Published in final edited form as:
Psychosom Med. 2012 October ; 74(8): 869–872. doi:10.1097/PSY.0b013e31826af636.

Set-shifting among adolescents with bulimic spectrum eating disorders

Alison M Darcy, PhD[1], **Kathleen Kara Fitzpatrick, PhD**[1], **Danielle Colborn, PhD, BA**[1], **Nandini Datta, BS**[1], **Vandana Aspen, PhD**[1], **Colleen Stiles Shields, MA**[2], **Daniel Le Grange, PhD**[2], and **James Lock, MD, PhD.**[1]

[1]Child and Adolescent Psychiatry, Stanford University School of Medicine, Department of Psychiatry and Behavioral Sciences, 401 Quarry Road, Stanford, CA 94305

[2]Department of Psychiatry and Behavioral Neuroscience, The University of Chicago Medical Center, 5841 S. Maryland Ave., Chicago, IL 60637

Abstract

Objective—Set-shifting difficulties are observed among adults with bulimia nervosa (BN). This study aimed to assess whether adolescents with BN and BN-spectrum eating disorder (EDs) exhibit set-shifting problems relative to healthy controls.

Methods—Neurocognitive data from 23 adolescents with BN were compared to 31 adolescents with BN-type ED Not Otherwise Specified (EDNOS-BN); and 22 healthy controls (HC) on various measures of set-shifting (Trail Making Task [shift task], Color-Word Interference, Wisconsin Card Sorting Test, and Brixton Spatial Anticipation Task).

Results—No significant differences were found among groups on set-shifting tasks (p values >. 35), and effect sizes were small (Cohen's f <0.17).

Conclusions—Cognitive inflexibility may develop over time as a result of the ED, though it is possible that there is a subset of individuals for whom early neurocognitive difficulty may result in longer illness trajectory. Future research should investigate the existence of neurocognitive taxons amongst larger samples, as well as employ longitudinal designs to fully explore biomarkers and illness effects.

Trial Registration—clinicaltrials.gov NCT00879151.

Keywords

Bulimia Nervosa; Set-shifting; Neurocognition; Eating Disorders; Cognitive inflexibility

Introduction

BN is a serious psychiatric disorder that arises in adolescence and is characterized by recurrent episodes of binge eating and purging (1). Risk assessments for BN in adolescents identify a wide range of factors, but in many cases these are not directly related to symptom expression and development. As such, a recent approach to etiological understanding and treatment development is the examination of neurocognitive correlates (2). Set-shifting difficulty is implicated as a potential risk marker, candidate endophenotype and maintaining factor in EDs (3). Set-shifting is the ability to move between ideas, concepts, or tasks

Corresponding author: Alison Darcy, PhD, Stanford University School of Medicine, Department of Psychiatry and Behavioral Sciences, 401 Quarry Road, Stanford, CA 94305, USA. adarcy@stanford.edu Ph: +1 650 736 7972; Fax: +1 650 721 3322.

fluidly, such that those who have poor set-shifting are characterized by perseverative and rigid styles and behaviors. Poor set-shifting is reported in adults with BN (3, 4), however, systematic review suggests that findings are mixed and there are little data on BN-type ED Not Otherwise Specified (EDNOS-BN). In general there is a widely recognized deficit in the literature on the relationship between neurocognition and bulimic syndromes (5).

To our knowledge, no published study has examined set-shifting among adolescents with BN. This is important for several reasons: 1. Illness onset typically occurs during adolescence; 2. Identifying specific neurocognitive features among adolescents could suggest new avenues for treatment development and 3. The argument that cognitive inflexibility is a candidate endophonetype or risk marker for BN would be weaker if this neurocognitive signature is not observed in younger non-chronic patients. If set-shifting difficulties are not observed among adolescents, then it is more likely that the effects observed among adults are a result of the illness, as opposed to a preexisting or causative feature.

This study aimed to establish whether adolescents with BN and EDNOS-BN demonstrate a neurocognitive profile similar to adults. Measures were chosen to provide comparison to the adult literature. We hypothesized that adolescents with BN and EDNOS-BN would demonstrate more set-shifting difficulties than a comparison sample of healthy controls.

Methods

Participants

Fifty-four adolescents were recruited from a 2-site (University of Chicago and Stanford University) randomized clinical trial for adolescents ages 12–18 with BN. All BN participants met Diagnostic and Statistical Manual of Mental Disorders –Fourth Edition, text revision (DSM-IV-TR) (1) criteria for BN, or EDNOS-BN, defined as an average of one binge-eating episode (subjective or objective) and one purging episode per week for the past 3 months, with at least one binge-eating or purging episode occurring in the past month. Diagnoses were determined using the Eating Disorder Examination (EDE, see below).

