Cognitive Remediation Therapy for Adolescent Inpatients with Severe and Complex Anorexia Nervosa: A Treatment Trial

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Abstract

Cognitive remediation therapy (CRT) is a low-intensity treatment adjunct for individuals with severe and complex anorexia nervosa (AN) with difficulties in globally-oriented, flexible thinking. Previously trialled in adults, this study investigated whether individual and group CRT was a feasible, acceptable and beneficial treatment for 125 adolescent inpatients with severe and complex AN. Seventy patients (mean age=15.22, SD=1.44) received 10 sessions of individual CRT and 55 patients (mean age=14.89, SD=1.74) received 10 sessions of group CRT. In individual CRT, 1 patient (1.43%) dropped-out and there were medium-sized improvements in bigger picture thinking and set-shifting, small to large-sized improvements in switching-related initiation and inhibition skills and large-sized improvements in motivation to recover. Group CRT had higher drop-out (9.09%; n=5) and produced small-sized improvements in global information processing and medium-sized improvements in self-reported cognitive flexibility and high acceptability ratings. Data suggest a randomised controlled trial for adolescents with AN is warranted.

Keywords: Cognitive remediation therapy, anorexia nervosa, eating disorders, inpatient treatment, adolescents, set-shifting, central coherence

Introduction

Eating disorders (EDs) including anorexia nervosa (AN) and bulimia nervosa (BN) are serious and complex mental illnesses with a biopsychosocial pathogenesis and can become chronic, enduring and highly disabling (Schmidt et al., 2016). Intervening early, during typical adolescent onset (Swanson, Crow, Le Grange, Swendsen & Merikangas, 2011) is vital and outpatient Family Based Treatment shows promising outcomes for adolescents with AN (Couturier, Kimber & Szatmari, 2013). However, less is known about how best to enhance treatment for the growing group of young people with this more severe and complex form of illness which can necessitate inpatient treatment (Health and Social Care Information Centre, 2016).

One brief treatment adjunct showing positive outcomes in adults needing inpatient care for severe and enduring AN is Cognitive Remediation Therapy (CRT; Tchanturia, Giombini, Leppanen & Kinnaird, 2017; Tchanturia, Lounes & Holltum, 2014). CRT aims to target inefficiencies in central coherence and set-shifting, known to be cognitive maintaining factors for AN (Harrison et al., 2012; Treasure & Schmidt, 2013) and observed in both adolescent and adult AN populations (Lang, Lopez, Stahl, Tchanturia & Treasure, 2014a; Lang, Stahl, Espie, Treasure & Tchanturia, 2014b; Lang & Tchanturia, 2014; Lang et al., 2016; Westwood, Stahl, Mandy & Tchanturia, 2016; Wu et al., 2014). Cognitive exercises are used to build and improve cognitive skills to facilitate thinking around emotions, beliefs and behaviour change in relation to the illness itself if/when the patient is ready to access more intensive forms of psychotherapy (Tchanturia et al., 2008). A treatment manual is available at www.katetchanturia.com (Tchanturia, Davies, Reeder & Wykes, 2010), with toolkits adapted for young people (Maiden, Baker, Espie, Simic & Tchanturia, 2014; Lindvall, Owen & Lask, 2011) and carers (Lang, Treasure & Tchanturia, 2015).

Two systematic reviews (Dahlgren & Rø, 2014; Tchanturia, Lounes & Holttum, 2014) highlight improved cognitive functioning and low drop-out rates for adults with AN across four randomised controlled trials (RCTs). For adolescents with AN, a systematic review and meta-analysis identified eight published uncontrolled studies with small-sized improvements in central coherence and set-shifting after individual and group CRT, alongside low drop-out and positive feedback from patients (Tchanturia, Giombini, Leppanen & Kinnaird, 2017). A small group treatment study published subsequently further corroborates these findings (Kuge et al., 2017; n=7).

Thus, CRT may be a useful treatment adjunct for adolescents with AN, prompting the need for an RCT. However, a number of limitations of the current literature need further exploration. Although some recent studies include larger samples (e.g. Giombini, Moynihan, Turco & Nesbitt, 2017a, n=92), many are case studies or small case series (e.g. van Noort, Pfeiffer, Lehmkuhl & Kappel, 2015, n=1), omit neuropsychological outcomes (e.g. Dahlgren, Lask, Landrø & Rø, 2014, n=17) or include mixed inpatient/outpatient samples (e.g. Van Noort, Kraus, Pfeiffer, Lehmkuhl & Kappel, 2016, n=24) rather than assessing the usefulness of CRT for adolescents with severe and complex AN (i.e. those needing inpatient treatment with high comorbidity). Therefore, this longitudinal, uncontrolled trial aimed to enhance understanding of the benefits of CRT in individual and group format in a large sample of adolescent inpatients with severe and complex AN to inform decision-making regarding a future RCT.

It was hypothesised that CRT would be an acceptable and feasible treatment for adolescent inpatients with AN in both group and individual formats and that after, compared to before CRT, adolescents would demonstrate improvements in cognitive functioning, assessed via neuropsychological tasks.

