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ORIGINAL ARTICLE

Evaluation of individual cognitive remediation therapy (CRT) for the treatment of young people with anorexia nervosa

Lucia Giombini[1] · Jennifer Moynihan[1] · Matteo Turco[1] · Sophie Nesbitt[1]

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Abstract
Purpose Research suggests that there are cognitive inefficiencies underlying Anorexia Nervosa (AN), with CRT showing promise in improving these inefficiencies in adults. This area has yet to be explored in a younger population. The aim of this study was to evaluate the use of CRT for young people.
Methods A within-subjects design was used to compare the performance of children and adolescents with AN on several neuropsychological measures administered before and after a course of CRT.
Results Ninety-two female participants diagnosed with AN aged between 11 and 17 ($M = 14.8$, SD = 1.6), all receiving treatment at a specialist inpatient unit. The assessment consisted of the Rey–Osterrieth Complex Figure test (ROCFT), the Behaviour Rating Inventory of Executive Function–Self-Report (BRIEF-SR), and the D-KEFS Colour-Word Interference Test (CWT). Repeated-measures t tests were used to analyse the ROCFT and BRIEF-SR data. There was a significant improvement in Central Coherence Index ($p < .001$), Immediate Recall ($p < .001$), Shift ($p < .001$) Cognitive Shift ($p = 002$), Behavioural shift ($p < .001$), Emotional Control ($p < .001$), Working Memory ($p = .001$), Plan/Organize ($p < .001$), Monitor ($p = .001$) BRI ($p < .001$), MI ($p = .001$), and GEC ($p < .001$). On the D-KEFS CWT, a repeated-measure Wilcoxon signed-rank test revealed a significant improvement in Error Rate ($p = .019$) and a repeated-measures t test revealed a significant improvement in time taken ($p < .001$).
Conclusions Results suggest that CRT for children and adolescents with AN could strengthen specific cognitive domains.

Keywords Cognitive remediation therapy · Anorexia nervosa · Central coherence · Cognitive flexibility · Executive functioning · Treatment

Introduction

Anorexia Nervosa (AN) is a complex eating disorder characterised by an extreme pursuit of thinness, distorted body image, and morbid fear of food [1]. While it affects a sizeable minority of the general population (0.3 %) [2], its aetiology remains unclear.

A large body of research literature has been devoted to exploring the neuropsychological features of AN [3–6] with some researchers going as far as asking whether there is a neuropsychological profile specific to AN [7]. The literature to date has predominantly been focused on adult populations, with many studies positing that there are differences in cognitive performances between people with AN and healthy controls. Specifically, adults with AN have been consistently reported to produce poorer performances in the cognitive domains of central coherence (the ability to see the "bigger picture") (for a review, see [3]) cognitive flexibility (switching attention from one stimulus to another) [4, 5, 8] and visuospatial processing (the ability to perceive and understand spatial relationships), although this may improve with weight gain [9]. Fewer studies have focused on exploring the cognitive performances in

L. Giombini and J. Moynihan indicate co-first authorship.

✉ Lucia Giombini
lucia.giombini@partnershipsincare.co.uk

[1] Rhodes Wood Hospital, Partnerships In Care, Sheperd's Way, Brookmans Park, Hatfield, London AL96NN, UK

children and adolescents (for reviews [10, 11]). A recent review reported that children and adolescents with AN were less cognitively flexible than healthy controls, although the difference was more pronounced in adult samples [11]. A recent largest study conducted by Lang et al. [12] also found that children and adolescents with AN had weaker central coherence and were cognitively less flexible than the healthy controls. Using the Rey–Osterrieth Complex Figure Test (RCFT), Lang et al. [12] found that patients with AN focused more on the detailed elements of the figure at the expense of the global elements. In addition, using the Wisconsin Card Sorting Test, they found patients with AN made more perseverative errors, suggesting more difficulty in switching. Other studies, however, have found no differences between children and adolescents with AN and healthy controls on central coherence [13] or cognitive flexibility [14]. Due to the limited number of studies, mixed designs, and inconsistent results, there is as yet no clear consensus regarding the cognitive profile of children and adolescents with AN.