Other inclusion criteria were proficiency in the English language with at least one parent speaking fluent English, sufficient medical stability for outpatient treatment, and if on a medication for a co-morbid psychiatric disorder (e.g. depression) then a stable dosage of pharmacotherapy for a minimum of at least 2 months must have been provided with the participant still meeting other inclusion criteria. Study participants were excluded for diagnosis of psychotic syndrome and/or taking anti-psychotics, a history of head injury, seizure or other medical co-morbidities that may interfere with cognitive ability or weight maintenance.

A total of 22 healthy controls were recruited from the community around Stanford University and Palo Alto, California, by advertisements placed on University notice boards and email listserves. Controls were all female, had no lifetime history of a psychiatric disorder, were not taking any psychotropic medication, had 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. All participants signed informed consent (signed by parents for participants <18 years old) and/or assent (participants <18 years old) forms before participation.

Measures

Primary outcome variables were decided *a priori*. All participants were administered a neuropsychological test battery at baseline. Raw scores were used to allow for analysis of between-group variation.

General Intelligence

Weschler Abbreviated Scale of Intelligence (WASI); Weschler Intelligence Scale for Children (WISC-IV); and the Weschler Adult Intelligence Scale (WAIS)—For the purposes of this study, we used four subtests as a proxy for the full test (Vocabulary, Similarities, Block Design, Matrix Reasoning) thus estimated, rather than full-scale IQ values are given.

Set-shifting

Delis-Kaplan Executive Functioning System (D-KEFS)—The D-KEFS(6) evaluates executive functioning and has been normed for individuals aged 8 to 89 years. In the current study, the Trail Making, Color-Word Interference and Verbal Fluency subtests were administered.

Trail Making Task comprises five paper-and-pen trials: Identification tasks, two sequence switching tasks, and motor speed. The current study evaluated the seconds taken to complete the switching task. We included motor speed as a descriptive variable. Results from a recent review concluded that the evidence for impairment on this Trail Making Task is inconsistent (5).

The Color-Word Interference task is a Stroop task presented on flash cards with color names written in dissonant color ink. This task assesses inhibition as well as a switch task, with a change in rules for task completion.

Verbal fluency – consists of naming, category fluency and category switching. All three trials were administered but, only category switching was evaluated.

Wisconsin Card Sorting Task (WSCT Computerized version 4)—The WSCT(7) requires response to environmental feedback, ability to shift rules and ability to inhibit previously appropriate responses. The primary outcome variable of interest is the number of perseverative errors (persisting with an incorrect rule). Non-perseverative errors and number of categories completed were also assessed. Evidence for impairment among individuals on this task in other studies is mixed (5).

Brixton Spatial Anticipation Task—The Brixton Spatial Anticipation Task (8) is a concept attainment task. A blue circle is present in a sequence of ten numbered unmarked circles. The position of the blue circle changes from trial to trial in a logical sequence and the participant has to work out this sequence. The outcome variable is the total number of incorrect predictions.

Psychological Assessments

Eating Disorders Examination (EDE) and EDE-Questionnaire (EDE-Q)—The EDE (9) was administered to clinical participants. It is a standardized semi-structured interview, and "gold standard" instrument, measuring severity and frequency of the characteristic psychopathology and key behaviors of EDs over the past four weeks, or for diagnostic items, the previous 3 months. Inter-rater reliability between trained interviewers is high (Kappa coefficient of at least .9) and the measure has good internal consistency

among ED samples with acceptable alpha coefficients for its subscales; Dietary Restraint (.75); Eating Concern (.78); Shape Concern (.68), and Weight Concern (.82).

The EDE-Q(10) is a validated and reliable, short-form, self-report version of the EDE and was administered to HC participants. Among undergraduate women internal consistencies range from .78 to .93 and .57 to .70 for behavioral features such as binge eating and purging (11).

BN participants were also administered the Schedule for Affective Disorders and Schizophrenia for School-Aged Children, Present and Lifetime Version (K-SADS-PL)[14 to determine comorbidity and medication use.

Procedure

Study participants were assessed prior to the first treatment session. All participants received $50. Data were collected over a 28-month period (from April 2009 to July 2011).

Ethical approval

This study was approved by both the Stanford University and the University of Chicago Institutional Review Boards.

Statistical Analysis

One-way analysis of variance (ANOVA) tests were conducted to ascertain whether significant differences existed between the three groups. Baseline characteristics that differed between the groups were entered as covariates, and eight analyses of covariance (ANCOVA) tests were conducted to identify differences on set shifting. For the main outcome variables, alpha was adjusted using Bonferonni correction to .006 to guard against Type 1 error (.05/8). Cohen's f was used for effect size calculation. Cohen suggests that f values of 0.1, 0.25, and 0.4 represent small, moderate, and large effect sizes respectively.