Method

Design

This uncontrolled trial employed a repeated-measures design. The study received ethical approval from the London-Dulwich National Health Service Research Ethics Committee, ref 11/LO/1606 and research was conducted in keeping with the World Medical Association Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects.

Participants

All consecutive referrals of any gender were offered CRT. Patients aged 12-18 whose AN diagnosis was confirmed by a Consultant Psychiatrist (HAK) via a clinical interview were eligible for participation if able to comprehend English.

Treatment Context

The inpatient service is a specialist child and adolescent ED unit for young people aged 8-18. Patients are referred from community treatment programmes, specialist ED inpatient units and general paediatric settings. Admission criteria are an ED of a severe and complex nature which has not previously responded to treatment, alongside medical complications associated with a severely compromised nutritional status. Alongside medical monitoring and dietetic input, treatment includes weekly individual therapy, group therapy, occupational therapy, art psychotherapy, family therapy and nursing key-working sessions, drawing on cognitive behavioural therapy, motivational interviewing, systemic and

psychodynamic approaches. Approximately 50% of patients are treated under a Section of the Mental Health Act and an internal audit found an average admission of 146.19 days (SD=110.22).

Treatment

Data collection took place between December 2011 and March 2016. Individual sessions were delivered between December 2011 and July 2014 and group sessions were held between August 2014 and March 2016. Like the adult context (Whitney, Easter & Tchanturia, 2008), CRT was offered on admission.

Individual Context

Patients were offered ten 45-minute sessions weekly with an Assistant Psychologist or a Research Assistant trained and supervised by a qualified and licensed Clinical Psychologist specialising in EDs (AH). An agenda is set and homework discussed before a cognitive exercise is completed and open questions used to promote metacognition. Homework tasks are then agreed on. Exercises are described in the manual by Tchanturia et al., 2010 available at www.katetchanturia.com, Lindvall, Owen and Lask's (2011) toolkit retrieved from: http://www.oslo-universitetssykehus.no/SiteCollectionDocuments/Fagfolk/Forskning%20og%20utvikling/RASP/1.-7.%20The%20CRT%20Recource%20Pack.pdf

Group Context

CRT groups ran for 45 minutes weekly over 10 sessions, co-facilitated by a Clinical Psychologist and an Assistant Psychologist. Content was drawn from Tchanturia et al., (2010), the Flexibility Group materials produced by Maiden et al., (2014) retrieved from www.katetchanturia.com and group CRT in Tchanturia and Doris (2015). Groups followed the same format as individual CRT. The group was closed to new referrals after the first session with new admissions invited to the next group.

Measures

The individual CRT neuropsychological assessment battery was informed by Rose, Frampton and Lask (2001) and approaches in the adult literature (Harrison et al., 2012) to which readers can refer for detailed explanations of measured employed. A smaller battery was selected for group CRT to reduce patient burden, mirroring the approach in the adult literature which tends towards self-report formats, making it feasible for patients to complete outcome measures within the group setting before and after treatment (Tchanturia, Larsson & Brown, 2016). Assessments were conducted by an appropriately supervised and trained Assistant Psychologist or Research Assistant.

Self-Report Measures

Clinical Characteristics

AN symptoms were measured using the 28-item Eating Disorder Examination Questionnaire (Fairburn & Beglin, 1994), a self-report tool which measures eating behaviours and attitudes over the past 28 days on a seven-point scale. The 20-item State Trait Anxiety Inventory (STAI-C; Spielberger, 1970) measured anxiety on a scale of 1–4. Obsessive

compulsive disorder symptom comorbidity was measured using the 32-item Child Obsessional Compulsive Inventory (CHOCI-R; Shafran et al., 2003) using a three-point scale. The Beck Depression Inventory (BDI; (Beck, et al., 1961) measured depression across 21 items using a 0-3 Likert scale. Higher scores on these measures indicate greater psychopathology. The Motivational Stages of Change for Adolescents Recovering from an Eating Disorder (MSCARED; Gusella, Butler, Nichols & Bird, 2003) measured motivation to change, with patients identifying their stage of recovery based on Prochaska & DiClemente's (1983) transtheoretical stages of change: precontemplation, contemplation, preparation, action and maintenance.

Demographic Information

Age, illness duration and gender were obtained from patient notes. Weight and height were recorded by nursing keyworkers and used to calculate weight for height percentages informed by Junior MARSIPAN *(*Royal College of Psychiatrists, 2012) and World Health Organisation growth standards charts (World Health Organisation, 2009).

Self-Report Measures of Neuropsychological Functioning

The 12-item Cognitive Flexibility Scale (Martin & Rubin, 1995) measures patients' perceptions of their cognitive flexibility, used previously in a study of twenty 4-6 session CRT groups for adult women with AN accessing inpatient or intensive daycare services (Tchanturia, Larsson & Brown, 2016).

Experimental Measures of Neuropsychological Functioning

Intelligence (IQ) was estimated using two subtests of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999; matrix reasoning and vocabulary). The abbreviated version was used to reduce patient burden.

