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Development and validation of the Detail and Flexibility Questionnaire (DFlex) in eating disorders

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ABSTRACT

Whilst neuropsychological testing provides the most accurate profile of cognitive functioning, the time consuming nature of individual assessment deems it impossible for many research and clinical settings. This paper presents the development and validation of the Detail and Flexibility Questionnaire (DFlex), a 24-item self-report scale measuring two aspects of neurocognitive functioning; cognitive rigidity (difficulty with set-shifting/flexibility) and attention to detail (weak coherence). Exploratory factor analysis extracted two subscales, further confirmed and refined by item response analysis. Both subscales showed high internal reliability, construct validity (as compared to relevant subscales of the Autistic-Spectrum Quotient) and strong discriminant validity with large effect sizes found between both lifetime eating disorder and healthy control groups, and between current and recovered anorexia nervosa. We suggest using the cognitive rigidity and attention to detail subscales independently to give a rough approximation of these two aspects of cognitive style as they manifest in the context of everyday life.

1. Introduction

New models to explain anorexia nervosa (AN) have focussed on underlying mechanisms that cover vulnerability in addition to maintaining factors. The Maudsley Maintenance Model of AN (Schmidt & Treasure, 2006) details four domains that contribute to the maintenance of AN, the first of which is obsessive–compulsive personality traits. It has long been known that obsessive–compulsive traits are common in the eating disorders (Halmi et al., 2005; Kaye, Weltzin, & George Hsu, 1993) and impact on recovery (Crane, Roberts, & Treasure, 2007), however assessment has largely focussed on the behavioural and diagnostic aspects of obsessive–compulsive disorder such as ordering and cleaning behaviours. Over the last few years, focus has started to shift from visible behaviours of those with an eating disorder to underlying cognition by investigating neurocognitive profile (Treasure, 2007; Treasure, Lopez, & Roberts, 2007). This paper will focus on two cognitive styles identified through neuropsychological assessment that may fall under the obsessive–compulsive umbrella.

Cognitive flexibility or set-shifting, the ability to be flexible with one's mindset in adapting to new task demands or changes in situations, is a key aspect of executive function. A meta-analytic review identified 15 studies in the literature assessing set-shifting in the eating disorders, with consistent difficulties seen across AN, bulimia nervosa (BN) and recovered AN groups using neuropsychological tasks such as the Wisconsin Card Sorting Test, Trail Making Task, and the Brixton Test (Roberts, Tchanturia, Stahl, Southgate, & Treasure, 2007; Tchanturia, Campbell, Morris, & Treasure, 2005). Set-shifting has been implicated as an endophenotype of eating disorders (Holliday, Tchanturia, Landau, Collier, & Treasure, 2005; Roberts, Tchanturia, & Treasure, 2010; Treasure et al., 2007), and proposed as part of a cognitive neuroscience hypothesis of AN (Steinglass & Walsh, 2006). This trait can manifest both in aspects of the patients' everyday life (e.g. rigid housekeeping routines) and in terms of illness symptomology (e.g. rules around food preparation/choice of food).

More recently, the concept of weak coherence (formally referred to as "weak central coherence", see Happe & Booth, 2008) has been explored in the eating disorders. In the main this tendency to focus on intricate detail rather than the general tendency to integrate parts in their global context has been extensively studied in the autism literature (Happe, 2005). Research evidence suggests that this inherent bias toward detail is also present in the eating disorder population, as measured by tasks such as the Embedded Figures Task, Matching Familiar Figures Task, and the Rey-Osterrieth Complex Figure (Lopez, Tchanturia, Stahl, Happe, et al., 2008; Lopez, Tchanturia, Stahl, & Treasure, 2008a, 2008b; Oldershaw, Treasure, Hambrook, Tchanturia, & Schmidt, 2011; Roberts, Tchanturia, & Treasure, submitted for publication; Southgate, Tchanturia, & Treasure, 2008; Tokley & Kemps, 2007). A focus on detail is exemplified by the obsessive attention to precise calorie content of food items in AN.

