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Set Shifting Among Adolescents with Anorexia Nervosa

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Abstract

Objective—Set shifting difficulties are documented for adults with anorexia nervosa (AN). However, AN typically onsets in adolescents and it is unclear if set-shifting difficulties are a result of chronic AN or present earlier in its course. This study examined whether adolescents with short duration AN demonstrated set shifting difficulties compared to healthy controls (HC).

Method—Data on set shifting collected from the Delis-Kaplan Executive Functioning System (DKEFS) and Wisconsin Card Sort Task (WCST) as well as eating psychopathology were collected from 32 adolescent inpatients with AN and compared to those from 22 HCs.

Results—There were no differences in set-shifting in adolescents with AN compared to HCs on most measures.

Conclusion—The findings suggest that set-shifting difficulties in AN may be a consequence of AN. Future studies should explore set-shifting difficulties in a larger sample of adolescents with the AN to determine if there is sub-set of adolescents with these difficulties and determine any relationship of set-shifting to the development of a chronic form of AN.

Keywords

Neurocognition; Anorexia Nervosa; Adolescents; Set Shifting; Cognitive Flexibility

Some have suggested that the cognitive style of adults with anorexia nervosa (AN) may be an endophenotype for AN. One feature of this cognitive style is described as cognitive inflexible (difficulties in set-shifting) and these problems have been observed in people with AN across a variety of tasks [1]. Set shifting, or cognitive flexibility, refers to the ability to move back and forth between tasks, operations, and sets [1]. Clinical observations of AN patients document thinking styles that are persistent, rigid, conforming, and obsessional [2, 3]. Such inflexibility may make patients with AN less likely to agree and/or respond to treatment [4]. Studies on set-shifting ability among adults with AN are consistent with these clinical observations [5]. Systematic neuropsychological studies find that adults with AN take significantly longer to shift set than subjects with similar IQs who did not have AN [1].

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In addition, set shifting difficulties appear to be familial. In a study comparing set-shifting in 47 pairs of sisters discordant for AN and 47 healthy unrelated women who were comparable in age and IQ, the authors found that sisters with and without AN took significantly longer than unrelated healthy women to shift their cognitive set and demonstrated greater perceptual rigidity [4]. Set shifting difficulties do not appear to be related to malnutrition as they persist in women who are weight recovered [1][6–8]. Nonetheless, data suggest there is an improvement in set-shifting in AN participants following weight-restoration on specific tasks, including the WCST [9] thus weight recovery may partially remediate some of these difficulties. Together, these studies strengthen the argument that set-shifting difficulties are a potential endophenotype for AN. However, these data are largely limited to adult, often, chronically ill samples [1, 9]. As a result, it is unclear if set shifting problems are primary deficits or result from the illness over time. Without equivalent studies among adolescents with short duration AN, it is impossible to rule out the effect of chronic malnutrition, or habit effects associated with chronic AN.

Because adolescence is both the period during which AN develops and a period of rapid development of cognitive function, the examination of these processes in adolescents is essential to the discussion of these processes in AN. In one previous study by Hatch and colleagues [10], the authors found motor speed difficulties in acute AN as well as some differences in interference tasks, as measured by a Go-No-Go paradigm. More interestingly, relative to themselves, adolescent participants with AN improved significantly following weight restoration. Due to differences in the types of tests administered, comparison with adult samples is difficult, but these results suggest that for adolescents executive functioning skills are attenuated during acute illness and may represent state markers of illness rather than traits [10]. To shed additional light on this issue, the current study utilized the same measures given to adult samples to allow a one-on-one comparison on task performance in this group. Based on the data on adults with chronic AN, we hypothesized that adolescents with AN would have inefficiencies in set shifting and motor speed compared to a healthy comparison sample.

Method

Recruitment and procedure

Participants were recruited from a pediatric inpatient service treating medical problems associated with adolescent eating disorders. Participants were approached by members of the treatment team who introduced potential participants to research staff. Consent was obtained from parents/guardians and signed assent for participation was gathered from participants. Participants over 18 signed consent forms for themselves. Adolescent females with AN or partial AN (defined as meeting all DSM IV criteria for AN amenorrhea) between the ages of 12 and 18 years were eligible for inclusion. 32 participants were recruited over 2 years. Exclusion criteria for participants included: a history of head injury with loss of consciousness, seizures, psychosis, neurocognitive disorders, lack of proficiency in English and a current diagnosis of Bulimia Nervosa or ED-Not Otherwise Specified. A total of 22 healthy controls were recruited from sources in the community. Controls had no significant psychiatric history, no family member with a history of ED and were normal weight (> 85%

Mean Body Weight). All assessors were trained, certified and supervised by a licensed clinical psychologist.

