



Binge-eating disorder may be distinguished by visuospatial memory deficits



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ABSTRACT

Objective: Binge eating disorder (BED), characterized by recurrent episodes of loss of control overeating, is highly comorbid with overweight and obesity. Both loss of control eating and higher body mass index have been associated with poor memory. The current study sought to clarify the relationships between BED, weight and memory. Specifically, visual memory was examined, given evidence of impaired visuospatial abilities in overweight individuals and little research on visual memory in BED.

Method: Overweight and normal-weight women with BED and matched healthy controls were administered the Rey Complex Figure Test.

Results: Planned contrasts revealed that normal-weight healthy controls performed better than all other groups on the immediate and delayed recall portions of the task. Performance on the immediate recall portion was better among normal-weight individuals than overweight individuals, and performance on both the immediate and delayed recall portions was better among individuals without BED than those with BED. No differences between groups were seen on the copy or recognition trials.

Conclusions: Visual memory appears to be impaired among overweight participants and both normal and overweight participants with BED. This finding was specific to retrieval. Replication of this finding in BED using different measures of memory is needed.

Research suggests a relationship between excess body weight and memory deficits (Prickett, Brennan, & Stolwyk, 2015). In addition, evidence from the animal and human literatures suggests that diets high in fats and sugars are associated with impaired performance on memory tasks along with reduced markers of neural plasticity within the hippocampus (Cordner & Tamashiro, 2015; Francis & Stevenson, 2011; Kendig, Boakes, Rooney, & Corbit, 2013). Importantly, there is evidence to suggest that diet-related memory deficits can be observed in animals even when controlling for increased body weight (Granholtm et al., 2008; Kendig et al., 2013). In humans, performance on a memory task has been negatively correlated with self-reported uncontrolled eating across weight categories (Calvo, Galioto, Gunstad, & Spitznagel, 2014). Given that binge eating disorder (BED) is characterized by recurrent episodes of binge eating foods high in fats and sugars (Raymond, Bartholome, Lee, Peterson, & Raatz, 2007; Yanovski, Leet, Yanovski, et al., 1992) and is highly comorbid with overweight and obesity, memory impairment is expected to be greater among those with this diagnosis regardless of weight category.

Previous studies investigating memory performance among those with BED have primarily assessed verbal memory. With one exception (Duchesne, Mattos, Appolinario, et al., 2010), results from these studies

do not suggest differences due to BED diagnosis (Galioto, Spitznagel, Strain, et al., 2012; Lavender, Alosco, Spitznagel, et al., 2014; Manasse et al., 2015; Muller, Brandl, Kiunke, et al., 2014). However, prior studies are limited by the use of small samples ($n = 16$) (Galioto et al., 2012) and samples with sub-threshold BED (Manasse et al., 2015; Muller et al., 2014) or a lifetime history but not a current diagnosis of BED (Lavender et al., 2014). The aim of the current study was to examine performance on a task of visuospatial memory in a sample of BED participants, as spatial memory has been shown in the animal literature to be impaired following access to high-fat and -sugar diets (Greenwood & Winocur, 1990; Kendig et al., 2013). Duchesne, Mattos, Appolinario, et al., (2010) found that relative to obese controls, obese participants with BED showed greater errors on a Zoo Map task that requires participants to formulate a plan to navigate between locations on a map, providing preliminary evidence that BED may be associated with impairment in spatial processes.

Three studies have assessed visual memory among overweight or obese participants with the Rey Complex Figure Test (RCFT) used in the current study. For this task, participants are asked to copy a complex geometric figure and subsequently asked to produce this image from memory after 3 and 30-minute delays. Two studies show poorer recall

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in overweight or obese samples (Boeka & Lokken, 2008; Roberts, Demetriou, Treasure, & Tchanturia, 2007), though both studies found poor performance on the copy trial, suggesting potential limited initial encoding of the figure and compromising its use as a measure of memory. One study found no differences between normal-weight, overweight and obese individuals using this measure (Gonzales et al., 2010); however, the small sample size may have limited the ability to identify group differences. Given these findings, evidence remains inconclusive regarding the relationship between visual memory performance and excess body weight.

To our knowledge, only one study has examined RCFT performance among overweight individuals with BED. Compared to normal-weight healthy controls (HCs), overweight participants with BED demonstrated poorer performance on percentage of recall (Aloi, Rania, Caroleo, et al., 2015). This effect remained significant after controlling for both BMI and diagnosis, indicating potential memory differences between the groups. In addition, compared to HC, individuals with BED had a lower score on the Rey-Accuracy Index in the copy condition of the RCFT, again suggesting poor encoding of the stimulus later tested for recall. Finally, this study did not compare overweight BED to weight-matched controls. Given findings that overweight individuals tend to demonstrate poorer recall on this measure (Boeka & Lokken, 2008; Roberts et al., 2007), clarification of whether differences are due to BED or weight is needed. In light of previous findings (Aloi et al., 2015; Boeka & Lokken, 2008; Roberts et al., 2007), we expected that overweight participants as well as those with BED would perform more poorly on the RCFT. Further, we expected that delayed recall would follow a similar pattern as immediate recall; that is, if immediate recall was poor we expected delayed recall to be impaired.