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It is of clinical interest to examine how these neurocognitive styles may shape behaviours. This has been a focus of interest in the literature on autism. Baron-Cohen, Wheelwright, Skinner, Martin, and Clubley (2001) developed the Autism-Spectrum Quotient (AQ) which incorporates domains that represent both social cognition and information processing biases seen in autism. Two of the domains represented in the AQ approximate cognitive flexibility (attentional shifting subscale) and weak coherence (attention to detail subscale), where people with autism report elevated scores on both subscales (Baron-Cohen et al., 2001). Pilot research suggested that whilst the attentional shifting subscale of the AQ discriminated between AN patients and controls, the attention to detail subscale did not (Hambrook, Tchanturia, Schmidt, Russell, & Treasure, 2008). On further investigation, it is likely that the detail subscale of the AQ is conceptually insensitive in what is a majority female clinical group, for example a large number of items are biassed toward masculine traits (e.g. "I usually notice car number plates, or similar strings of information"). Therefore the aim of the present study is to design and validate a self-report measure of behaviours possibly linked to poor set-shifting and weak coherence relevant to the eating disorder population. It is hypothesised that scores on this measure will be reliably higher amongst eating disorder patients compared to controls.

2. Material and methods

2.1. Item pool generation

A group of experienced clinicians and researchers working at the Institute of Psychiatry at the Maudsley Hospital in London generated items targeting inflexible and detail focussed behaviours. Items were drawn from clinical observation and experience, and from comments, feedback or letters from patients themselves regarding aspects of their cognitive style. Additionally, items of relevance from the AQ (Baron-Cohen et al., 2001) were included, with the authors' permission. This list was then circulated to additional colleagues within the unit, with a request to add any further items that were thought relevant. Face and content validity were considered as items were included. In total, 54 items were generated for the pilot scale. A 6-point Likert scale was used, with anchors strongly agree, and strongly disagree.

2.2. Measures

In addition to the DFlex, this study employed the AQ and the Eating Disorder Diagnostic Scale (EDDS). The AQ is a 50-item questionnaire measured on a 4-point Likert scale, from strongly agree to strongly disagree. Ten questions each measure 5 different domains; social skills, attention switching, attention to detail, communication, and imagination. The AQ shows good test–retest and inter-rater reliability (Baron-Cohen et al., 2001). The EDDS is a 22 item self-report measure structured around the DSM-IV criteria for an eating disorder. Items are measured in a variety of formats as determined by the nature of the question including a 6-point Likert scale (e.g. "Have you had a definite fear that you might become fat or gain weight"), yes/no response (e.g. "…did you eat until you were uncomfortably full") and frequency ratings (e.g. "how many times on average…. made yourself sick"). The scale shows good reliability, validity and internal consistency in addition to discriminant validity compared to clinical interview (Stice, Telch, & Rizvi, 2000).

2.3. Participants and procedure

The 54-item pilot questionnaire was sent out to approximately 500 members of the Maudsley eating disorder unit volunteer database. This database is made up of volunteers with either current or past eating disorder, who have an ongoing willingness to help with research. The majority of volunteers are women with current or past AN. The pilot questionnaire was sent to volunteers as part of a small pack of questionnaires, along with a bi-annual newsletter (research update) and flyers recruiting for ongoing projects within the unit. A pre-paid addressed envelope was provided.

Data were also collected from healthy controls who were recruited from a range of places such as student campuses, general practitioner waiting rooms, flyers in the community (e.g. libraries and café's) and the Institute of Psychiatry's healthy volunteer database (MindSearch). All healthy controls were screened for eating behaviour based on responses to the EDDS (Stice et al., 2000).

The study was approved by the local research ethics committee.

