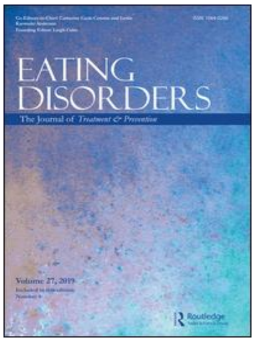

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Cognitive rigidity and heightened attention to detail occur transdiagnostically in adolescents with eating disorders

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ABSTRACT

Cognitive inflexibility and attention to detail bias represent a promising target in eating disorder (ED) treatment. While prior research has found that adults with eating disorders exhibit significant cognitive inflexibility and heightened attention to detail, less is known about these cognitive impairments among adolescents, and across EDs transdiagnostically. To address this gap, adolescent females (N = 143) from a residential ED program with anorexia nervosa, bulimia nervosa, or other specified feeding or eating disorder completed the Detail and Flexibility Questionnaire (DFlex) and measures of ED and general psychopathology. Transdiagnostically, adolescents with EDs scored higher than an archival sample of healthy control adolescents on both cognitive rigidity ($p < .001$; Cohen's $d = 1.92$) and attention to detail ($p < .001$; Cohen's $d = 1.16$). These cognitive impairments were significantly associated with severity of eating pathology, and these relationships existed independent of age, duration of illness, or body mass index (BMI). Our findings suggest cognitive inflexibility and heightened attention to detail occur transdiagnostically in adolescents with eating disorders and are unlikely to be a scar of the disorder. Future prospective research is needed to determine whether these cognitive styles represent an endophenotype of eating disorders.

Clinical Implications

- Adolescents with eating disorders have heightened cognitive inflexibility
- Adolescents with eating disorders have heightened attention to detail
- These cognitive styles are independent of age, illness duration, or body mass index

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Supplemental data for this article can be accessed here.

- Enhancing patient awareness of cognitive biases may improve treatment outcomes

Eating disorders typically onset in adolescence (Lewinsohn, Striegel-Moore, & Seeley, 2000) and are defined by disturbances in eating behaviors with marked impairment in physical and psychosocial functioning (American Psychiatric Association, 2013). Yet even the best available treatments are effective for just roughly half of these patients, leaving many individuals with chronic or treatment-refractory illnesses (Waller et al., 2014). In particular, cognitive style has been identified as a feature that may impact treatment engagement and outcome (Tchanturia, Davies, & Campbell, 2007). Individuals with heightened cognitive rigidity may have difficulty changing familiar, maladaptive eating routines in favor of recovery. Similarly, a heightened attention to detail may promote continued fixation on disorder-relevant rituals, which may impede treatment. For instance, many eating-disorder rituals such as calorie counting and body checking (e.g., fixating on the presence of a space between thighs, size of a specific body part, etc.) are emblematic of over-attention to details. Indeed, neuropsychological studies of adults with eating disorders suggest that greater cognitive rigidity and heightened attention to detail are characteristic of individuals with these illnesses, leading to the hypothesis that these cognitive impairments may be an endophenotype of the disorder (Roberts, Tchanturia, Stahl, Southgate, & Treasure, 2007).

However, the majority of studies finding impaired neuropsychological functioning among individuals with eating disorders have been conducted in adults during acute stages of illness (e.g., Holliday, Tchanturia, Landau, Collier, & Treasure, 2005). Therefore, it is unclear whether these impairments represent "scars" of the eating disorder that worsen with increasing illness duration and age. If these same impairments were present among adolescents with eating disorders, even accounting for differences in illness duration, this would instead provide evidence to support the endophenotypic nature of these impairments. In the current literature, studies of these cognitive inefficiencies in adolescents with eating disorders are scarce, and published findings are equivocal. Using standard neuropsychological tasks, some studies have found heightened cognitive rigidity among adolescents with anorexia nervosa-restrictive subtype (AN-R; McAnarney et al., 2011), and others have reported that adolescents with AN (including both AN-R and AN-binge/purge subtype [AN-BP]) perform similarly to healthy controls on set-shifting tasks that require switching between strategies, stimuli, or tasks (Shott et al., 2012; van Noort, Pfeiffer, Ehrlich, Lehmkuhl, & Kappel, 2016). Similarly, one study found no significant differences between adolescents with BN and healthy controls on set-shifting tasks (Darcy et al., 2012). However, these studies included small sample sizes (*N*s ranging from 15 to 60 adolescents with eating disorders), which may have limited the ability to detect significant differences, and no studies to date have examined cognitive rigidity and attention to detail among a transdiagnostic clinical sample of adolescents with eating disorders (including subthreshold eating disorders).