Set-Shifting

The Brixton Spatial Anticipation Test (Burgess and Shallice, 1997) and the Delis-Kaplan Executive Function System Trail Making Test (The Delis-Kaplan Executive Function System; D-KEFS; Delis, Kaplan, & Kramer, (2001) measured the cognitive or conceptual (non-verbal) domain of the executive function of set-shifting; Verbal Fluency (The Delis-Kaplan Executive Function System; D-KEFS; Delis, Kaplan, & Kramer, (2001) measured set-shifting in the verbal domain. The Delis-Kaplan Executive Functioning System (DKEFS) Color-Word Interference Test (CWIT); D-KEFS; Delis, Kaplan, & Kramer, (2001) and the The Hayling Sentence Completion Test (Burgess & Shallice, 1997) measured set-shifting and initiation.

Central Coherence

The central coherence index of the copy trial discussed in depth in Lang et al., (2016) of the Rey-Osterrieth Complex Figure Test (Osterreith, 1944) measured global processing.

Feasibility

Reflections on ease and practicality of adapting and implementing CRT for a severe cohort of young people with EDs were explored throughout the study in regular group and individual supervision sessions and key themes from these meetings are included as indications of the feasibility of delivering CRT as part of an inpatient treatment programme.

Acceptability

Patient Satisfaction Questionnaire

A three-item satisfaction questionnaire adapted from Tchanturia and Baille (2015) using a 5-point likert scale (0-4) was administered after group CRT to measure perceptions of the group's usefulness, whether patients would recommend it to others or attend again in future.

Uptake and drop-out were recorded as indicators of acceptability.

Procedure

Consent was collected from patients aged 16+, with assent collected from legal guardians of those <16. All patients had access to an independent advocate to assist with decision-making around participation and were informed that they could withdraw from the study at any point up until their data were anonymously entered into the research database and that this would not affect their ongoing treatment. The Consultant Psychiatrist was encouraged to raise medical concerns regarding participation and General Practitioners were informed of participation. Patients treated under a Section of the Mental Health Act were discussed at the Multidisciplinary Team Meeting (MDT) and given additional support from the independent advocate. If a patient became unable to consent to participation due to

deteriorating mental or physical condition, their participation was placed on hold until they were able to continue their engagement with the study.

Figure 1 illustrates the assessment procedure for individual and group CRT.

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Data Analysis

Intention to treat analysis (Fisher et al., 1990) was adopted. In the case of missing post-CRT assessment data, data collected pre-CRT were carried over. Data were analysed using the Statistical Package for the Social Sciences (SPSS) Version 21 for Windows. Paired sample t-tests were conducted to explore possible changes over time with the Bonferroni correction applied to account for multiple testing (0.05/6=adjusted alpha of 0.008). Cohen's *d* provided the effect size estimation; 0.2=small, 0.5=medium, 0.8=large (Cohen, 1988).

Results

Individual Delivery of Cognitive Remediation Therapy

Figure 2 illustrates recruitment data for individual CRT.

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Table 1 provides demographic, clinical and neuropsychological outcome data for individual CRT.

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After, compared to before CRT, there were small-sized reductions in the severity of ED symptoms, a large-sized improvement in weight for height percentage and a large-sized reduction in trait anxiety. There was a small-sized increase in self-reported symptoms of depression and a large-sized change in patients' motivation to change, with significantly more patients moving into the action and maintenance stages. After CRT, patients demonstrated a medium-sized shift towards global information processing, measured using the RCFT.

Regarding set-shifting, there were small-sized improvements in trail-making test performance and in the ability to inhibit irrelevant information and shift-set on the colour-word interference task, alongside large-sized improvements in initiation and inhibition skills

on the Hayling test. There was negligible improvement in non-verbal set-shifting measured using the Brixton Spatial Anticipation test and set-shifting in the verbal domain, measured by the verbal fluency task.

Feedback from clinicians delivering CRT suggested that it was straight-forward to deliver and required minimal preparation: *"The manual was easy to follow and apply in sessions;"* they experienced it as being interesting *"it's different to other treatments I have delivered or observed – it was interesting to think about thinking as it isn't something you would necessarily normally do,"* and low in intensity: *"I find it is something that the really low weight patients can engage with instantly."* They enjoyed participating in the tasks and helping patients to be more aware of their thinking styles: *"I like taking part in the tasks myself – I have certainly learnt something about my own style*." Supervisors reported a key theme in supervision was problem-solving ways of assisting patients to engage with homework: *"it was difficult when patients hadn't completed the homework and I found it hard to overcome this when patients found it difficult to experiment*." Another perspective was around whether CRT would change AN symptoms: *"I really like delivering CRT, it's like sharing skills for life, but is this really going to help with the ED symptoms?"*

Group Delivery of Cognitive Remediation Therapy

Data were collected from seven CRT groups delivered over 20 months. Fifty-five patients opted to attend, an average of 8 per group (minimum=6; maximum=10). At the time the groups were delivered, there were 20 beds in the service, all occupied with those meeting inclusion criteria and therefore this represents an uptake rate of approximately 40%. Table 2 provides pooled outcome data for the seven groups.

Two patients dropped out from one group at session 5 and one patient from three of the other groups, all at session 1, representing a drop-out rate of 9.09%. Table 2 provides outcome measures for group delivery of CRT.

