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Are orthorexia nervosa symptoms associated with cognitive Inflexibility?

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ABSTRACT

This study investigated whether symptoms of orthorexia nervosa, a conjectured disorder characterized by obsessive thoughts and compulsive behaviors regarding healthy eating, are associated with cognitive inflexibility. Participants (25 in the orthorexia symptoms group, 25 in the control group) completed the Eating Habits Questionnaire and computerized versions of the Wisconsin Card Sorting Test and the Trail Making Test. Of the 11 variable measurements from these cognitive tests, only one significantly differed between the groups, with the orthorexia symptoms group making more errors than the control group on the first part of the Trail Making Test that does not actually require any set shifting. These results suggest that although orthorexia is associated with inflexible thoughts and behaviors specific to healthy eating, the condition does not seem to be associated with cognitive inflexibility as an executive function deficit.

1. Introduction

Orthorexia nervosa (ON) is a conjectured eating disorder that involves a pathological preoccupation with and strict adherence to a diet that the person perceives to be healthy and pure (Bratman and Knight, 2000; Dunn and Bratman, 2016; Moroze et al., 2015). Although ON is not currently recognized as a psychiatric disorder in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (American Psychiatric Association, 2013), based on two decades of empirical research and clinical case studies, Dunn and Bratman (2016) contend that ON is a legitimate disorder with the following diagnostic criteria: (1) obsessive mental preoccupation and compulsive behavior regarding a restrictive diet that the individual believes is healthy; (2) dietary violations causing an exaggerated fear of illness, sense of impurity, and feelings of shame; (3) dietary rules escalating over time and including complete elimination of entire food groups and frequent fasts or cleanses in an attempt to purify the body; (4) malnutrition and corresponding medical complications resulting from a severely restrictive diet; (5) impairments in personal, social, vocational, or academic functioning resulting from their obsessive preoccupation and compulsive behavior; and (6) their self-worth and satisfaction being excessively dependent on their strict adherence to their restrictive diet.

Research shows that ON symptoms are positively correlated both with tendencies that characterize individuals with obsessive-compulsive disorder (OCD; Asil and Surucuoglu, 2015; Bundros et al., 2016; Gleaves et al., 2013; Hayes et al., 2017; Koven and Senbonmatsu, 2013) and with disordered eating behaviors that characterize individuals with anorexia nervosa (AN; e.g., Bo et al., 2014; Bundros et al., 2016; Gleaves et al., 2013; Hayes et al., 2017; Segura-Garcia et al., 2012, 2015). Relevant to OCD, people with ON demonstrate recurrent, intrusive thoughts and obsessions about health and food, as well as compulsions such as strong urges to eat in a ritualized manner (Koven and Abry, 2015; Koven and Senbonmatsu, 2013) and to follow a rigid schedule of specific exercise activities (Haman et al., 2017; Oberle et al., 2018; Segura-Garcia et al., 2012). Relevant to AN, ON and AN share such common characteristics as perfectionism, anxiety, and extreme control over their environment that includes but is not limited to their diet (Bundros et al., 2016; Koven and Abry, 2015). Further, similar to AN, ON has been associated with low body satisfaction and high preoccupation with being or becoming overweight for women but not for men (Brytek-Matera et al., 2015), as well as certain lifestyle habits that include greater sport and exercise activity (Hyrnik et al., 2016; Malmborg et al., 2017; Oberle et al., 2018; Segura-Garcia et al., 2012; Varga et al., 2013, 2014).

In light of these findings, some researchers believe that ON and AN should be considered as a continuum of the same psychopathological dimension with different grades of severity (Dell'Osso et al., 2016, 2018b; Gramaglia et al., 2017). This psychopathological dimension has further been extended to include autism spectrum disorders (ASD; Dell'Osso et al., 2016; Gillberg et al., 2010), consistent with research showing that compared to healthy controls, people with AN exhibit more behavioral and cognitive traits that are characteristic of ASD, including restricted and repetitive behaviors, behavioral and cognitive inflexibility, and deficits in social skills, communication, and theory of mind (Dell'Osso et al., 2018a; Huke et al., 2013; Tchanturia et al., 2013; Treasure, 2013; Westwood et al., 2016). Yet, ON seems to differ from AN regarding gender and BMI. With AN, a low BMI is a diagnostic criterion for the disorder (American Psychiatric Association, 2013), and women outnumber men in prevalence of AN with an average ratio of 9:1 (Fisher et al., 2014; Forman et al., 2014; Nicely et al., 2014; Norris

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et al., 2014). In contrast, a recent literature review revealed that seven out of seven studies found ON symptoms to be either unrelated or positively correlated with BMI, and that nine out of 12 studies found that ON symptoms either do not significantly differ between men and women or are greater in men than in women (Oberle et al., 2017). Thus, ON may have unique manifestations in spite of an overlapping neuropsychological profile with AN, OCD, and ASD.