3. Results

3.1. Participant demographics

The first group of participants (and those used for the psychometric analyses) consisted of 202 volunteers, all with a lifetime diagnosis of a DSM-IV eating disorder as measured by the EDDS (AN = 68.6%; BN = 16.2%; EDNOS = 15.1%). Mean age was 36.56 (SD = 12.11). Mean body mass index (current) was 19.21 (SD = 5.15) with a lowest BMI ever of 16.65 (SD = 6.59). All but four of the samples were female, with 97.8% being of White British ethnicity. Just over half (53.8%) had a university qualification. Just under half (47.6%) were in paid employment, with 14.1% currently studying, 9.7% unemployed, and 6.5% retired. See Table 1 for scale and subscale scores.

The second group participants were 188 healthy volunteers, with a mean age of 24.97 (SD 11.22) and mean body mass index of 22.21 (SD 3.35). In contrast to the clinical sample, the vast majority of participants were students (73%), and again were predominantly female (85%) and of White British ethnicity (81%). Only 22% were in paid employment, with four people being unemployed and one retired.

3.2. Exploratory factor analysis

An exploratory factor analysis was conducted first to identify the number of factors explained by the scale and also to reduce the number of items required. Only participants with a lifetime eating disorder diagnosis were included in this analysis. Nine participants with missing diagnostic details were excluded. All 54 original items were subject to a principal axis factoring analysis (PFA) using Varimax rotation in SPSS 15.0. Initially, factors with eigenvalues greater than 1

Table 1
DFlex total scale and subscale scores for lifetime eating disorder and healthy control groups.

	Lifetime ED (n = 202)	Healthy Control (n = 188)	t-test	p	Effect size (Cohen's *d*)
DFlex total	87.50 (21.74)	66.85 (16.08)	10.29	<0.001**	1.08
Factor 1: Cognitive Rigidity	47.28 (12.42)	34.08 (9.31)	11.52	<0.001**	1.20
Factor 2: Attention to Detail	40.31 (10.99)	32.80 (7.96)	7.46	<0.001**	0.78
Relevant AQ Subscales					
Attentional Switching	6.21 (2.24)	4.14 (2.31)	8.79	<0.001**	0.91
Attention to Detail	5.66 (2.28)	5.07 (2.30)	2.47	0.01*	0.26

DFlex Detail and Flexibility Questionnaire; AQ Autistic Spectrum Quotient; ED eating disorder.

were extracted however rotation of this model failed to converge within 25 iterations. The scree plot indicated that the 2 or 4 factor models would provide the best fit. PFA extracting 4 and 3 factors, explaining 46.50% and 42.85% of the variance (respectively) were conducted. These solutions provided multiple cross loadings, indicating that items/questions were relevant to more than one factor. When the clusters of items in the three- and four-factor models were assessed together, they did not make as much conceptual sense as the two-factor model. Given these findings and the information from the scree plot, the remainder of the analysis was carried out assuming a two-factor model.

EFA extracting two factors initially explained 34.22% of the variance. After deleting 12 items with loadings less than 0.4 on either component, this increased to 42.20%. On investigation of the general concept of each factor (factor 1 — cognitive rigidity; factor 2 — attention to detail) and consultation with experts, a further eight items that did not conceptually fit their factor were deleted, increasing the variance explained to 44.72%. This gave 15 items on each of the two factors. Internal consistency was assessed using Cronbach's alpha. For factor 1 "cognitive rigidity" this was found to be 0.93, and for factor 2 "attention to detail" 0.90 (see Appendix A for the DFlex). Cronbach's alpha for the overall scale was 0.95, indicating the developed scale has very high internal consistency.