INSERT TABLE 2 ABOUT HERE

Patients self-reported medium-sized improvements in cognitive flexibility and showed small-sized improvements in global processing (RCFT). There was a high degree of satisfaction with an average rating of 4.15 out of 5 (SD=0.62).

Qualitative Feedback from the Cognitive Remediation Groups

The open-ended question on the patient satisfaction questionnaire which asked for written feedback was completed infrequently. Six patients stated: *"I found the group sessions helpful. Before these, I used to not see the bigger picture, but now I can;" "I thought it was fun doing the origami;" "I liked CRT. It made me see things in a different way and to see the bigger picture. I liked doing activities with everyone and group work. I would like to do some work on self-esteem and socialising;" "It was good, well done;" "Most of it was good, I liked it. I preferred the more practical/visual tasks rather than just writing. I enjoyed the most the illusions and stress ball game, I didn't enjoy the task." "I kinda enjoyed it at times. I find groups cringy and boring, although when we do activities it seems better and more interesting. They can't really help me in anyway but can pass time and can be fun at times;"*

This suggests patients found the groups engaging and enjoyed the activity-based aspect. Some felt that the CRT groups helped to improve their cognitive abilities, whereas one comment suggested a lack of confidence in groups to help them make changes.

Regarding feasibility of group delivery, the same materials used for the individual sessions were used and therefore no further investment in resources was required. A teaching session was provided to assist team members to enable engagement and support homework. Regarding staff hours, including supervision, preparation, note-writing and the actual delivery of the group by the two facilitators, approximately 40 hours were required to run one 10 session group. Dividing this by the average group attendance of 8, this equates to 5 hours of staff time per patient required to achieve the small to medium-sized improvements in cognitive skills.

Discussion

This study aimed to explore the impact of CRT delivered in individual and group contexts for young people with severe and complex AN requiring intensive treatment in an inpatient setting, with the goal of providing high-quality supporting evidence for the need for a future RCT. The first hypothesis which was that CRT will be an acceptable and feasible treatment for adolescents receiving inpatient treatment for AN in a group and individual format was supported by the data. In the individual context, there was a low rate of drop-out and this was also observed in the group context (9.09%; n=5). Patients receiving group CRT rated it as highly acceptable (4.15 out of 5; SD=0.62). Feedback from the service and clinicians delivering the treatment reinforced its feasibility as a component of the treatment programme. The second hypothesis, that after, compared to before CRT, adolescents with AN would demonstrate improvements in cognitive functioning, measured using neuropsychological tasks, was largely supported by the data. In the individual context, there was a medium-sized increase in bigger picture thinking, mirrored in the group context, with a small-sized improvement on the same measure (RCFT). In the individual context, patients showed small-sized improvements across two set-shifting tasks (Trail-Making and Colour-Word Interference Tasks) and a large-sized improvement in initiation and inhibition skills (Hayling Test). However, there was negligible improvement on two of the other set-shifting tasks (Brixton Spatial Anticipation and Verbal Fluency). In the group context, patients reported large-sized improvements in flexibility. After CRT, patients reported being in the action stage of change (MSCARED) which perhaps contributed to a large-sized improvement in weight and future studies should include measures of self-efficacy to explore this further. Patients also reported large-sized reductions in trait anxiety, but CRT was not associated with improvements in state anxiety, depression or OCD symptoms.

The data corroborate the moderate improvements in cognitive functioning observed in adult RCTs and previous uncontrolled adolescent studies (Dahlgren & Rø, 2014; Tchanturia et al., 2014; Tchanturia et al., 2017). Notably, this study and Giombini et al's (2017a) uncontrolled trial which also included a large sample of 92 adolescent inpatients with AN both now demonstrate a significant improvement in global information processing measured using the RCFT (d=0.44 in their study and d=0.5 in this study) after CRT.

There are a small number of differences between these findings and other adolescent studies. Unlike, Dahlgren, Lask, Landrø and Rø (2013), this study did not find that CRT improved verbal fluency, possibly due to sampling differences, as theirs included both inpatients and outpatients. Improvements in this study were of a larger magnitude than Pretorius et al's (2012) group CRT day-patient cohort and perhaps inpatients with more complex and severe illnesses experience greater benefit, a finding also observed an adult RCT (Brockmeyer et al., 2014). There was less drop-out in this study than Asch et al., (2014) in which only 20% of inpatients completed CRT.

It was interesting to observe the large-sized reduction in trait anxiety. Improved cognitive skills may enable young people to solve problems more easily and having an enhanced toolbox of cognitive strategies may reduce anxiety around everyday life. Future studies may wish to include problem-solving outcomes to investigate further. It may have been that the albeit negligible increase in state anxiety and the small-sized increase in depression were explained by patients progressing towards discharge feeling worried about the transition towards the community and the challenge of gaining weight may have affected

their mood. Thus future implementations of CRT may need to utilise cognitive exercises to explore flexible/bigger picture thinking strategies to help reduce discharged-related distress.

CRT did not improve cognitive functioning on all tasks, with negligible improvement observed on the Brixton Spatial Anticipation Test and DKEF Verbal Fluency task. These tasks might be less sensitive to change than others in adolescents, which provides useful information regarding the test battery for future RCTs.