Although cognitive rigidity and attention to detail are usually examined via neuropsychological assessments, these can be time intensive and expensive, which renders them infeasible in most clinical and research settings. In addition, examining cognitive processes in a transdiagnostic sample may be particularly important given the fluid and changing nature of eating-disorder diagnoses over time (Eddy et al., 2008). For instance, diagnostic crossover is extremely common in eating disorders, such that nearly two-thirds of individuals with an initial diagnosis of AN experience diagnostic crossover (either between AN subtypes or from AN to BN) over time (Eddy et al., 2008). Considering the role of cognitive rigidity and attention to detail bias as transdiagnostic constructs that may be present to varying degrees in many different diagnoses could also inform treatment selection. Thus, it is imperative to investigate practical forms of assessment. Administration of a full neuropsychological assessment (which has historically been used to assess biases such as cognitive rigidity and attention to detail) can take between two to five hours, and is likely not feasible in most clinical settings. To promote measurement of these cognitive biases in clinical practice, Roberts, Barthel, Lopez, Tchanturia, & Treasure (2011) developed and validated the Detail and Flexibility Questionnaire (DFlex), a 24-item self-report measure of behaviors indicative of cognitive rigidity and attention to detail. Supporting validity of this measure, DFlex scores were correlated with the attentional switching ($r = 0.72$, $p < .001$) and attention to detail ($r = 0.26$, $p < .001$) subscales of the Autism-Spectrum Quotient (AQ; Baron-Cohen et al., 2001) in the original validation study.

Recent research has utilized the self-report DFlex in adolescent populations. Lang et al. (2015) compared cognitive styles between adolescents with AN and healthy controls, finding significantly heightened cognitive rigidity and attention to detail among adolescents with AN. However, to our knowledge, no published study has evaluated DFlex scores in a transdiagnostic adolescent sample. This is important because eating disorders typically onset during adolescence, and cognitive impairments have also been identified in other eating disorders such as bulimia nervosa (BN; Roberts et al., 2007). Moreover, the presence of cognitive impairments early in disorder development (e.g., during adolescence) may help elucidate why disordered eating patterns become entrenched for some individuals and hinder early change in treatment. Further, the degree to which these cognitive impairments are present among individuals with atypical eating disorders (e.g., other specified feeding or eating disorder [OSFED]), as well as how these cognitive impairments are associated with clinical impairment due to eating-disorder symptoms, is largely unknown.

Therefore, in the current study, we addressed four aims relevant to enhancing the understanding of cognitive functioning in adolescents with eating disorders. First, we examined if adolescents with eating disorders displayed elevated cognitive rigidity and attention to detail bias as measured by the DFlex, compared to healthy controls. Second, we tested whether these impairments were present transdiagnostically, or whether they differed by eating-disorder diagnosis (i.e., AN-R, AN-BP, BN, and OSFED). We hypothesized that scores on the DFlex would be higher across eating-disorder patients compared to archival data on healthy control adolescents, indicating cognitive rigidity and attention to detail bias, and that these biases would not differ by diagnosis. Third, we examined whether heightened cognitive rigidity and attention to detail were associated with greater severity of eating pathology, disorder-relevant rituals of body checking, eating pathology-related clinical impairment, age, and duration of illness. As a prior study by Lozano-Serra, Andrés-Perpiña, Lázaro-García, and Castro-Fornieles (2014) found these cognitive biases to be associated with low weight, we also examined whether cognitive rigidity and attention to detail were associated with body mass index (BMI). We hypothesized that severity of eating pathology, impairment due to eating pathology, age, duration of illness, and BMI would show significant bivariate associations with greater cognitive rigidity and attention to detail. Fourth, we tested whether the relationship between cognitive impairments and eating pathology existed independently of age, duration of illness, or BMI (given that these cognitive biases have also been associated with low weight;).We hypothesized that, even after accounting for age, duration of illness, and BMI, cognitive rigidity and attention to detail would be associated with greater eating pathology.