Results

Baseline characteristics for the 3 groups are presented in Table 1. The groups did not differ on any baseline characteristic with the exception of IQ where the HC group had significantly higher estimated IQ scores than the BN and EDNOS-BN groups.

ANCOVAS with IQ entered as a covariate failed to find any evidence of difference between the groups on any variable under study. Effect sizes were small.

Discussion

The study aimed to ascertain whether set-shifting difficulties identified among adult samples with BN are present among adolescents with BN and EDNOS-BN thereby assessing the potential of this neurocognitive feature as a candidate endophenotype or risk marker for BN syndromes. We failed to find evidence of differences between adolescents with BN, and EDNOS-BN, and HC on set-shifting tasks. While there is no literature with adolescents with BN with which to make a direct comparison, our findings are similar to a small number of studies that failed to find significant differences between adults with BN and HCs on the Trail Making Task; the WCST, or the Brixton (see (5) for review).

Similar performance by all groups on set shifting suggests the possibility that cognitive inflexibility may develop over time as a consequence of BN. Set-shifting problems could arise from either the symptoms of BN themselves (binge eating and purging), the effect of co-morbidity and/or a conscious attempt to become more rigid in the context of dietary

restriction, which ultimately leads to a bulimic cycle, ultimately changing their neurocognitive signature over time. This hypothesis is in concert with most cognitive–behavioral models of BN symptomatology, however only a prospective longitudinal design can fully confirm the viability of such a hypothesis.

While our sample was relatively small and findings need to be replicated, the failure to find impairment among adolescents casts doubt on the viability of cognitive inflexibility as an identifiable risk marker for later development of BN. It does not preclude the possibility, however, that cognitive inflexibility could be a risk marker for more enduring illness, reflected in the adult data but lost in the group means here which presumably include some individuals who will recover before reaching adulthood. It may be that differing profiles exist within the data that may yield more meaningful dichotomies and provide information about illness trajectory or other clinical variables, and the development of tailored treatment approaches. This strategy was adopted by Roberts and colleagues (3) who found differences in those with superior versus weak set-shifting abilities among adults. A larger sample would facilitate the examination of distinct profiles with BN samples, and this should be explored in future studies.

The major limitation of our study was the small sample size relative to published studies of adults. However, to our knowledge it is the first study to report on set-shifting abilities of adolescents with BN. Another advantage is the inclusion of a BN-EDNOS group, although they did not represent the full spectrum of EDNOS. Nonetheless, the failure to find a difference between the BN groups suggests that set-shifting performance is not affected by severity of BN symptoms. Other advantages include the use of a range of carefully chosen measures to assess differing dimensions of set-shifting. We also used measures that have been employed in ED samples. In addition, this study adds to the small literature on neurocognitive correlates of ED symptomatology, and in particular, BN, which has been understudied in comparison to AN to date (5). While cognitive inflexibility is established amongst adults with AN and to a lesser extent, BN, this study suggests that set-shifting problems may develop over time as a result of the illness, rather than being at the core of an endophenotype that signals it.

Acknowledgments

Research was supported by the Davis Foundation and the National Institutes of Health: NIH SPO#37129; and R01 MH079979.

Acronyms used in text

BN	bulimia nervosa
EDNOS-BN	eating disorder not otherwise specified – bulimia nervosa
HC	healthy controls
ED	eating disorder
DSM	Diagnostic and Statistical Manual
EDE(-Q)	Eating Disorder Examination-(Questionnaire)
MBW	Median Body Weight
DKEFS	Delis-Kaplan Executive Functioning System
WASI	Weschler Abbreviated Scale of Intelligence

WISC	Weschler Intelligence Scale for Children; and the Weschler Adult Intelligence Scale
IQ	Intelligence Quotient
WCST	Wisconsin Card Sort Task
K-SADS-PL	Schedule for Affective Disorders and Schizophrenia for School-Aged Children, Present and Lifetime Version