3.3. Item response analysis

Item response analysis (IRA) was carried out in MPLUS version 5.0 to investigate performance of the 30-item scale extracted in the exploratory factor analysis. A model based on maximum likelihood estimation with a probit link function was fitted. Item characteristic curves for each question were then assessed separately for each factor. Based on this analysis, it was decided to remove 6 further items from the scale, 3 from each factor. These items showed poor differentiation between response levels. The item characteristic curves of the final questions contained in each factor are shown in Fig. 1 (factor 1: cognitive rigidity) and Fig. 2 (factor 2: attention to detail). Fig. 3 (left hand figures) shows the general item characteristic curves as a function of each factor.

Removing the further 6 items from the scale only lead to a slight reduction in Cronbach's alpha to 0.91 for factor 1 "cognitive rigidity" and 0.88 for factor 2 "attention to detail". Furthermore, we considered the impact on the total information function for both factors, which was small. Fig. 3 (right hand figures) illustrates the Total Information Functions for both factors in the final scale. The resulting 24-item DFlex scale total correlated well with the original 54-item scale total ($r = 0.97$).

3.4. Construct validity

Construct validity of the DFlex was assessed against the attention switching and attention to detail subscales of the AQ. Whilst gender differences between the two scales (discussed above) are apparent, the AQ was still judged as the closest conceptual fit to the DFlex. Descriptive statistics for both AQ and DFlex subscales are presented in Table 1. The correlation coefficient was calculated between factor 1 of the DFlex (cognitive rigidity) and the AQ attention switching subscale. A strong correlation was found, $r = 0.72$ ($p < 0.001$). Secondly, factor 2 (attention to detail) of the DFlex was correlated with the AQ attention to detail subscale, where a moderate correlation was found $r = 0.26$ ($p < 0.001$).

3.5. Discriminant validity

Significant group differences were found at both the full scale and subscale levels when comparing the lifetime eating disorder and healthy control samples (see Table 1), indicating that the DFlex discriminated well between groups. In order to investigate whether the DFlex further discriminated between illness states, those with a diagnosis of AN only were separated from the sample for individual analysis. *T*-tests were conducted between DFlex scores of those with current AN (mean BMI = 15.50, SD = 2.42), and those recovered from AN (mean BMI = 20.48, SD = 2.05). Only threshold AN cases were included. The groups did not differ on current age ($t(124) = -0.34$, $p = 0.74$). As can be seen in Table 2, both the total scale score and