Methods

Participants

From July 2011 to October 2012, we recruited adolescent and young adult females upon admission to a residential eating-disorder treatment program in the Boston area as part of a larger study of the distribution of *DSM-IV* vs. *DSM-5* eating-disorder diagnoses in this setting (Thomas et al., 2015). On average, participants completed the research assessment within 5 days of admission. Excluding patients who were re-admitted during the recruitment timeframe and had already taken part in the study, 150 of 164 consecutively admitted patients (91.4%) agreed to participate. For the current analyses, we excluded participants with a diagnosis of avoidant/restrictive food intake disorder (n = 4) and participants who did not complete the primary outcome measure (DFlex) (n = 7), resulting in an analytic sample of N = 143 (as some participants with ARFID also did not complete the DFlex). Graduate-level research assessors assigned DSM-5 diagnoses using the Eating Disorder Examination v. 16.0 (Fairburn, Cooper, & O’Connor, 2008) and

Table 1. Demographic features of a residential treatment-seeking sample of females with eating disorders, by diagnosis.

	M(SD)					
	AN-R (*n* = *45*)	AN-BP (*n* = *24*)	BN (*n* = *28*)	OSFED (*n* = *46*)	*F* (3, 139)	*p*
Age	17.27 (2.21)[a]	18.25 (2.50)[a,b]	19.32 (2.72)[b]	18.09 (2.68)[a,b]	3.61	.01
Duration of illness	3.69 (3.63)[a]	4.04 (3.28)[a]	5.21 (3.35)[a]	4.85 (3.57)[a]	1.46	.23
BMI	16.17 (1.09)[a]	16.75 (1.04)[a]	22.82 (4.80)[b]	20.60 (3.12)[c]	41.01	<.001

Note. Age and duration of illness are reported in years. Age ranged from 13 to 26 years; BMI ranged from 13.47 to 38.01. Participants with OSFED included those diagnosed with atypical AN (n = 22), subthreshold BN (n = 5), purging disorder (n = 18), and OSFED-other (n = 1). Superscripts indicate groups that are significantly different in the same row.

a diagnostic interview keyed to the *DSM-5* criteria for feeding and eating disorders (Walsh, personal communication, February 24, 2011; see Thomas et al., 2015). Demographic information including age, duration of illness, and BMI are included in Table 1.

Archival control data from a study by Lang and colleagues included 43 healthy female adolescents, with a mean age of 15.11 (*SD* = 1.94) and mean body mass index of 20.34 (*SD* = 1.99) (Lang et al., 2015). Participants in this healthy control sample were excluded for any current or past history of an eating disorder or any other psychiatric disorder (Lang et al., 2015). These data were used as a comparison for the eating-disorder sample.

Measures

The *DFlex* is a self-report questionnaire comprising 24 items rated on a 6-point Likert scale yielding a total score and two subscales for cognitive rigidity and attention to detail. To assess cognitive rigidity, individuals rate agreement with statements including “I get distressed if plans get changed at the last minute” or “When others suggest a new way of doing things, I get upset or unsettled.” Similarly, to assess attention to detail, individuals rate agreement with statements like “I can get hung up on details when reading rather than understanding the gist.” Higher scores indicate greater cognitive rigidity and greater bias towards attention to detail. Internal consistency in the current study for the DFlex was adequate: cognitive rigidity (Cronbach’s alpha = .79) and attention to detail (Cronbach’s alpha = .80). Scores on both subscales can range from 12 to 72. In the current sample, scores on the cognitive rigidity subscale ranged from 23 to 72, and scores on the attention to detail subscale ranged from 24 to 72. Average scores on the cognitive rigidity and attention to detail subscales (*M*s = 51.70 and 46.83, respectively) were comparable to the original validation sample of adults with eating disorders (*M*s = 47.28 and 40.31, respectively).