Another commonality between ON and all of these disorders could be cognitive inflexibility, or the inability to adapt one's thoughts and behaviors in response to new information or events. Such inflexibility may be seen in the extreme rigidity of ON thoughts (e.g., unwavering belief that their diet is superior to others' diets) and behaviors (e.g., eating specific quantities of specific foods prepared in specific ways and eaten at specific times). In the only published investigation of cognitive inflexibility associated with ON, Koven and Senbonmatsu (2013) had participants complete the Wisconsin Card Sorting Test (WCST) and Trail Making Test (TMT), which are two well-known neuropsychological tasks assessing cognitive flexibility, or set shifting. Of the four performance measures that they selected to use from these two tests, only one had significant group differences, whereby the control group had more correct responses on the WCST than did the ON group. Regarding the other disorders, several studies have demonstrated cognitive inflexibility through impaired performance on the WCST and TMT in individuals with AN (e.g., Abbate-Daga et al., 2011; Aloi et al., 2015; Buzzichelli et al., 2018; Roberts et al., 2010; Spitoni et al., 2018) and in individuals with OCD (e.g., Abramovitch et al., 2013; Moritz et al., 2001; Ozcan et al., 2016; Tükel et al., 2012; Wen et al., 2014).

A potential problem with the work by Koven and Senbonmatsu (2013) is their use of the ORTO-15 (Donini et al., 2005) as a measure of ON. A recent literature review (Oberle et al., 2017) revealed that the mean Cronbach's alpha measure of internal consistency for the ORTO-15 among six studies was 0.55 (SD = 0.27). Moreover, with the recommended ORTO-15 threshold score of 40, the mean ON prevalence rate among 11 studies was 55% (SD = 24%), far higher than the estimated prevalence rate of 1% based on recently proposed diagnostic criteria (Dunn and Bratman, 2016; Dunn et al., 2017). This threshold score was also associated with a high false alarm rate (i.e., incorrectly diagnosed with ON) of 28% and a high miss rate (i.e., failure to correctly diagnose with ON) of 44% (Donini et al., 2005). These problems with the measure's validity and reliability could be due to the fact that some questions apply to beliefs rather than to behaviors (e.g., “Do you think that consuming healthy food may improve your appearance?”), some apply more to AN than to ON that is theoretically more concerned with quality than quantity of food (e.g., “When eating, do you pay attention to the calories of the food?”), some are not relevant to all geographic regions (e.g., “Do you think that on the market there is also unhealthy food?”), and some are confusing in meaning (e.g., “When you go in a food shop, do you feel confused?”).

Further, pertaining to the proposed diagnostic criteria for ON (Dunn and Bratman, 2016) that were described in the first paragraph of this introduction, the majority of questions on the ORTO-15 pertain only to Criterion 1. This measure does not include any items relevant to Criteria 3 or 4, and it includes only one item relevant to Criterion 2, two items relevant to Criterion 5, and one item relevant to Criterion 6. An alternative measure of ON could be the Eating Habits Questionnaire (EHQ; Gleaves et al., 2013), which has 11 items relevant to Criterion 1, one item relevant to Criterion 3, six items relevant to Criterion 5, and three items relevant to Criterion 6. Thus, while both scales assess an individual's obsessive mental preoccupation and compulsive behavior regarding “healthy” eating (Criterion 1) with several items, the EHQ has 10 items assessing other important aspects of ON that predominantly include clinical impairments resulting from the individual's eating behaviors (Criteria 2–6), whereas the ORTO-15 only has four such items. As described in the method section below, the EHQ also has good internal consistency, test-retest reliability, and construct validity.

