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Overlapping neurocognitive inefficiencies in anorexia nervosa: A preliminary investigation of women with both poor set-shifting and weak central coherence

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Introduction

Neurocognitive assessment in structurally intact mental health populations aims to identify subtle inefficiencies rather than pronounced deficits in neurocognitive functioning. These inefficiencies can contribute to our developing understanding of the processes underlying and maintaining mental illness. Neurocognitive findings in the field of eating disorders have consistently highlighted two aspects of executive functioning that pose particular difficulties for those with anorexia nervosa (AN): poor set-shifting and weak central coherence (for systematic reviews, see Lang, Lopez, Stahl, Tchanturia, & Treasure, 2014; Roberts, Tchanturia, Stahl, Southgate, & Treasure, 2007). Poor set-shifting (cognitive inflexibility) has been found in current and recovered AN across a number of different studies and neurocognitive measures (Danner et al., 2012; Tenconi et al., 2010; Wu et al., 2014), and has been associated with poor prognostic factors such as longer duration of illness, more severe eating behaviours, higher self-harm, lower self-esteem, higher comorbid anxiety (Roberts, Tchanturia, & Treasure, 2010) and higher levels of depression (Abbate-Daga, Buzzichelli, Marzola, Amianto, & Fassino, 2014). Weak coherence, the tendency to focus on detail to the extent that its global context or meaning is lost, has also been found in both current and recovered AN (Aloi et al., 2015; Lang et al., 2014; Lopez et al., 2008; Tenconi et al., 2010). As with poor set-shifting, poor prognostic factors have been found in those with a current eating disorder and persistent detail focus, for example higher self-report depression and increased rates of social and specific phobia (Roberts, Tchanturia, & Treasure, 2013). Findings on clinical correlates of neurocognitive profile are however limited and often inconsistent, highlighting the need for further studies ideally with larger datasets and robust clinical information.

While these two neurocognitive inefficiencies and their associated clinical features have been investigated independently, to the best of our knowledge this is the first paper to explore how often these inefficiencies overlap (i.e. present simultaneously). This investigation is therefore exploratory in nature. Of particular interest is whether subtle overlapping inefficiencies 1) present at a different frequency across AN subtypes, and 2) will have a compounding effect on AN presentation and prognostic features.

Method

Participants

Participants were 54 outpatient women with current AN (27 ANR restricting type; 27 ANBP binge-purge type). They are a subset of a larger published sample (Roberts et al., 2010; Roberts et al., 2013), which consisted of additional cases with partially remitted AN, recovered AN, women with bulimia nervosa, and unaffected sisters of those with AN and bulimia nervosa. For the purposes of this study, only cases of current AN clinically rated as mild (n=16), moderate (n=22) or severe (n=16) in presentation (not those in partial remission) were included.

Mean age of the current sample was 24.2 (SD=6.14), with an average of 15.4 years of education (SD=2.61). Current mean BMI (kg/m^2) was 17.3 (SD=2.14) with a lowest ever BMI of 13.9 (SD=1.95). Mean age of AN onset was 16.8 years (SD=4.19) with duration of illness at 7.4 years (SD=5.18). As rated by SCID clinical interview on a scale of 1 (severe), 2 (moderate), and 3 (mild), current severity was on average 2.0 (SD=0.78).

Measures

Clinician rated measures were the Structured Clinical Interview for DSM-IV diagnosis (First, Gibbon, Spitzer, & Williams, 1997), the Yale-Brown Obsessive-Compulsive Scale (Goodman et al., 1989), and the Yale-Brown-Cornell Eating Disorder Scale (Mazure, Halmi, Sunday, Romano, & Einhord, 1994). Self-report measures were the Frost Multidimensional Perfectionism Scale (Frost, Marten, Lahart, & Rosenblate, 1990), the Obsessive-Compulsive Inventory-Revised (Foa et al., 2002), and the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983).

Neurocognitive measures of set-shifting ability were the Wisconsin Card Sorting Test CV-4 (Heaton, Chelune, Talley, Kay, & Curtiss, 1993), the Brixton Task (Burgess & Shallice, 1997), the Trail Making Test (Reitan, 1955), and Haptic Illusions (Uznadze, 1966). Neurocognitive measures of weak coherence were the Rey-Osterrieth Complex Figure (Osterrieth, 1944) and the Group Embedded Figures Test (Witkin, Oltman, Raskin, & Karp, 2002). Details pertaining to test administration and scoring procedures can be found in Roberts et al. (2010; 2013).

Procedure

Women were recruited from a specialist NHS outpatient unit on a consecutive basis over 18 months, and by invitation through a volunteer database. Information, consent and self-report measures were posted to each patient before the assessment appointment. Clinical presentation and neurocognitive functioning was assessed in a session lasting on average 1.5 - 2 hours. Weight and height was checked at the appointment. Participants were paid a small fee in recognition of their time. The study was approved by the local research ethics committee. Data obtained were in compliance with the Helsinki Declaration.