Eating-disorder examination (EDE)

EDE version 16.0 (Fairburn et al., 2008) is a reliable rater administered interview that captures eating-disorder symptom severity and frequency on a scale from 0 to 6. Higher scores indicate greater symptom severity and frequency. The internal consistency of the global score in the present study sample was adequate (Cronbach's alpha = .88)

Clinical impairment assessment (CIA)

The CIA (Bohn & Fairburn, 2008) is a self-report measure with 16 items that assess the level of psychological impairment in personal, cognitive, and social domains that may be associated with ED symptoms. Items are rated on a scale from 0 (not at all) to 3 (a lot), with higher scores indicating greater psychological impairment. Internal consistency of the CIA in the present study sample was adequate (Cronbach's alpha = .93).

Body checking questionnaire (BCQ)

The BCQ (Reas, Whisenhunt, Netemeyer, & Williamson, 2002) is a reliable and valid 23-item self-report questionnaire that measures body checking behaviors, or the repeated checking of body shape and/or weight (e.g., repeatedly checking to see if thighs touch) (Reas, White, & Grilo, 2006) on a 1 (never) to 5 (very often) Likert scale. Higher scores indicate more frequent body checking behaviors. Internal consistency of the BCQ in the present study sample was adequate (Cronbach's alpha = .95).

Demographics

Nursing staff weighed and measured patients on the day of admission to the residential treatment center using a standard hospital grad scale and stadiometer. Participants self-reported their age and duration of illness.

Statistical analyses

To address Aim 1 (compare DFlex scores between eating disorders and healthy controls), we compared means on the DFlex cognitive rigidity and attention to detail subscales from the study sample to available healthy control means on these subscales using an independent samples *t*-test. To address Aim 2 (compare DFlex scores between eating-disorder diagnoses), we compared DFlex cognitive rigidity and attention to detail subscale scores across *DSM-5* diagnoses using analysis of variance (ANOVA). To address Aim 3 (assess relationships between DFlex scores, clinical characteristics, and demographics), we conducted bivariate correlations to examine associations between eating pathology (EDE global score), body checking, clinical impairment, age, duration of illness, BMI, and DFlex scores across the sample. Finally, to address Aim 4 (test if the relationship between DFlex scores and eating pathology is independent of age, duration of illness, or BMI), we conducted a hierarchical regression analysis with age, duration of illness, and BMI entered in step 1, and cognitive rigidity and attention to detail entered in step 2 to predict eating pathology measured via EDE global score.

There were no missing data in the present analytic sample. This is likely because the online questionnaires were configured to flag any missed items for participants and give them an opportunity to respond before moving to the next questionnaire. All analyses were conducted in R (Development Core Team, 2013) via *t.test, cor, anova*, and *lm* in base R, and *vif* in the *car* package.

Results

Aims 1 and 2: comparisons with healthy controls and diagnostic categories

Average DFlex cognitive rigidity scores for the full transdiagnostic sample (M = 51.70, SD = 9.21) were significantly higher than those for healthy controls (M = 34.79, SD = 7.40) reported by Lang et al. (2015), with a large effect size $t(184) = 11.07$, $p < .001$; Cohen's $d = 1.92$. Similarly, the clinical sample (M = 46.83, SD = 9.40) scored higher than healthy controls (M = 36.31, SD = 7.89) on the attention to detail scale, $t(184) = 6.68$, $p < .001$; again with a large effect size Cohen's $d = 1.16$. Diagnostic groups did not differ significantly on the cognitive rigidity or attention to detail scales in the omnibus ANOVA so we did not evaluate *post-hoc* group comparisons (Table 2).

Aim 3: correlations of DFlex scores with demographics and eating pathology

We present correlation analyses in Table 3. Supporting our hypotheses, cognitive rigidity and attention to detail demonstrated significant positive correlations, ranging from small to moderate in size, with eating pathology (EDE global score), body checking (BCQ), and eating disorder-related impairment (CIA). Unexpectedly, neither cognitive rigidity nor attention to detail was correlated with BMI. In line with our hypotheses, cognitive rigidity was positively associated with age and illness duration; however, attention to detail was not.

Table 2. DFlex subscale and total scores by diagnosis.

	M(SD)					
	AN-R (n = 45)	AN-BP (n = 24)	BN (n = 28)	OSFED (n = 46)	F(3, 139)	p
Cognitive rigidity	52.71 (9.44)	50.99 (9.75)	53.36 (9.80)	50.08 (8.27)	1.01	.39
Attention to detail	47.41 (9.88)	45.70 (8.07)	49.25 (9.49)	45.37 (9.43)	1.17	.32

Table 3. Zero-order correlations among DFlex scores, demographics, and eating pathology.