The current study seeks to operationally replicate the work of Koven and Senbonmatsu (2013), investigating the possible cognitive inflexibility associated with ON, but using a more valid and reliable measure of ON and including additional performance measures for the WCST and TMT. Based on the overlap between ON and both AN and OCD, combined with past research demonstrating impaired set shifting in both AN and OCD, we hypothesized that ON symptoms would be associated with cognitive inflexibility through impaired performance on the WCST and TMT. In particular, we hypothesized that compared to a control group, an ON symptoms group would have more perseverative responses and errors on the WCST, as well as more errors and longer completion times for Trail B of the TMT.

2. Method

2.1. Participants

For this study, 453 undergraduate students at a large university in the southern region of the United States completed the EHQ (Gleaves et al., 2013), and from this initial pool of participants, as described in detail in the following section, 25 (6 men, 19 women) comprised the ON symptoms group and 25 (3 men, 22 women) comprised the control group. For these latter 50 selected participants, their ages ranged from 18 to 34 years (M = 21.30, SD = 2.43), and based on self-reported ethnicity, the majority were Caucasian (44%), Hispanic or Latino (34%), or African American (10%). Informed consent was obtained from all participants, and in exchange for their participation, they were entered into a drawing for one or four $25 gift certificates for Amazon.com.

2.2. Measures and procedure

2.2.1. Assessment of ON symptoms

For the first part of this study, undergraduate students in several different psychology courses were invited to complete online the EHQ (Gleaves et al., 2013), a 21-item measure of ON symptomology. As demonstrated by Oberle et al. (2017), the EHQ includes a Behaviors scale with eight items about healthy eating behaviors (e.g., “I follow a health-food diet rigidly” ; Cronbach's alpha = 0.87) and a Problems scale with nine items about problems or impairments that are associated with those behaviors (e.g., “My healthy eating causes significant stress in my relationships” ; Cronbach's alpha = 0.79). For the current study, the Cronbach alpha values were 0.88 for the composite questionnaire with all items, 0.86 for the Behaviors scale, and 0.71 for the Problems scale. The EHQ also has excellent test-retest reliability with a test-retest coefficient of 0.78 (Gleaves et al., 2013). Moreover, Gleaves et al. established the construct validity of the EHQ, finding its scores positively correlated with levels of both obsessive-compulsive tendencies and disordered eating behaviors, consistent with past research that found these same correlations but using a different measure of ON (Asil and Surucuoglu, 2015; Bo et al., 2014; Bundros et al., 2016; Hayes et al., 2017; Koven and Senbonmatsu, 2013; Segura-Garcia et al., 2012, 2015).

A total of 453 students completed the EHQ, and the scores determined eligibility for inclusion into the ON symptoms group and the control group. For ON symptoms group eligibility, the total EHQ score had to be within the top 25th percentile, and the average Likert ratings for both the Behaviors and Problems scales had to be at least 2 (i.e., “slightly true”) reflecting that the statements about healthy eating behaviors and corresponding problems described them at least slightly. The latter criterion is especially important because many people who are committed to healthy eating would not be at risk of ON if they do not experience any problems as a result of their eating behaviors (Dunn and Bratman, 2016; Moroze et al., 2015). Comparably, for control group eligibility, the total EHQ score had to be within the bottom 25th percentile, and the average Likert ratings for both the Behaviors and Problems scales had to be less than 1.5 (i.e., closer to “not at all true” than to "slightly true"), reflecting that the statements about healthy eating behaviors and corresponding problems did not describe them. Of the students completing the EHQ, 56 were eligible for inclusion into the ON symptoms group, and 91 were eligible for inclusion into the control group.

2.2.2. Assessment of cognitive flexibility

For the second part of this study, 106 eligible students (all 56 who were eligible for the ON symptoms group and a randomly selected sample of 50 who were eligible for the control group) were invited to complete computerized versions of the WCST (Grant and Berg, 1948) and the TMT (Reitan, 1958) with the Inquisit software (www.millisecond.com). Of those eligible, 25 in the ON symptoms group and 25 in the control group completed both cognitive tests.