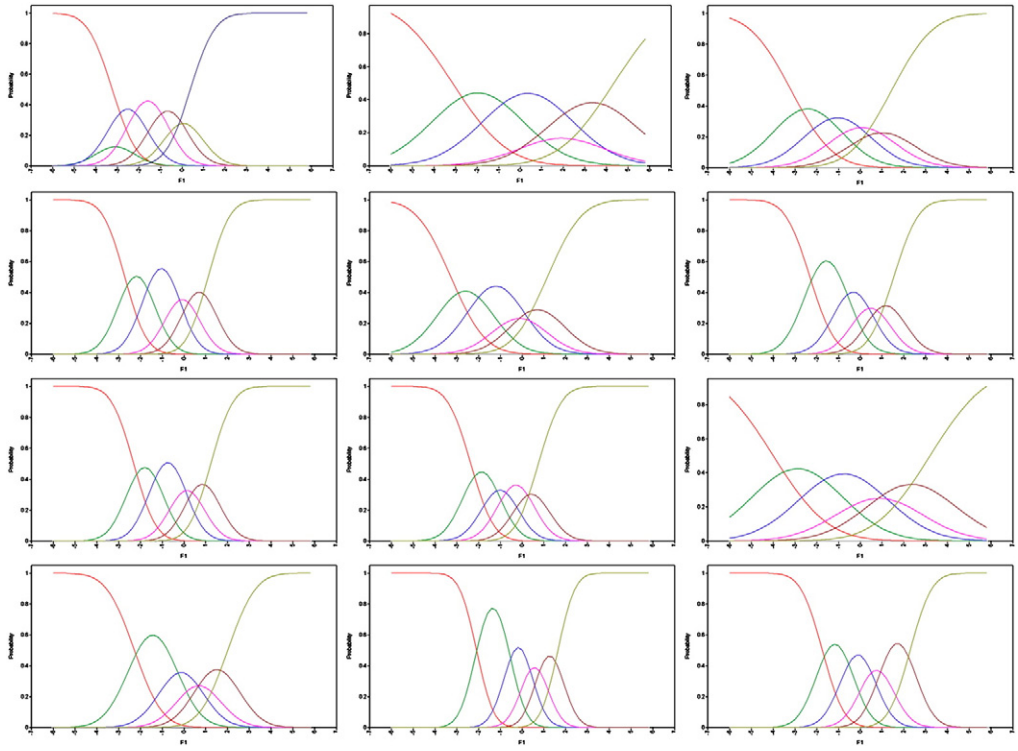

Fig. 1. Item characteristic curves for each item of factor 1 "Cognitive rigidity".

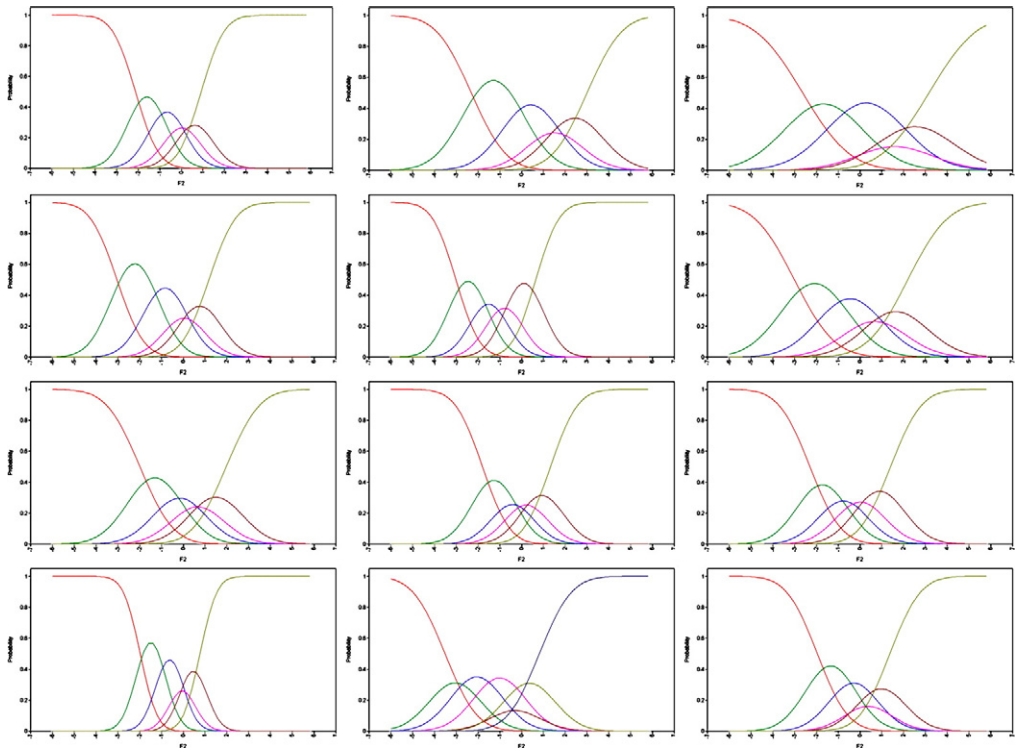

Fig. 2. Item characteristic curves for each item of factor 2 "Attention to detail".

subscale scores clearly discriminated between illness states, where those with current AN scored higher than those recovered from the illness. Effect sizes were large between clinical groups. Scores of those recovered from AN remained significantly higher than those of healthy controls (Bonferroni post-hoc cognitive rigidity, $p<0.001$; detail focus, $p=0.02$). Discriminant validity was less satisfactory for the AQ, particularly with regard to the attention to detail subscale where no significant difference between groups was found.