	Cognitive Rigidity	Attention to detail	Age	BMI	Duration of illness	EDE global	BCQ total
Cognitive rigidity	–						
Attention to detail	.71**	–					
Age	.19*	.12	–				
BMI	−.03	.02	.33**	–			
Duration of illness	.18*	.12	.65**	.22**	–		
EDE global	.28**	.31**	.28**	.15	.21*	–	
BCQ total	.24**	.25**	.05	.06	.04	.61**	–
CIA	.40**	.38**	.24**	.13	.09	.73**	.58**

Note. $^{*}p < .05$; $^{**}p < .01$. EDE = Eating Disorder Examination; BCQ = Body Checking Questionnaire; CIA = Clinical Impairment Assessment.

Aim 4: regression analyses examining illness severity, DFlex scores, and eating pathology

We conducted a hierarchical linear regression to identify whether cognitive rigidity and attention to detail were associated with eating pathology (EDE global score) above and beyond the contributions of BMI, duration of illness, and age (Table 4). Inspection of diagnostic plots (see Supplemental Figure 1) indicates that regression assumptions (linearity of data, homogeneity of variance, normality of residuals, no influential cases) were met. Given the high correlations between some variables in our model – particularly the two DFlex subscales – we also examined variance inflation factors (VIF) among our predictor variables, which indicated no problematic multicollinearity (all VIFs < 2.5).

Step 1, which examined the relationship between age, duration of illness, BMI, and eating pathology was significant (p = .006) and explained 6.6% of the variance in eating pathology. The model significantly improved with the addition of cognitive rigidity and attention to detail (p = .002), with this final model explaining 13.3% of the variance in eating pathology. In the final model, no individual variables were statistically significant, although the p values for attention to detail (p = *.06*) and age (p = .07) were just above the alpha threshold of .05.

Table 4. Hierarchical regression model examining predictors of eating-disorder psychopathology.

	F	p	df	Adjusted R^2	t	p	β
Step 1	4.32	.006	3	.07			
Age					2.09	.04	0.11
Duration of illness					0.47	.64	0.02
BMI					0.73	.47	0.02
Step 2	5.36	<.001	5	.13			
Age					1.86	.07	0.09
Duration of illness					0.24	.81	0.10
BMI					0.94	.35	0.03
Cognitive rigidity					0.80	.43	0.01
Attention to detail					1.90	.06	0.03

Note. Cognitive rigidity and attention to detail contributed to variance in global eating-disorder psychopathology above and beyond the effects of age, duration of illness, and BMI, $\Delta R_a^2 = .06$, $\Delta F = 1.04$, $p = .002$.

Discussion

In a residential treatment sample of adolescents with eating disorders, we found that self-reported cognitive rigidity and bias toward attention to detail were higher compared to healthy control adolescents and did not differ across diagnostic groups. This finding lends support to previous research demonstrating that greater cognitive rigidity and attention to detail, assessed via neuropsychological tasks, are prominent in adolescents in early stages of illness across a range of clinically significant eating pathology (Allen et al., 2013). Further, we found that simultaneously adding cognitive rigidity and attention to detail to a model predicting eating pathology explained significantly more variance in eating pathology, above and beyond the effects of BMI, age, and duration of illness. However, neither cognitive rigidity nor attention to detail was significant in the final model. Although VIF indicated no problematic multicollinearity among our independent variables, one reason for the non-significance of cognitive rigidity and attention to detail may be due to the fact that these variables were strongly correlated (r = .71). In addition, our modest sample size (N = 143) may have precluded our ability to detect significant effects of these independent variables.