In the WCST, participants are given a deck of 128 cards to sort into four piles marked by the following cards: one red triangle, two green stars, three yellow crosses, and four blue circles. Participants are never told the sorting rule (i.e., sorting by number, color, or shape); instead, the word "correct" appears when they place the card in the correct pile, and the word "wrong" appears when they place the card in an incorrect pile. The sorting rule changes after 10 consecutive correct responses, and the test ends when the participant either runs out of cards or successfully completes six categories: two for each sorting rule. The variables for this test are total errors (number of incorrect responses), percent perseverative errors (percent of errors that were perseverative), percent perseverative responses (percent of responses that were perseverative), categories completed (number of the six sequences of 10 consecutive correct responses that were completed), failure to maintain set (number of errors made once a rule is known, as evidenced by five consecutive correct responses), trials to complete first category (number of trials taken to complete the first sequence of 10 consecutive responses), and learning to learn index (average difference in percent errors between successive categories, with positive values reflecting fewer errors on the next category).

In the TMT, participants are instructed to move the computer mouse to draw lines from node to node as fast as possible. Trail A includes numbers only, with lines being drawn from 1 to 2, 2 to 3, and so on; whereas Trail B includes numbers and letters, with lines being drawn from 1 to A, A to 2, 2 to B, and so on. For each trail, the variables were errors (number of errors made) and completion time (time taken to complete the trail).

3. Results

Independent t tests were conducted to evaluate group differences on each variable from the WCST and TMT (see Table 1). For all tests, an alpha level of 0.05 was used to determine statistical significance based on the probability values, and Cohen's d was calculated as a measure of effect size. Based on the recommendations of Cohen (1988), a Cohen's d value of 0.2 was considered a "small effect," 0.5 was considered a "medium effect," and 0.8 was considered a "large effect." For the WCST, although none of the group differences were statistically significant, small effects were found for four variables: total errors (Cohen's $d = 0.21$), percent perseverative responses (Cohen's $d = 0.20$), categories completed (Cohen's $d = 0.30$), and learning to learn index (Cohen's $d = 0.36$). Compared to the control group, whereas the ON symptoms group made more errors, completed fewer categories, and had a lower learning to learn index, they also had a lower percent of perseverative responses. For the TMT, there was one statistically significant difference, with the ON symptoms group making more errors than the control group on Trail A ($p = 0.02$). Aside from the difference on this variable, two other variables had small effects: Trail A completion time (Cohen's $d = 0.30$) and Trail B errors (Cohen's $d = 0.28$). Compared to the control group, the ON symptoms group took longer to complete Trail A, but they also made fewer errors on Trail B. On a final note, the ON symptoms group and the control group did not significantly differ on the demographic characteristics of age, $t(48) = 1.47$, $p = 0.15$, Cohen's $d = 0.41$, or gender, $\chi^2 = 1.22$, $p = 0.27$.

4. Discussion

The results failed to support our hypothesis that ON symptoms would be associated with cognitive inflexibility. For the WCST, based on small and statistically non-significant effects (i.e., p value greater than 0.05 and Cohen's d value greater than 0.2), although the ON symptoms group performed slightly worse than the control group in terms of total errors and categories completed, they had fewer perseverative responses, which are the type of responses associated with cognitive inflexibility. For the TMT, although the ON symptoms group performed worse than the control group on Trail A with numbers only, they had fewer errors on Trail B, which is the trail that requires cognitive flexibility with the continuous switching between numbers and letters. Perhaps the ON symptoms group had more errors on Trail A and more total errors on the WCST than the control group due to a lack of effort, a possibility that may warrant further investigation. Regardless, as indicated above, neither of these errors are the ones associated with cognitive inflexibility.

Our findings are consistent with the only published investigation of cognitive inflexibility in people with ON symptoms, whereby Koven and Senbonmatsu (2013) found that the ON group had fewer correct responses than the control group on the WCST, but that the groups did not significantly differ on the other WCST variables, on the TMT Trail B, or on a verbal fluency set-shifting task. Based on this early research, ON symptoms do not seem to correspond to cognitive inflexibility. This tentative conclusion contrasts with research showing

Table 1
Group differences on the cognitive tests.