3.6. Demographic considerations

A significant age difference was found between clinical and control groups ($t(373)=9.62$, $p<0.001$). However age did not correlate with cognitive rigidity or attention to detail scores for the lifetime eating disorder group ($r(179)=-0.003$, $p=0.97$; $r(176)=-0.024$, $p=0.76$, respectively) or the control group ($r(188)=-0.11$, $p=0.12$; $r(189)=-0.11$, $p=0.12$, respectively).

3.7. Population norms

We have presented total scale and subscale scores for the DFlex for a lifetime community eating disorder sample (Table 1) and those with current and recovered AN (Table 2). Scores above the approximate current AN mean (cognitive rigidity = 53; attention to detail = 44) are suggested at this stage as indicating clinically significant traits.

4. Discussion

This paper has presented a new self-report measure to assess levels of coherence and set-shifting ability, designed with the eating

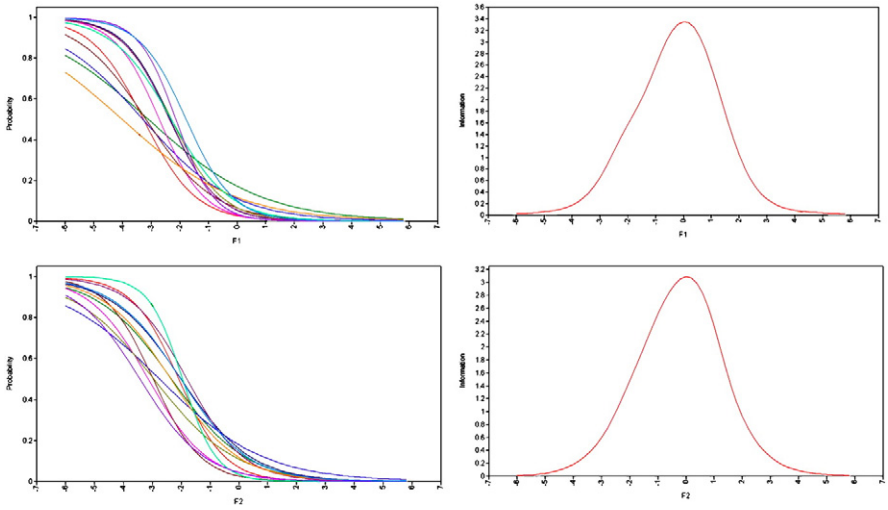

Fig. 3. Item characteristic curves (general) and total information functions for factor 1 (top graphs) and factor 2 (bottom graphs).

Table 2
DFlex total and subscale scores for current and recovered anorexia nervosa.

	AN current (n = 68)	AN recovered (n = 52)	t-test	p	Effect size
DFlex total	96.35 (18.09)	77.06 (18.76)	5.70	<0.001**	1.06
Factor 1: Cognitive Rigidity	52.73 (10.78)	40.56 (10.38)	6.29	<0.001**	1.16
Factor 2: Attention to Detail	43.60 (9.76)	36.50 (10.11)	3.89	<0.001**	0.72
Relevant AQ Subscales					
Attentional Switching	6.82 (1.80)	5.40 (2.41)	3.64	<0.001**	0.69
Attention to Detail	5.99 (2.16)	5.38 (2.23)	1.52	0.13	0.28

DFlex Detail and Flexibility Questionnaire; AQ Autistic Spectrum Quotient; AN anorexia nervosa.

disorder population in mind. The Detail and Flexibility Questionnaire (DFlex) is a brief 24-item measure where responses are measured on a 6-point Likert scale. Factor analysis on the pilot 54-item questionnaire suggested a two factor model (cognitive rigidity and attention to detail), which fitted our conceptual intention. Item response analysis suggested further item elimination to create the most concise yet complete version of the scale. Internal reliability of the DFlex total scale and subscale scores was high. Our hypothesis was confirmed in that those with a lifetime eating disorder diagnosis displayed significantly higher levels of both poor set-shifting and heightened attention to detail (large effect size) than the control group.