1. Methods

1.1. Participants

Participants ($N = 132$) were recruited for a study to characterize BED. Four groups of women were recruited: overweight with BED (OW-BED) ($n = 32$), normal-weight with BED (NW-BED) ($n = 23$), overweight without BED (OW-HC) ($n = 48$), and normal-weight without BED (NW-HC) ($n = 29$). Individuals were excluded due to medical conditions including diabetes, seizure disorder, or history of head injury with a loss of consciousness ≥ 10 min. Individuals with hypertension, high blood pressure, and hypothyroidism were included if their conditions were managed with medication and were stable for at least 6 months. Healthy controls were excluded if they had existing psychiatric conditions.

1.2. Procedure

Eating disorder pathology and psychological disorders were assessed using the measures described below. Weight and height were taken using a scale with a stadiometer. On a separate day, neuropsychological measures were administered. The present study was approved by the university institutional review board.

1.3. Measures

1.3.1. Eating Disorders Examination (EDE) Version 16.0 (Fairburn, 2008)

The EDE is a standardized semi-structured interview measuring the severity and frequency of eating disorder psychopathology.

1.3.2. The Structured Clinical Interview for DSM-IV (SCID-I) (First, Spitzer, Gibbon, & Williams, 2002)

The SCID-I is a semi-structured clinical interview used to assign Axis I diagnoses in accordance with the Diagnostic and Statistical Manual of Mental Disorders (DSM IV-Text Revision Axis-I) (American Psychiatric Association, 2000).

1.3.3. Raven's Progressive Matrices (RPM) (Raven, Raven & Court, 2004)

The RPM assesses non-verbal abstract reasoning and is regarded as an estimate of fluid intelligence.

1.3.4. Rey Complex Figure Test and Recognition Trial (RCFT) (Meyers & Meyers, 1995)

The RCFT asks examinees to reproduce a complicated line drawing, first by copying it freehand (Copy Trial), and then drawing from memory after a 3 minute delay (Immediate Recall) and again after a 30 minute delay (Delayed Recall). Examinees are not told beforehand that they will be asked to draw the figure from memory; the Immediate and Delayed Recall conditions are therefore tests of incidental memory. The scoring system divides the complex figure into 18 units. Each unit is scored separately for accuracy and placement. A score of 0, 0.5, 1, or 2 is assigned to each unit of the figure based on these two criteria. Thus, raw scores ranging from 0.0 to 36.0 may be obtained for the Copy, Immediate Recall, and Delayed Recall trials. The Recognition condition was administered immediately after the Delayed Recall trial and requires participants to indicate items recognized from the Copy trial (see Meyers & Meyers, 1995).

Both the RPM and RCFT were scored in accordance with the published manuals by a Masters-level Ph.D. candidate (KE) without knowledge of participant's group status.

1.4. Data analytic plan

Age adjusted T-scores for all RCFT measures were used in all analyses. Therefore, age was not included as a covariate. Minority status was coded with Caucasian as '0' and non-Caucasian as '1' and included as a covariate if a chi-square test revealed significant differences. Education level was included as a covariate if a one-way ANOVA revealed significant group differences. We employed a group (i.e., NW-HC, OW-HC, NW-BED, OW-BED) analysis of covariance to determine whether performance on the RCFT Copy Trial varied between groups. A separate multivariate analysis of covariance (MANCOVA) was used to examine performance on the memory tasks included in the RCFT (Immediate Recall, Delayed Recall, and Recognition) across the four groups. Planned contrasts for weight category and diagnosis were also conducted. Post-hoc Bonferroni corrections were used when testing group differences.

2. Results

2.1. Demographics

See Table 1 for a summary of demographic information. BED participants met DSM-5 (American Psychiatric Association, 2013) BED criteria for the last three months and reported an average of 2.98 ($SD = 1.29$) episodes of binge eating per week, with no significant differences in frequencies between NW-BED and OW-BED ($p = 0.52$). Of participants with BED, 25 had co-occurring psychiatric disorders: 11 with a lifetime history of mood disorders, 5 with current mood disorders, 2 with a lifetime history of anxiety disorder, 10 with current anxiety disorder and 2 with a lifetime history of substance abuse.

2.2. Preliminary analyses

A chi-square test indicated that the groups differed significantly on minority status, such that there were more individuals of minority status in the overweight groups than the normal-weight groups ($\chi^2[4] = 38.08, p < 0.01$), with greater African American participants in both overweight groups. Groups differed significantly on education level ($F(3, 124) = 8.86, p < 0.01$), such that overweight individuals had less education than normal-weight individuals. Therefore, education level and minority status were controlled for in all subsequent analyses. The presence of mood disorders or use of medication that may

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