Measures

Participants completed self-report questionnaires and a neuropsychological assessment battery for assessment of general intelligence, eating psychopathology, and set-shifting tasks.

General Intelligence

Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV)[11] /Wechsler Adult Intelligence Scale, Third Edition [12](WAIS-III): The WISC-IV and WAIS-III are assessments of intellectual and cognitive functioning in children, ages 6 to 16, and adults ages 16–89 respectively. In the current study, only four core subtests of the WISC-IV and WAIS-III were administered: Block Design, Similarities, Vocabulary, and Matrix Reasoning. Prorated IQ scores were used in this evaluation as estimates of full IQ.

Set Shifting Tasks

Wisconsin Card Sorting Test: Computerized Version, Fourth Edition (WCST-CV4) [13]: The WCST is a neuropsychological test of set-shifting ability. In addition to set shifting the WCST assesses a number of cognitive abilities: memory, attention, and visual processing. Raw scores were used in this analysis.

Delis-Kaplan Executive Functioning Scales (D-KEFS)[14] Selected subtests: The D-KEFS is a comprehensive, standardized assessments of executive functioning that can be used with both children and adults, ages 8–89 years. Selected subtests administered included: Trail Making Test, a measure of motor and visual set-shifting abilities; Verbal Fluency, which tests verbal set-shifting abilities and Color Word Interference, a measure of verbal inhibition and set-shifting abilities. Unlike a standard Stroop paradigm, however, the DKEFS Color Word Interference task adds a switching task, in which participants must switch between color and word naming sets.

Brixton Spatial Anticipation Task.[15]: The Brixton is a computer-administered test that presents the examinee with ten numbered circles, with one filled in blue [15]. The blue circle moves around according to various patterns that change after a set is completed. Participants identify where the blue circle will move next and must reason through the pattern. The test consists of 56 trials with 8 rule changes. Set shifting difficulty is measured by the number of times a participant incorrectly predicts where the circle will move.

Eating Psychopathology

Eating Disorder Examination-Self Report (EDE-Q)[16]: The Eating Disorder Examination Questionnaire (EDE-Q) is a well validated measure that asks participants to rate eating, shape, and weight concerns from the past 28 days in a 7-point, Likert-type scale.

Ethical Approval

The protocol and consent processes associated with this study were approved by Stanford's Institutional Review Board

Data Analysis

Group means for demographic and outcome variables were compared using independent t-tests. To guard against Type-1 error, alpha was adjusted using Bonferonni correction to .006 (.05/8). Cohen's *d* effect sizes were calculated for all comparison variables.

Results

Baseline characteristics for the groups can be seen in Table 1. As expected, AN patients had significantly lower percent mean body weight than adolescent healthy controls. The groups did not differ on any other demographic variable. As expected the AN group demonstrated significantly slower motor speed. However, contrary to our prediction based on adult findings, we found no significant differences between the groups on any of the measures of set shifting. Further, the effect sizes on the comparisons were generally small. Only the WCST number of categories completed and Brixton task had medium effect sizes.

Discussion

This study assessed set-shifting inefficiencies in adolescents with AN. We failed to find convincing evidence from our assessment battery to suggest that adolescents with AN performed differently on set-shifting tasks compared to adolescent HCs. These findings differ from those in adults with AN, but are consistent with one previous study on adolescents with AN that used a different neurocognitive assessment battery which also found no evidence of cognitive flexibility inefficiency in adolescent AN other than slower motor speed during a period of acute malnutrition. The similar performance of adolescents with and without AN suggests that the neurocognitive inefficiencies observed among adults with AN may be a result of chronic illness. Younger patients with AN who are at risk for developing a chronic course may have a greater tendency to develop set shifting inefficiencies in the context of continued dietary restriction and weight loss. Thus, although they are not different from peers in terms of cognitive flexibility at the early stages of AN, they are at risk for not developing or maintaining cognitive flexibility as they grow older. While this idea is speculative, it is supported by the findings of previous studies that have found evidence of impaired performance on the WCST [9] and the Brixton among adults [17]. In addition, in the current sample, performance of adolescents with AN was similar to reported means for recovered adults with AN [9][17], supporting the notion that adolescents who remain ill into adulthood may fail to achieve the level of cognitive flexibility expected of adults.