Both subscales of the DFlex showed superior discriminant validity between both lifetime eating disorder and controls, and current and recovered anorexia nervosa (AN) compared to that of the AQ subscales. Whilst the AQ attentional switching subscale discriminated well between groups with a large effect size, the attention to detail subscale reached significance but with only a small effect size. As the mean difference between groups was notably smaller than previous findings where no significance was found (Hambrook et al., 2008), the significant group difference reported here is likely because of the substantially larger sample size. The small effect size of the AQ detail subscale in the current sample in addition to insensitivity in smaller samples supports the need for the attention to detail subscale of the DFlex which targets weak coherence in the absence of gender biassed questions. It is interesting to note that, as with the AQ, the attention to detail trait was more difficult to isolate (in that a smaller effect size was seen) compared to the cognitive rigidity trait using the DFlex. Whilst differences between groups were highly significant, given that weak coherence is a relatively new concept in eating disorders compared to impairment in cognitive flexibility, this lessened specificity may indicate that there are still aspects of this cognitive style that we are yet to understand and therefore tap into with self-report items.

Mean responses for the two subscales are presented as potential norms for the DFlex in a community AN sample. Given the relationship between set-shifting and coherence has only just started to be explored, we suggest that the full scale score be interpreted with caution. It may be pertinent for further research using this scale to report independent subscale scores rather than a full scale score until this relationship is more fully understood. Further investigation within distinct cohorts is needed in order for accurate norms of other clinical groups (such as current BN and acute/inpatient AN) to be separately assessed.

It should be cautioned that a self-report measure cannot assess these traits with the same level of specificity as individual neuropsychological assessment. As with all self-report instruments, a level of insight is required in order for the patient or participant to accurately rate their tendencies to focus on detail, or to become 'stuck' in rigid behavioural patterns. However scores on both subscales are elevated in the current vs recovered AN group, following the clinically observed pattern of these traits being exaggerated with weight loss. Even with recovery from AN and significantly lower scores on the DFlex than those with current AN, these traits still persist in the recovered group as self-report scores remain significantly higher than those of healthy controls. This stepping stone of impairment lends further support to the hypothesis that these traits may be endophenotypes of eating disorders (Lopez, Tchanturia, Stahl, & Treasure, 2008c; Roberts et al., 2010, submitted for publication; Treasure et al., 2007), given that they remain to a degree in the recovered state. Given the relatively high BMI of the current AN group, investigation of the DFlex in an acute inpatient AN population will help to inform the influence of illness severity and insight on DFlex validity.

The nature of the current study did not permit for questionnaire respondents to receive a full neuropsychological assessment of set-shifting and coherence traits, in order to validate the DFlex with behavioural assessment (e.g. Wisconsin Card Sorting Test; Group Embedded Figure Task). Such an undertaking would serve to illuminate the relationship between self-report responses and inherent neurocognitive and behavioural biases. Additionally, whilst the clinical group was demographically representative, they were compared against a majority student sample that was over 10 years younger on average. As psychometric analysis employed the clinical population only, any factors relevant to the control group had no influence on the statistical development and validation of the DFlex. No significant correlation was found between age and DFlex score for either cohort. However demographic discrepancy could influence the effect size between the two groups as reported in Table 1, therefore the use of matched healthy controls in further studies could serve to more accurately illustrate between group differences on these domains. A further limitation was the use of the self-report EDDS to determine eating disorder diagnosis rather than clinical assessment. A focus on demographic and clinical details in future studies will help to clarify the relationship between poor set-shifting/weak coherence and eating disorder characteristics.

