with AN adopt a more detailed and fragmented approach to the drawing, the resulting figure is just as complete and accurate as those adopting a more global approach. This is not the case with the overweight group, where an effect size close to 0.8 means that the overweight group produce a substantially poorer-quality figure on completion (Figure 2). On observing the drawing style of the overweight group, videos of the RCFT indicate a substantially more chaotic drawing style – fast, impulsive and with little attention to neatness (despite being asked to copy the figure 'as carefully as you can'). This lack of organization due to the chaotic drawing style may partly explain the low scores on both central-coherence index and accuracy for the overweight group. This pattern is different to the one seen at the underweight end of the spectrum [12], and its link with the impulsivity characteristic of binge eaters is intriguing.

Consistently small effect sizes seen for all set-shifting tasks indicate that overweight participants did not differ substantially in terms of cognitive flexibility.

Although exploratory, this study is limited by the disproportionate sample sizes. A 5:1 ratio across weight groups and a sample size of only ten in the overweight group makes it difficult to detect between-group differences. For this reason, effect sizes were chosen to present the data over multivariate statistics, as effect size is able to take sample size into account. It is therefore exciting that such large effect sizes were seen for central-coherence tasks. Should further research in

Figure 2. Example copy of the Rey–Osterrieth Complex Figure from the overweight population.



obesity compliment the findings presented here, it may be appropriate for a form of cognitive remediation treatment to be trialed in this population, following from its success in AN [11].

In summary, it will be of interest to further investigate the neuropsychological profile of the overweight/obese/BED population. Tentative support is provided for weak central coherence in the overweight group, meriting further study of this information processing style in this clinical group.

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Bibliography

1. Miyake A, Freidman NP, Emerson MJ, Wizki AH, Howerter A, Wager TD: The unity and diversity of executive functions and their contributions to complex ‘frontal lobe’ tasks: a latent variable analysis. *Cognit. Psychol.* 41, 49–100 (2000).
2. Tchanturia K, Anderluh MB, Morris RG *et al.*: Cognitive flexibility in anorexia nervosa and bulimia nervosa. *J. Int. Neuropsychol. Soc.* 10(4), 513–520 (2004).
3. Tchanturia K, Serpell L, Troop N, Treasure J: Perceptual illusions in eating disorders: rigid and fluctuating styles. *J. Behav. Ther. Exp. Psychiatry* 32(3), 107–115 (2001).
4. Tchanturia K, Morris R, Anderluh M, Collier D, Nikolaou V, Treasure J: Set shifting in anorexia nervosa: an examination before and after weight gain, in full recovery and relationship to childhood and adult OCPD traits. *J. Psychiatr. Res.* 38(5), 545–552 (2004).
5. Tchanturia K, Morris R, Surguladze S, Treasure J: An examination of perceptual and cognitive set shifting tasks in acute anorexic nervosa and following recovery. *Eat. Weight Disord.* 7(4), 312–315 (2002).
6. Holliday J, Tchanturia K, Landau S, Collier D, Treasure J: Is impaired set-shifting an endophenotype of anorexia nervosa? *Am. J. Psychiatry* 162(12), 2269–2275 (2005).
7. Roberts ME, Tchanturia K, Stahl D, Southgate L, Treasure J: A systematic review and meta-analysis of set shifting ability in eating disorders. *Psychol. Med.* 37(8), 1075–1081 (2007).
8. Tokley M, Kemps E: Preoccupation with detail contributes to poor abstraction in women with anorexia nervosa. *J. Clin. Exp. Neuropsychol.* 29(7), 734–741 (2007)
9. Lopez C, Tchanturia K, Stahl D *et al.*: An investigation of central coherence in women with anorexia nervosa. *Int. J. Eat. Disord.* (2007) (In Press).
10. Happe F, Frith U: The weak coherence account: detail-focused cognitive style in autism spectrum disorders. *J. Autism Dev. Disord.* 36(1), 5–25 (2006).
11. Davies H, Tchanturia K: Cognitive remediation therapy as an intervention for acute anorexia nervosa: a case report. *Eur. Eat. Disord. Rev.* 13(5), 311–316 (2005).
12. Tchanturia K, Whitney J, Treasure J: Can cognitive exercises help treat anorexia nervosa? *Eat. Weight Disord.* 11, E112–E116 (2006).
13. Jeong SK, Nam HS, Son MH, Son E-J, Cho KH: Interactive effect of obesity indexes on cognition. *Dement. Geriatr. Cogn. Disord.* 19(2–3), 91–96 (2005).
14. Brubacher D, Monsch AU, Stahelin HB: Weight change and cognitive performance. *Int. J. Obes.* 28, 1163–1167 (2004).
15. Gunstad J, Paul RH, Cohen RA, Tate DF, Spitznagel BM, Gordon E: Elevated body mass index is associated with executive dysfunction in otherwise healthy adults. *Compr. Psychiatry* 48, 57–61 (2007).
16. Garner DM, Olmsted MP, Bohr Y, Garfinkel PE: The eating attitudes test: psychometric features and clinical correlates. *Psychol. Med.* 12(4), 871–878 (1982).
17. Osterrieth P: Test of copying a complex figure: contribution to the study of perception and memory. *Archives de Psychologie* 30, 206–356 (1944).
18. Witkin H: *A Manual for the Embedded Figure Test.* Consulting Psychologists Press, CA, USA (1971)

Website

101. Thalheimer W, Cook S: How to calculate effect sizes from published research articles: a simplified methodology. www.work-learning.com/effect_sizes.htm