Statistical methods

Neurocognitive scores were categorised as elevated if they fell above or below one standard deviation of the healthy control mean (in the direction of poor task performance) using healthy control data for each task from the aforementioned studies (Roberts et al., 2010; Roberts et al., 2013). One standard deviation was selected as a threshold due to the stated aim to investigate subtle neurocognitive inefficiencies rather than stark impairments in functioning. Cases were then categorised as having poor set-shifting or having weak coherence if they had an elevated score on at least half of the administered tasks for each domain (i.e. at least 2 of 4 set-shifting tasks; at least 1 of 2 coherence tasks).

Cases were split into those with overlapping neurocognitive inefficiencies (poor set-shifting and attention to detail), those with one inefficiency or the other, and those with no inefficiencies. A chi-square test was employed to investigate differences in the frequency of traits by AN subtype.

Groups were then compared across demographic and clinical features. Given the analysis employed uneven group sizes including one small group (n=11), Cohen's d effect sizes (Cohen, 1988) were calculated in place of multivariate statistics to investigate the strength of any group differences.

Results

Frequency of overlapping inefficiencies across subtypes

Initial frequency analysis explored the prevalence of both, one, or no neurocognitive inefficiencies across AN subtypes. 15% of restricting type AN (ANR) and 26% of binge/purge AN (ANBP) showed overlapping inefficiencies (AN regardless of subtype = 20.4%). One inefficiency or the other was found in 85% of ANR and 66% of ANBP. For both ANR and ANBP, attention to detail was the most common inefficiency (52%/56%, respectively). The chi-square did not reach significance ($X^2(2)=3.43$, $p=0.18$) suggesting that there was no meaningful difference in the frequency of neurocognitive characteristics between ANR and ANBP.

Only two cases (4% of the sample; both ANBP) showed neither poor set-shifting or attention to detail. These two cases were dropped from subsequent analyses.

Relationship with demographic and clinical features

Table 1 outlines descriptive statistics and Cohen's d effect sizes across demographic and clinical features for the two neurocognitive groups (overlapping vs. one inefficiency). The group with overlapping inefficiencies had a more severe current illness as clinically rated on the SCID (moderate effect size), and a lower lifetime BMI (small effect size). YBC rituals were also higher (moderate effect size) indicating more severe disordered eating behaviours at the worst phase of the illness (e.g. ritualised eating & food preparation, body checking, exercising routines). These findings are suggestive of a more severe AN presentation. Self-report self-harming behaviours were also higher in the group with overlapping inefficiencies (moderate effect) with over half of these women reporting lifetime self-harm.

Comparisons on self-report measures showed no notable group differences with all effect sizes small or negligible. Similarly, ANR and ANBP subtypes did not differ with regard to clinical features (p-value range 0.1 - 0.9).

Discussion

It is well established in the literature that poor set-shifting and weak coherence present at a higher rate in those with AN than in the general population. This brief report explored the frequency with which women with AN present with both poor set-shifting and weak coherence as overlapping neurocognitive inefficiencies, and whether any notable differences in clinical correlates exist between the groups.

Findings suggest that on average, one in five outpatients with current AN display overlapping neurocognitive inefficiencies. There was no significant difference in frequency when split by AN subtype, although ANBP were observed to show slightly higher numbers of women with overlapping traits. This trend is consistent with a number of previous studies, where significant differences between AN subtypes are not found however in some cases ANBP trend toward a more exaggerated neurocognitive profile (Abbate-Daga et al., 2014; Lang et al., 2014; Roberts et al., 2010; Roberts et al., 2013). Across both subtypes, attention to detail was the most highly endorsed inefficiency, presenting in just over half of the current cases.

Some indicators of a more severe presentation of AN were noted in those with overlapping neurocognitive inefficiencies, in terms of clinician-rated illness state, ritualistic eating disorder behaviours, higher levels of self-harm and lowest ever BMI. Duration of illness, also considered a poor prognostic marker, did not differ between groups notably although those with overlapping traits had been ill slightly longer (small effect) but with wide variance. The impact of duration of illness/current illness state on neurocognitive profile remains unclear, with mixed findings across studies (Danner et al., 2012; Lopez et al., 2008; Roberts et al., 2010; Roberts et al., 2013; Tchanturia et al., 2011; Tenconi et al., 2010). The link found here between neurocognitive profile and self-harming behaviours is novel, and merits future attention. Of particular interest would be whether emotional dysregulation acts as a moderator/mediator between neurocognitive profile and self-harming behaviours.

While the current study is exploratory in nature, the interplay of these two cognitive styles makes sense clinically when considering a typical patient with AN who reports careful attention to detail in terms of rules and rituals centred around food selection and preparation, caloric intake, body checking, exercise and so forth. Where this patient has both neurocognitive inefficiencies, their cognitive rigidity means they are unable to shift perspective from that of their detailed rules and rituals to the bigger picture of their general nutritional health, or a focus on their future. Essentially they get rigidly "stuck" in detail, and by nature of their neurocognitive profile may struggle to independently shift set in order to gain a wider perspective. Bearing the aforementioned correlates in mind, clinicians may find a thorough assessment of deliberate self-harm and AN-related rituals useful for formulation and treatment planning, in those with overlapping inefficiencies.