One striking findings was the low drop-out in both the group and individual context which were significantly lower than reported for other ED treatments (Dejong, Broadbent & Schmidt, 2012) and corroborates systematic reviews on CRT (Tchanturia et al., 2014; Tchanturia et al., 2017). This may be because CRT asks patients to think about thinking, rather than facing the ED itself, which can be threatening for patients given the ego-syntonic nature of AN (Treasure & Schmidt, 2013). Alternatively, patients may have been interested in CRT and in developing alternative strategies to assist with everyday challenges and were motivated to attend sessions for these reasons. Indeed, these were themes highlighted in Giombini et al's (2017) qualitative findings in a similar population of 70 adolescent inpatients with AN.

This was an uncontrolled study with CRT offered as a treatment adjunct and one inevitable limitation is the extent to which improvements in weight, motivation to change and cognitive functioning were due to the CRT or other offerings within the treatment programme. Although weight status would be expected to have some degree of impact on

cognitive ability (Keys, 1950), Tchanturia et al., (2004) in an adult ED population and Kjærsdam Telléus et al., (2016) in adolescents have both shown that weight and weight gain alone are not predictors of significantly improved cognitive ability and therefore CRT may have evoked improved cognitive functioning. Only a small number of males were included in the trial, in part due to the number of male beds in the service. More work is needed to explore the relative benefits for male and female patients. The length of time over which this work was conducted may have been a confounding variable due to changes in ward and patient group dynamics. Future RCTs should employ a longer follow-up period to explore the longevity of the observed changes.

In conclusion, this study contributes to the evidence base for the CRT treatment adjunct for supporting adolescents with severe and complex AN requiring inpatient treatment. In keeping with the National Institute for Health and Care Excellence (NICE; 2017) guidelines which promote the avoidance of iatrogenic extended admissions and the use of inpatient treatment solely to provide psychological treatment, this low intensity brief cognitive intervention which was acceptable to severely unwell individuals with AN could be a useful adjunct to medical stabilisation, provide cognitive skills and a positive experience of engagement with treatment to enable the commencement or continuation of more intensive psychotherapies in the community, aiding reduced admission duration through increasing motivation to change. An RCT is therefore warranted to further explore the efficacy of this treatment enhancer for those with the most severe forms of illness.