Despite the limitations of self-report questionnaires, it is because of the ease with which such a measure can be administered, saving significant time and financial resource, that this scale was developed. As both poor set-shifting and weak coherence are implicated as maintaining factors of an eating disorder, even self-report of such traits in the absence of neuropsychological assessment may form a valuable aspect of treatment formulation for clinicians. Case reports and pilot results indicate that targeting these obsessive–compulsive personality traits in both inpatient and outpatient settings is acceptable to the patient and may improve treatment outcome (Lopez, Roberts, Tchanturia, & Treasure, 2008; Tchanturia et al., 2008; Tchanturia, Davies, & Campbell, 2007). Additionally, whilst item generation was conducted with the eating disorder population in mind, scale items are not food or shape specific and therefore the DFlex may be applicable in other clinical populations.

5. Conclusion

This paper presents a new self-report measure of the neurocognitive traits cognitive flexibility and attention to detail as they manifest in everyday life. It is hoped that this measure will enable both researchers and clinicians without the resource of formal neuropsychological assessment to gain a level of understanding as to whether weak coherence and/or set-shifting difficulties are of relevance for their patients.

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Contributors

Authors MR and CL designed the protocol and supervised data collection. Author MR organised the data and wrote the manuscript. Author SB conducted the statistical analyses. Authors KT and JT provided expert supervision of the project. All authors were involved in item generation, contributed to manuscript editing, and have approved the final manuscript.

Conflict of interest

All authors declare that they have no conflict of interest.

Appendix A. Detail and Flexibility Questionnaire (DFlex)

Below are a list of statements. Please circle the response that best describes to what extent you agree or disagree with each statement.	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
1. I get angry if people do not do things my way	1	2	3	4	5	6
2. I sometimes bore others as I go on to an excess about somethings	1	2	3	4	5	6
3. I get upset if other people disturb my plans for the day by being late	1	2	3	4	5	6
4. I have difficulty making decisions	1	2	3	4	5	6
5. When others suggest a new way of doing things, I get upset or unsettled	1	2	3	4	5	6
6. I find it difficult to remember the story line in films, plays or books, but can remember specific scenes in great detail	1	2	3	4	5	6
7. Once I get into an emotional state, eganger or sadness, it is very difficult to soothe myself	1	2	3	4	5	6
8. I spend as much time on more or less important tasks	1	2	3	4	5	6
9. I like to make plans about complex arrangements, eg journeys and work projects	1	2	3	4	5	6
10. I can get hung up on details when reading rather than understanding the gist	1	2	3	4	5	6
11. I have high levels of anxiety/discomfort: I can see/feel/taste that things might not be quite right	1	2	3	4	5	6
12. I tend to focus on one thing at a time and get it out of proportion to the total situation	1	2	3	4	5	6
13. I like doing things in a particular order or routine	1	2	3	4	5	6
14. I can get lost in details and forget the real purpose of a task	1	2	3	4	5	6
15. I can be called stubborn or single minded as it is difficult to shift from one point of view to another	1	2	3	4	5	6
16. I find it difficult to do several things at once (multitasking)	1	2	3	4	5	6
17. I need clarity and rules when facing a new situation. Without rules, I easily feel lost	1	2	3	4	5	6
18. I find it hard to see different perspectives of a situation	1	2	3	4	5	6
19. I get very distressed if plans get changed at the last minute	1	2	3	4	5	6
20. I can get overwhelmed by too many details	1	2	3	4	5	6
21. I dislike change	1	2	3	4	5	6
22. I depend on others to help me get things into perspective, as I tend to have a rather blinkered view on things in my life	1	2	3	4	5	6
23. I often feel vulnerable and unsafe as I am unable to see threats (or opportunities) that are out of my field of vision	1	2	3	4	5	6
24. I find it hard to write concisely: I often overrun word limits and find it difficult to decide which details can be left out	1	2	3	4	5	6

Notes:
Cognitive rigidity subscale — odd numbered items.
Attention to detail subscale — even numbered items.

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