Individual and group intervention designed to address these characteristics are proving acceptable to AN patients and effective at remediating neurocognitive inefficiencies in a variety of clinical settings (for a systematic review, see Tchanturia, Lounes, & Holttum, 2014). Using tasks and puzzles to encourage flexibility and gestalt thinking through reflection, the therapist aims to increase neuroplasticity on a variety of nonthreatening tasks that can then be generalised to eating disorder behaviours and cognitions. Neurocorrelate research suggests that this approach might change the efficacy of cognitive processing at a functional level (Fonville et al., 2014), which is a promising finding given growing evidence for a disruption in functional connectivity in women with AN when engaging in effortful shift/response inhibition tasks (Collantoni et al., 2016; Zastrow et al., 2009). Even in the absence of a targeted neurocognitive intervention, early screening of neurocognitive profile (either using neuropsychological assessment or a targeted self-report measure such as the Detail and Flexibility Questionnaire (Roberts, Barthel, Lopez, Tchanturia, & Treasure, 2011) may help foster engagement and motivation in the early stages of treatment, by providing the clinician with less threatening yet still personalised content to focus on in-session.

The results presented here are exploratory and therefore have notable limitations. Although the overall sample size is acceptable for a neurocognitive investigation, uneven sample sizes when split by neurocognitive profile make statistical analysis problematic. The statistical criteria used to identify cases with poor set-shifting and weak coherence was broad (1 SD from HC norm), reflected by only two of the current cohort showing no neurocognitive inefficiencies. Employing this lenient criterion was in line with the stated aim to investigate subtle neurocognitive inefficiencies rather than stark impairments in functioning, however may have overstated the number of cases with clinically meaningful neurocognitive biases. It is also of note that the current cohort is a subset of that reported on previously in the literature as part of a larger study. The focus of the current analysis on those with overlapping inefficiencies is however novel. Despite these limitations, the current findings contribute to the literature by alerting clinicians and researchers to the approximate prevalence of these neurocognitive features presenting simultaneously in the outpatient setting, together with their likely clinical correlates.

Future work should replicate and extend these findings using larger samples and more sophisticated statistical analyses. Such investigations should be mindful to continue using a hypothesis driven approach in order to avoid the administration of long uninformative neurocognitive batteries (Tchanturia, Campbell, Morris, & Treasure, 2005). Larger datasets are available in the literature for specific neurocognitive measures such as the WCST and the Brixton Task (Tchanturia et al., 2012; Tchanturia et al., 2011), providing both clinicians and researchers with norms stratified by patient type. Longitudinal work will allow the field to understand the clinically meaningful impact of neurocognitive profile on illness recovery.

Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Table 1: Demographic and clinical features for women with AN and either one or both neurocognitive inefficiencies (poor set-shifting; attention to detail).

	One inefficiency (n=41)	Overlapping inefficiencies (n=11)	Cohen's d
Age	24.05 (6.23)	24.27 (6.50)	-0.03
Years of education	15.33 (2.39)	15.46 (3.53)	0.05
Age of onset	17.15 (4.48)	16.64 (2.54)	0.12
Duration of illness	6.98 (4.70)	7.45 (6.04)	0.33
SCID severity rating	2.12 (0.71)	1.73 (0.91)	0.52*
Current BMI	17.59 (1.93)	16.93 (2.36)	0.33
Lowest BMI	14.17 (1.67)	13.42 (2.48)	0.40
Self-harm	35.9%	54.5%	0.58*
YBC-EDS preoccupations	12.58 (2.50)	12.30 (2.26)	0.11
YBC-EDS rituals	11.68 (3.27)	13.20 (2.90)	0.48*
Y-BOCS obsessions	6.64 (6.66)	8.78 (7.23)	0.32
Y-BOCS compulsions	8.21 (6.56)	7.00 (6.27)	0.19
HADS Anxiety	11.51 (4.77)	11.09 (5.43)	-0.09
HADS Depression	6.38 (3.42)	7.09 (6.02)	-0.17
Frost Perfectionism Scale	98.44 (15.89)	95.41 (17.56)	0.19
OCI-R	21.42 (15.58)	19.14 (12.15)	0.15

SCID Structured Clinical Interview for DSM-IV; BMI Body Mass Index; YBC Yale-Brown-Cornell Eating Disorder Scale; Y-BOCS Yale-Brown Obsessive-compulsive Inventory; HADS Hospital Anxiety and Depression Scale; OCI-R Obsessive-compulsive Inventory-Revised

* Cohen's d effect size considered "moderate" at approximately 0.5 (Cohen, 1988)

Author note:

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