An alternative explanation of these findings may be that although on average there is no statistical difference between adolescents with AN and HCs on set-shifting tasks, there may be a subset of patients for whom poor set-shifting is present but undetected in our cross-sectional sample. This may be important if a subset does exist and the presence of an inflexible cognitive style increases the risk of developing a chronic course of AN. It may be that the precise nature of the cognitive inflexibility is that detected by the Brixton,

explaining the moderate effect size observed in this test. To answer this question adequately however, a larger sample utilizing a prospective study design would be ideal. However another strategy that may allow an approximate examination of this question, would be to explore taxons within a larger data set that utilized multiple assessment tools and an evaluation of compensatory strengths and across illness severity levels.

One important limitation of this study is the relatively small sample size. It is possible, particularly with a limited sample size for both the patient participants and healthy controls, that results may be sensitive to individual differences as well as age effects. Addressing this limitation would require a much larger sample, structured across specific age ranges, with evaluation of issues related to premorbid functioning. Additionally, to account for any rebound effect due to weight restoration as observed by Hatch and colleagues, follow-up, particularly post-weight restoration, would help to parse state versus trait effects of malnourishment. It is noteworthy as well that the adolescent AN sample used in this study was not as severely malnourished as the adult AN samples. Also, the contribution of possible co-morbid psychiatric disorders was not assessed in this study. Evaluations of neurocognitive functioning among adults with acute and remitted OCD indicate a pattern of results similar to that presented by adults with AN (e.g., set shifting and motor speed weaknesses). Nonetheless, while our sample size is small and findings needs to be replicated, the lack of strong indication within the data that set-shifting inefficiencies were present argues against the notion that cognitive inflexibility is an endophenotype or biomarker for AN.

Adolescents with AN appear to respond better to treatment, and it is possible that part of the reason for this is that they do not have difficulties in set shifting allowing them to participate and learn better in treatment. However, if problems with cognitive flexibility result from a persistent course of AN, this provides further support for the importance of early intervention and treatment efforts.

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Table 1

Demographic and descriptive variables (means [standard deviations]) for the groups

	AN	HC	T	p	Cohen's d
Age (years)	14.93 (1.88)	15.40 (1.89)	.894	.376	.26
%MBW	78.04 (6.55)	105.69 (12.83)	9.566	<.001	2.93
Estimated IQ	119.53 (14.50)	119.52 (11.95)	.003	.998	.00
Motor Speed	32.23 (12.59)	24.00 (6.30)	2.780	.008	.80
Verbal fluency	13.50 (3.87)	14.38 (4.01)	.665	.510	.05
Previous treatment	25%	0%	-	-	-
Previous ED hospitalization	6.3%	0%	-	-	-
EDEQ-RES	3.18 (1.52)	NA	-	-	-
EDEQ-EC	2.00 (1.61)	NA	-	-	-
EDEQ-WC	3.50 (1.97)	NA	-	-	-
EDEQ-SC	2.92 (2.00)	NA	-	-	-
EDEQ-Global	2.74 (1.70)	NA	-	-	-

Note: AN=anorexia nervosa group; HC= healthy control group; MBW = Mean Body Weight; EDEQ=Eating Disorder Examination-Questionnaire;

Investigation of difference between adolescents with AN and healthy controls on the primary outcome variables (means [standard deviations]).

Table 2

	AN (n = 32)	HC (n=22)	T	p	d
Trails Number Letter Sequencing (Seconds)	61.19 (23.19)	63.95 (17.51)	.458	.649	.13
Color word interference (inhibition/switch)	55.17 (9.97)	53.40 (11.63)	.568	.573	.16
Verbal fluency category switching	12.39 (3.65)	12.20 (3.42)	.185	.854	.05
WCST Perseverative Responses	6.22 (3.17)	6.52 (3.30)	.314	.755	.06
WCST Perseverative Errors	6.07 (2.88)	6.31 (2.98)	.276	.784	.08
WCST Non-Perseverative Errors	6.44 (4.90)	5.68 (5.28)	.501	.619	.13
WCST Categories Completed	6.00 (0.00)	5.94 (.22)	1.000	.331	.46
Brixton raw score	11.15 (6.64)	8.57 (3.65)	1.525	.135	.40

Note: All variables are raw scores; AN=anorexia nervosa group; HC=healthy control group; WCST = Wisconsin Card Sort Task.