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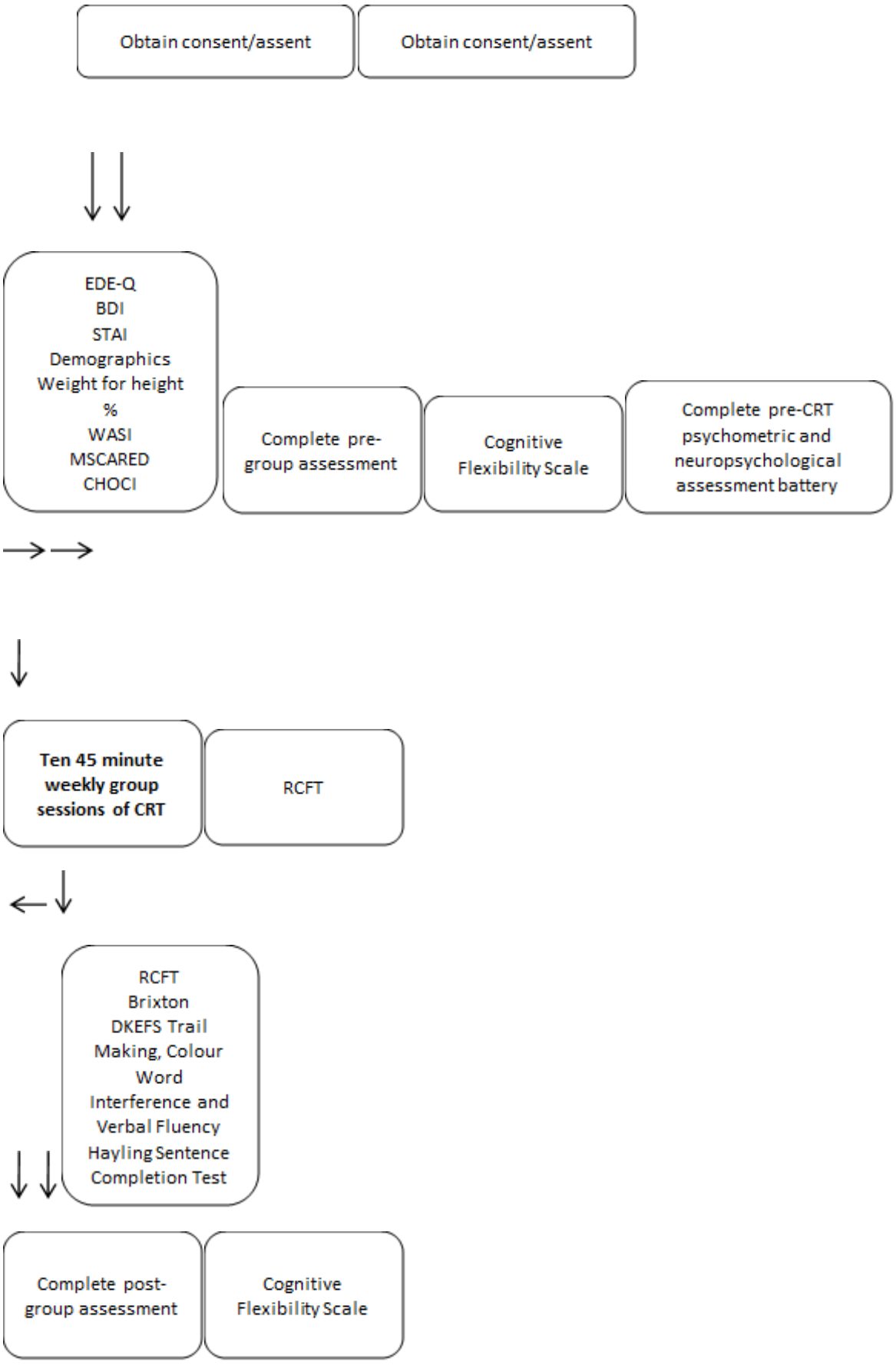
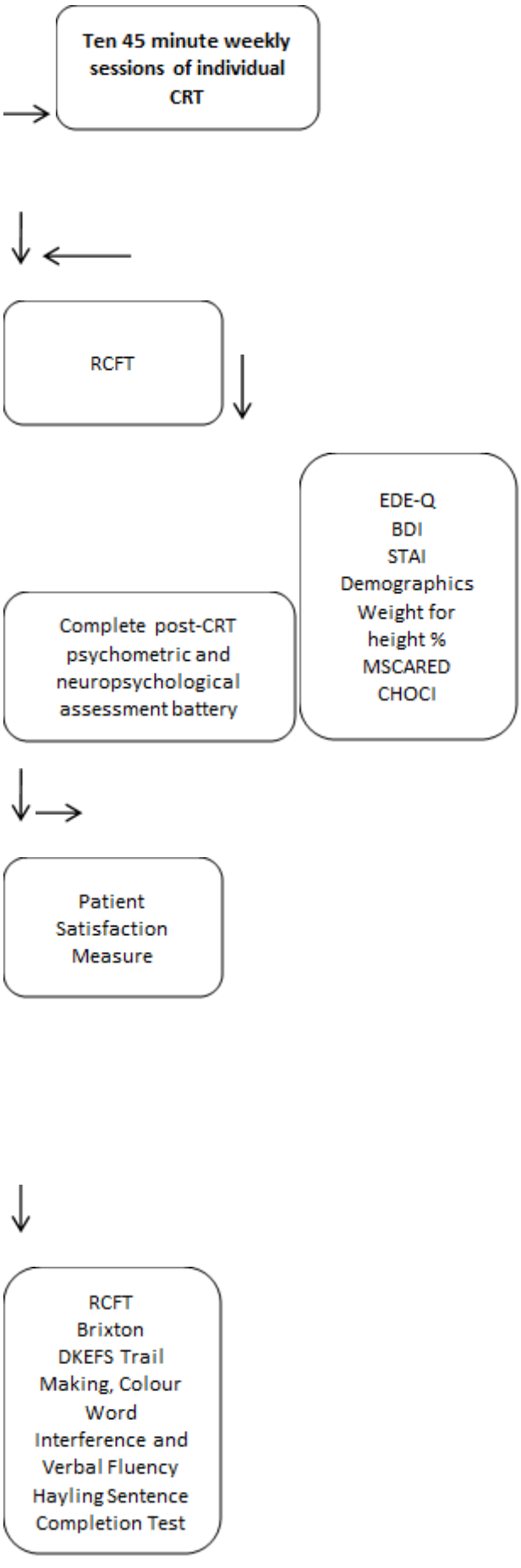
Figure 1: Flowchart Illustrating the Assessment of Outcome in Individual and Group Cognitive Remediation Therapy

Individual Cognitive Remediation Group Cognitive Remediation

Therapy Protocol Therapy Protocol




Ten 45 minute weekly sessions of individual CRT
RCFT
EDE-Q
BDI
STAI
Demographics
Weight for height %
MSCARED
CHOCI
Complete post-CRT psychometric and neuropsychological assessment battery
Patient Satisfaction Measure
RCFT
Brixton
DKEFS Trail Making, Colour Word Interference and Verbal Fluency
Hayling Sentence Completion Test

CRT=Cognitive remediation therapy, STAI=State Trait Anxiety Inventory (Spielberger, 1970), EDEQ=Eating Disorders Examination Questionnaire (Fairburn & Beglin, 1994), DKEFS=Delis-Kaplan Executive Functioning System (Delis, Kaplan & Kramer, 2001); RCFT=Rey-Osterreith Complex Figure Test (Osterreith, 1944); WASI= Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999); MSCARED= Motivational Stages of Change for Adolescents Recovering from an Eating Disorder (MSCARED; Gusella, Butler, Nichols & Bird, 2003); BDI= Beck Depression Inventory (BDI; (Beck, et al., 1961) ; CHOCI= Child Obsessional Compulsive Inventory (CHOCI-R; Shafran et al., 2003); Brixton= Brixton Spatial Anticipation Test (Burgess and Shallice, 1997)