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Table 1

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

	BN (n = 23)	EDNOS-BN (n=31)	HC (n=22)	Comparison
Age (years)	16.33 (1.18)	15.37 (1.77)	15.41 (1.89)	F(2, 83) = 3.07 p= .052
%MBW	109.14 (18.22)	108.31 (16.01)	105.69 (12.83)	F(2, 82) = 0.29 p = 0.75
IQ	106.81 (8.67)	109.88 (10.87)	118.43 (11.88)	**F(2, 79) = 7.5 p<.001 BN<HC; EDNOS-BN < HC;**
Motor Speed	27.13 (9.82)	26.06 (10.99)	24.00 (6.01)	F(2, 73) = .633; p=.534
Verbal fluency	43.00 (12.13)	40.97 (8.23)	38.41 (11.23)	F(2, 73) = 1.095; p=.340
One comorbidity (n)	12	16	-	χ^2 (2) = .284 p=.868
Multiple comorbidity (n)	16	8	-	
Depression diagnosis (n)	14	17	-	χ^2 (1) = .066 p=.798
Ill duration (months)	21.08 (16.41	15.01±13.58	NA	t(47.81)=1.534; p=.132
Medication use (n)	5	3	-	*
EDE-RES	3.64 (1.27)	3.11 (1.73)	NA	t(59.87)=1.389; p=.171
EDE-EC	3.07 (1.30)	2.75 (1.45)	NA	t(58.69)=0.906; p=.369
EDE-WC	3.80 (1.63)	3.75 (1.43)	NA	t(51.97)=0.124; p=.902
EDE-SC	4.22 (1.41)	4.12 (1.34)	NA	t(54.63)=0.295; p=.769
EDEQ-RES	NA	NA	0.60 (0.63)	NA
EDEQ-EC	NA	NA	0.38 (0.54)	NA
EDEQ-WC	NA	NA	1.22 (0.81)	NA
EDEQ-SC	NA	NA	1.44 (0.91)	NA
OBE episodes **	24.85 (16.43)	1.11 (1.87)	0.20 (0.63)	**F(2, 69) = 46.710; p<.001 BN>EDNOS-BN; EDNOS>HC**
Month 2	21.33 (20.33)	3.94 (6.60)	Not examined	**t(30.38) = 4.33 p<.001**
Month 3	19.18 (19.13)	3.91 (6.82)	Not examined	**t(31.12) = 3.95; p<.001**
Vomiting episodes **	31.33 (23.86)	18.20 (20.47)	0 (0.00)	**F(2, 60) = 8.97; p=.000 BN>HC; EDNOS-BN>HC**
Month 2	25.11 (22.94)	22.57 (39.84)	Not examined	t(60) = 0.29; p = .769
Month 3	18.88 (18.42)	19.45 (40.17)	Not examined	t(60) = .06; p = .946
Laxatives episodes **	2.41 (6.51)	2.03 (9.69)	0 (0.00)	**F(2, 68) = .353; p = .704**
Month 2	2.55 (6.32)	0.82 (2.90)	Not examined	t(60)=1.433; p = .157
Month 3	1.77 (4.66)	2.82 (8.89)	Not examined	t(60)=−.557; p = .580
Driven exercise **	12.33 (17.94)	16.09 (15.81)	0.10 (0.31)	**F(2, 69) = 4.04; p = .022 BN>HC; EDNOS-BN > HC**
Month 2	10.70 (17.47)	14.88 (15.28)	Not examined	t(60) = −1.00; p = .320
Month 3	12.07 (17.57)	13.62 (16.61)	Not examined	t(60) = −.356; p = .723

Note: All participants were female. BN=bulimia nervosa group; EDNOS-BN=bulimia-type eating disorder not otherwise specified group; HC= healthy control group; MBW = Median Body Weight; EDE=eating disorder examination; EDEQ=eating disorder examination-questionnaire; OBE=objective binge eating;

*Too few participants in each to conduct analysis;

**means come from EDE for clinical groups and EDE-Q for healthy control group OBE = objective binge eating episodes in past 28 days

Table 2

Analysis of covariance between the groups on the primary outcome variables (means [standard deviations]) with estimated IQ as a covariate

	BN (n = 23)	EDNOS-BN (n=31)	HC (n=22)	Comparison	f
Trails switching (secs)	64.91 (22.01)	67.26 (20.18)	64.05 (17.94)	F(2, 71) = .317; p=.792	.09
Color word interference (inhibition/switch)	56.78 (14.67)	57.74 (10.71)	52.95 (11.76)	F(2, 69) = .396; p=.675	.10
Verbal fluency category switching	12.30 (3.37)	12.68 (3.22)	12.26 (3.50)	F(2, 69) = .658; p=.521	.13
WCST Perseverative Responses	7.48 (6.76)	6.42 (2.69)	6.58 (3.28)	F(2, 69) = .407; p=.667	.11
WCST Perseverative Errors	7.00 (5.35)	6.16 (2.39)	6.37 (2.96)	F(2, 69) = .486; p= .617	.11
WCST Non-Perseverative Errors	6.39 (4.13)	5.77 (3.51)	5.74 (5.25)	F(2, 69) = .325 p=.827	.09
WCST Categories Completed	5.96 (.209)	6.00 (00)	5.95 (.22)	F(2, 71) = .909; p=.408	.16
Brixton raw score	12.22 (5.09)	10.45 (4.91)	8.39 (3.66)	F(2, 73) = 1.12; p=.331	.17

Note: All variables were raw scores; BN=bulimia nervosa group; EDNOS-BN=bulimia-type eating disorder not otherwise specified group; HC= healthy control group; WCST = Wisconsin Card Sort Task.