These findings begin shed light on the question of whether cognitive impairments are an endophenotype or a scar of eating disorders. If cognitive impairments were a scar of eating disorders, we would expect weak evidence of cognitive impairments among adolescents (with putatively shorter duration of illness than adults) and that the addition of cognitive impairment measures would not contribute to additional variance in eating pathology after accounting for age, duration of illness, and BMI. On the contrary, our findings demonstrated that cognitive impairments were already present among adolescents; and were not explained by BMI, duration of illness, or age; but rather contributed a significant amount of independent variance to eating pathology. These results suggest that these impairments may not represent a scar of the eating disorder. Rather, the limited associations with BMI, age, and duration of illness lend support for the proposal that these cognitive impairments may represent an endophenotype for eating disorders (Holliday et al., 2005). However, of note, average duration of illness for adolescents in the current sample was over 3 years, and extended periods of suboptimal nutrition in adolescence may have lasting impacts on cognitive development. As such, our data are unable to rule out the possibility of cognitive inflexibility and attention to detail representing, in part, a scar of the illness.

Our findings may encourage study of the use of cognitive remediation therapy (CRT) for adolescents with the full spectrum of eating disorders, including OSFED. CRT for AN was developed to augment treatment outcomes by decreasing cognitive rigidity and attention to detail bias

(Tchanturia et al., 2007), thus preparing a patient for a more intensive behavioral symptom-reduction therapy such as CBT. During CRT, the therapist administers neuropsychological assessments and self-report questionnaires, such as set-shifting tasks, that aim to help the patient develop insight into his or her cognitive biases. The patient is then encouraged to reflect on these insights and ultimately develops heightened awareness of his or her own cognitive patterns. While recent literature has highlighted the efficacy of CRT for adults with eating disorders (Danner, Dingemans, & Steinglass, 2015; Tchanturia & Lock, 2010), our findings suggest that CRT may be useful for adolescents as well. Indeed, a meta-analysis of case studies and series showed potential benefits of CRT for adolescents with AN (Tchanturia, Giombini, Leppanen, & Kinnaird, 2017). Initial RCTs demonstrate CRT is feasible for adolescents with AN (Lock, Fitzpatrick, Agras, Weinbach, & Jo, 2018), and additional RCTs are currently underway (Giombini et al., 2018). Of note, although the current literature has begun to investigate CRT for adolescents with AN, results from the current study suggest that CRT may also be helpful for adolescents with other EDs as well, including BN and OSFED.

Measuring cognitive rigidity and attention to detail bias using a self-report measure like the DFlex also may offer clinical value. Specifically, the DFlex may better reflect the patient's own experience of his or her cognitive impairments in the context of everyday life, and may be more sensitive to individuals' subjective experiences with cognitive rigidity and heightened attention to detail than standard cognitive tasks. It is possible that this may resonate with patients when motivating them to engage in treatment. However, it is important to note that no research to date has directly compared scores on the DFlex with neuropsychological tasks. Examining the correspondence between the DFlex and behavioral tasks is necessary in order to further establish the validity of the DFlex, and investigate the extent to which this measure may be subject to self-report biases. In addition, future research should also examine whether DFlex scores predict treatment outcomes among individuals with eating disorders, which could provide important information about the predictive validity of this measure.

Our findings should be considered within the context of study limitations. Our study was cross-sectional, thus we could not track how higher DFlex scores in adolescence predicted course of illness. Our study also involved the use of historical control data from a previous study by Lang et al. (2015), which may differ from our sample on third variables other than eating-disorder diagnoses and could have contributed to significant differences between the two groups. For instance, participants in the archival data were significantly younger (M_{age} = 15.11) than participants in the current sample (M_{age} = 18.09). Further, our sample only included females, and generalizability of these results to males is unknown; future studies examining cognitive impairments among adolescents with eating disorders should aim to recruit larger and more diverse samples. In addition, while our use of a residential treatment-seeking sample is a strength in the potential applications for this clinical group, the generalizability of these findings to less severe populations of adolescents with eating disorders is unknown.

Overall, our data provide preliminary evidence that heightened cognitive rigidity and attention to detail occur transdiagnostically, and that these cognitive impairments are not accounted for by age, BMI, or duration of illness. As evidence-based treatment for eating disorders achieves remission in only about 50% of cases (Fairburn et al., 2009; Waller et al., 2014), helping patients develop insight into their own cognitive biases that may be hindering treatment response, as well as providing more information about cognitive rigidity and attention to detail for clinicians and researchers may be important factors that can enhance treatment outcomes. Future research should also examine whether cognitive flexibility, rigidity, and attention to detail predict treatment outcome for adolescents with eating disorders.

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