Figure 2: Flowchart of Participation in Individual Cognitive Remediation Therapy

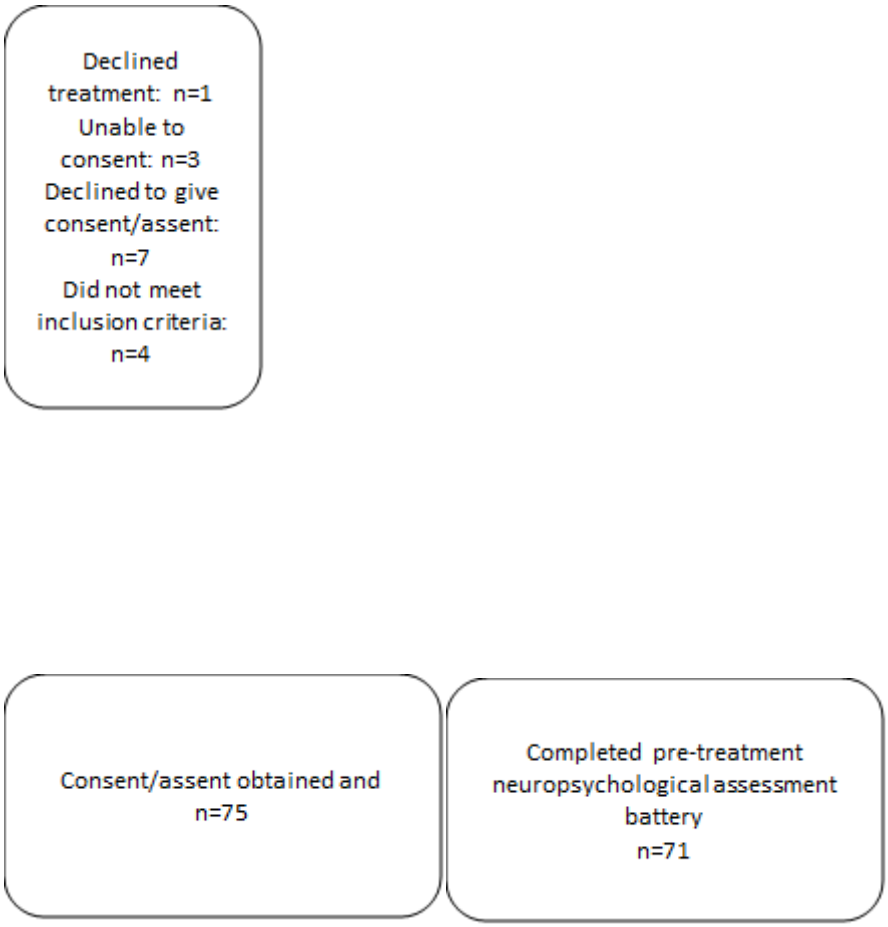


Table 1: Individual Cognitive Remediation Therapy Outcomes

Demographic Information (n=70) Mean (SD)	
Age	15.22 (1.44)
Gender	68 females (97%)
Diagnosis	Anorexia nervosa restricting subtype n=66 (94.3%); anorexia nervosa binge-purge subtype n=4 (5.7%)
Duration of illness (months)	47 (17) Range: 4-77
Number of previous hospital admissions to specialist/general paediatric services	2.31 (1.09) Range: 0-7
Full Scale IQ	107 (16)

Comorbid Disorders	No comorbid diagnosis n=12 (17.14%) Autism spectrum disorder n=4 (5.71%) Anxiety disorder n=55 (78.57%) Obsessive compulsive disorder n=20 (28.57%) Major depressive disorder n=57 (81.43%) Childhood onset schizophrenia n=1 (1.43%)		
Clinical Outcomes			
Mean (SD)	**Before Cognitive Remediation Therapy (n=70)**	**After Cognitive Remediation Therapy (n=70 ITA)**	**Test Statistics**

EDE-Q Global Score	3.59 (1.64) 95% CI: 3.25-4.22	3.18 (1.27) 95% CI: 2.57-3.79	t=1.19, df=69, p=0.08, *d*=0.3
Weight for Height percentage	79.27 (7.46) 95% CI: 77.17-81.63	89.00 (9.63) 95% CI: 86.30-91.72	t=-9.11, df=69, p=≤0.001 *d*=1.1
STAI State Anxiety	54.37 (24.87) 95% CI: 42.38-66.35	59.84 (9.82) 95% CI: 55.11-64.58	t=-0.90, df=69, p=0.38, *d*=0.28
STAI Trait Anxiety	53.88 (25.72) 95% CI: 45.65-62.10	29.05 (31.43) 95% CI: 18.99-39.10	t=3.97, df-69, p=≤0.001, *d*=0.86
CHOCI Global Score	18.91 (7.42) 95% CI: 13.92-23.89	17.55 (10.62) 95% CI: 10.40-24.70)	t=0.64, df=69, p=0.53, *d*=0.15
Beck Depression Inventory	21.4 (19.55) 95% CI: 2.88-45.68	25.80 (9.93) 95% CI:13.46-38.14	t=-0.49, df=69, p=0.65, *d*=0.37
MSCARED; Motivational Ruler (% category)	Precontemplation n=13 (18.6%) Contemplation n=27 (38.6%) Preparation n=20 (28.6%)	Precontemplation n=0 (0%) Contemplation n=3 (4.3%) Preparation n=22 (31.4%)	χ^2=56.59, df=5, p≤0.001, *d*=0.86