	Control group *M* (*SD*)	ON symptoms group *M* (*SD*)	*t*	*p*	Cohen's *d*
Wisconsin Cart Sorting Test					
Total errors	28.40 (18.42)	32.56 (20.74)	–0.75	0.46	0.21
Percent perseverative errors	36.92 (22.78)	33.44 (23.84)	0.53	0.60	0.15
Percent perseverative responses	10.66 (4.92)	9.76 (4.21)	0.70	0.49	0.20
Failure to maintain set	1.20 (1.63)	1.32 (1.68)	–0.26	0.80	0.07
Categories completed	5.32 (1.28)	4.88 (1.62)	1.07	0.29	0.30
Trials to complete first category	14.40 (5.63)	14.12 (5.51)	0.18	0.86	0.05
Learning to learn index	1.28 (2.50)	0.09 (3.93)	1.27	0.21	0.36
Trail Making Test					
Trail A errors	1.00 (1.08)	2.00 (1.83)	–2.36	0.02	0.67
Trail A completion time (s)	42.74 (12.34)	47.01 (16.03)	–1.05	0.30	0.30
Trail B errors	3.00 (2.48)	2.32 (2.39)	0.99	0.33	0.28
Trail B completion time (s)	58.03 (15.41)	56.16 (17.59)	0.40	0.69	0.11

Note. The degrees of freedom for each test were 48.

that cognitive inflexibility is characteristic of individuals with AN (e.g., Abbate-Daga et al., 2011; Aloi et al., 2015; Buzzichelli et al., 2018; Roberts et al., 2010; Spitoni et al., 2018) and individuals with OCD (e.g., Abramovitch et al., 2013; Moritz et al., 2001; Ozcan et al., 2016; Tükel et al., 2012; Wen et al., 2014). Thus, despite the overlap between ON and AN (Bo et al., 2014; Bundros et al., 2016; Gleaves et al., 2013; Hayes et al., 2017; Koven and Abry, 2015; Segura-Garcia et al., 2012, 2015) and between ON and OCD (Asil and Surucuoglu, 2015; Bundros et al., 2016; Gleaves et al., 2013; Haman et al., 2017; Hayes et al., 2017; Koven and Senbonmatsu, 2013; Oberle et al., 2018), ON appears to be a unique condition that differs from AN and OCD, at least with respect to cognitive flexibility.

The current study was not without its limitations, however. First, we did not control for comorbidity with AN or OCD, nor did we control for perfectionism, intelligence, or attention deficits that could impact performance on set-shifting tasks. Second, participation in this study was limited to college students who were not assessed with a clinical interview to determine ON diagnosis. Future research should attempt to replicate this study but controlling for the potentially confounding variables identified above, and recruiting a more diverse sample that includes participants of all age ranges and all levels of education, as well as participants from community settings such as health centers to increase the range of clinical ON symptoms. Another limitation of the current study is that the ON symptoms group included individuals with total EHQ scores in the top 25th percentile and meeting conservative criteria on the EHQ Behaviors and Problems scales reflecting that the statements about healthy eating behaviors and corresponding problems described them at least slightly. Thus, this ON symptoms group included individuals who may have some symptoms or characteristics of ON but who may not meet the diagnostic criteria proposed by Dunn and Bratman (2016). Based on subsequent research guided by those diagnostic criteria, Dunn et al. (2017) estimate that the prevalence of ON is less than 1%, comparable to the 1% prevalence rate of AN in the population (Hudson et al., 2007). Future research should explore a more appropriate method of diagnosis, beyond the ORTO-15 or EHQ, and then test for differences in cognitive flexibility between a clinical ON group and control group. Finally, another important limitation to the current study is low statistical power at 0.17 assuming that the effect size in the real world is small. Replication with a greater sample size is needed.

5. Conclusion

Consistent with the previously discussed overlap in symptomatology and characteristics between ON and AN, some researchers theorize that these two disorders are on a continuum of the same psychopathological dimension that may even include ASD. If this theory is true, then given past research showing cognitive inflexibility in patients with AN, we might also expect cognitive inflexibility to be a trait associated with ON. However, the current study's findings do not support this prediction, as the ON symptoms group did not perform significantly worse than the control group on any of the variables that relate to cognitive flexibility (i.e., perseverative responses and errors on the WCST, Trail B errors and response time on the TMT). In fact, although statistically insignificant ($p > 0.05$), compared to the control group, the ON symptoms group made fewer perseverative responses (Cohen's $d = 0.20$) and fewer Trail B errors (Cohen's $d = 0.28$). Moreover, this study found no statistically significant gender differences between the groups, consistent with the majority of past research investigations finding that ON symptoms are not more common in women than in men, in contrast to the significantly greater prevalence of AN in women. Thus, the current study suggests that ON may have manifestations that are distinct from AN, lending support to it being considered a unique eating disorder despite some overlap and/or comorbidity between the two conditions.

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Conflict of interest

The authors declare no conflicts of interest.

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