	Action n=8 (11.4%) Maintenance n=2 (2.9%)	Action n=30 (42.9%) Maintenance n=15 (21.4%)	
Neuropsychological Outcomes			
Central Coherence			
RCFT Central Coherence Index	1.23 (0.35) 95% CI: 1.11-1.34	1.41 (0.38) 95% CI: 1.27-1.53	t=-2.79, df=0.69, p=0.008, *d*=0.5
Set-Shifting			
Brixton Spatial Anticipation Test (Raw score)	14.63 (8.20) 95% CI: 11.81-17.44	13.23 (8.77) 95% CI: 10.22-16.24)	t=1.89, df=69, p=0.1, *d*=0.16
DKEFS Trail Making Test (Scaled score)	Scaled score: 9.97 (2.36) 95% CI: 9.13-10.81	Scaled score: 10.91 (2.17) 95% CI: 10.14-11.68	t=-2.46, df=69, p=0.019, *d*=0.41
DKEFS Verbal Fluency (Scaled score)	13.34 (3.84) 95% CI: 12.11-14.63	13.86 (3.35) 95% CI: 12.77-14.97	t=-0.61, df=69, p=0.543, *d*=0.05

Set-Shifting and Inhibition Tasks			
DKEFS Colour Word Interference Task (Scaled Score)	Scaled score: 10.35 (3.04) 95% CI: 9.24-11.47	Scaled score: 11.00 (2.59) 95% CI: 10.05-11.95	t=-2.46, df=69, p=0.019, *d*=0.41
Hayling Sentence Completion Test (Raw score)	17.54 (2.46) 95% CI: 16.72-18.36	19.11 (1.85) 95% CI: 18.49-19.73	t=-3.32, df=69, p=0.002, *d*=0.72

CI=Confidence interval; SD=Standard deviation; EDE-Q=Eating Disorder Examination Questionnaire (Fairburn & Beglin, 1994); STAI=State Trait Anxiety Inventory (Spielberger, 1970); CHOCI=Child Obsessional Compulsive Inventory; Shafran et al., 2003); MSCARED=Motivational Stages of Change for Adolescents Recovering from an Eating Disorder (MSCARED; Gusella, Butler, Nichols & Bird, 2003); *d*=estimation of effect size (Cohen, 1988; 0.2=small, 0.5=medium, 0.8=large); IQ=Intelligence Quotient estimated using the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999); RCFT=Rey-Osterrieth Complex Figure Test (Osterreith, 1944); DKEFS=Delis-Kaplan Executive Functioning System; Delis, Kaplan, & Kramer (2001); Intention to treat analysis (ITA)=denotes missing data for one participant is carried forwards from the baseline data-point in keeping with intention to treat analysis. Comorbid disorders were diagnosed by the treating Consultant Psychiatrist through a clinical interview, or by a specialist team in the case of autism spectrum disorder. NB in the case of comorbid diagnoses, the percentages do not total 100 due to patients presenting with multiple comorbidities.

Table 2: Group Cognitive Remediation Therapy Outcomes

Demographic Information (n=55) Mean (SD)	
Age	14.89 (1.74)
Gender	54 females (98%)
Diagnosis	Anorexia nervosa restricting subtype n=54 (98.19%); anorexia nervosa binge-purge subtype n=1 (1.81%)
Duration of illness (months)	41 (19) Range 2-72
Comorbid Diagnoses	No comorbid diagnosis n=6 (10.91%)
	Autism spectrum disorder n=2 (3.64%)
	Anxiety disorder n=45 (81.81%)

	Obsessive compulsive disorder n=10 (18.18%) Major depressive disorder n=40 (72.73%)		
Mean (SD)	**Before Cognitive Remediation Therapy (n=55)**	**After Cognitive Remediation Therapy (n=55; ITA)**	**Test Statistics**
Cognitive Flexibility Scale	39.67 (5.96) 95%CI: 38.06-41.28	44.10 (6.35) 95% CI: 42.39-45.82	t=-4.94, df-54, p=≤0.001, *d*=0.72
RCFT Central Coherence Index	1.25 (0.33) 95% CI: 1.16-1.34)	1.35 (0.42) 95% CI: 1.23-1.46	t=-1.96, df=54, p=0.05, *d*=0.25
Patient Satisfaction Questionnaire	NA	4.15 (0.62) 95% CI: 3.98-4.31	NA

NA: Not applicable; RCFT=Rey-Osterrieth Complex Figure Test (Osterreith, 1944); CI: confidence interval; Intention to treat analysis (ITA)=denotes missing data for one participant is carried forwards from the baseline data-point in keeping with intention to treat analysis. The maximum score for the Patient Satisfaction Questionnaire was 5. NB in the case of comorbid diagnoses, the percentages do not total 100 due to patients presenting with multiple comorbidities.