Cognitive remediation therapy (CRT) is an intervention that aims to improve cognition. It has been used in the treatment of many mental health conditions, most notably for patients with schizophrenia [15, 16], and has also been adapted for use in the treatment of AN specifically focusing on flexibility and bigger picture thinking (for more details of the intervention and research evidence, see [17]). The early case studies of CRT for AN [18–20] hypothesised that adults with AN would benefit from a treatment specifically designed to target their neuropsychological inefficiencies, chiefly weak central coherence, and poor cognitive flexibility (often described as set-shifting). Indeed, recent randomised treatment studies in adult AN have shown that CRT, as an adjunctive treatment, enhances cognitive flexibility (for review of the studies [17, 21, 22]) abstract thinking and is associated with quality-of-life improvement.

Studies investigating the efficacy of CRT in children and adolescents have predominantly been based on a group format delivery of the therapy [23, 24]. Few studies have investigated the effectiveness of individually delivered CRT for children and adolescents; however, Dahlgren, Lask, Landrø & Rø [25] used the Behaviour Rating Inventory of Executive Function (BRIEF) self-report (SR) and parent report (PR) [26], a measure of executive functioning, before and after a course of CRT. Participants self-reported more flexible in their behaviour, while parents reported improvements in flexibility and emotional control after CRT. In addition to the improvements in cognitive functioning, CRT was found to be acceptable to the patients. In a recent study by van Noort [27], individual CRT was found to be associated with improvements in flexibility but not central coherence. A limitation of the studies discussed above is that they remain exploratory in their design and have small sample sizes, making it difficult to generalise their findings.

This study aimed to systematically assess the efficacy of CRT in children and adolescents using an individual format. The Copy and Immediate recall conditions of the Rey Complex Figure Test [28] and Condition 4 of the Colour-Word Interference Test and Delis–Kaplan Executive Functioning System [29] were used, as these are two well-established tests for the evaluation of central coherence and cognitive inhibition/flexibility in AN (see Ravello Profile [30]). Based on the findings of Dahlgren [25], the BRIEF-SR [26] was also included in the battery and used to measure participants' perception of their executive functioning. It was hypothesised that there would be an improvement on the measured domains of neuropsychological functioning. Specifically, it was expected that, following a course of CRT, participants would improve in their central coherence and cognitive flexibility task performance.

Methods

CRT intervention

Sessions were based on the CRT Manual [31] and some tasks used in the sessions were chosen from the CRT Resource pack [32], specifically for adolescents with eating disorders. The content of the sessions varied depending on the age and the needs of the participants, as determined by the pre-CRT assessment, as well as from routine clinical observation (for further information about the CRT protocol, see [33]). CRT took place twice a week for a total of eight sessions. Each session lasted an average of 45 min. The sessions were delivered by assistant psychologists trained in CRT supervised by the clinical psychologist. An individual format was chosen, so that sessions could be tailored to the individual's cognitive strengths and inefficiencies (based on the pre-CRT assessment) and because it provides the opportunity for the therapist to model adaptive thinking styles (e.g., flexibility) in a safe environment [17].

Participants

A total of one-hundred and three participants were recruited for the study. All were sequentially admitted to a specialist inpatient unit for eating disorder and all had a diagnosis of AN based on the DSM-5. All participants were female, aged 11–17 years ($M = 14.80$, SD = 1.6). Of the total 103 participants, 11 participants (10.68 %) dropped out of the study; 5.83 % ($N = 6$) refused to complete part or all of the assessment, and 4.85 % ($N = 5$) were

discharged or transferred prior to completing the course of CRT. No patient failed to gain weight during their course of CRT, and therefore, no patient was excluded from the study for this reason.

Some of the participants were taking medication during the study; 34.78 % ($N = 32$) were taking an antidepressant, 7.61 % ($N = 7$) were taking an antipsychotic, 23.91 % ($N = 22$) were taking both an antipsychotic and an antidepressant, and the remaining 33.70 % ($N = 31$) were not taking any psychiatric medication.

Patients are admitted to the hospital when they can no longer safely remain in the community. All participants were receiving adequate nutrition to meet their needs (either a weight gaining or maintenance prescription according to weight for height percentage) prior to starting the CRT sessions. We offer a multi-disciplinary treatment. In regard to the psychological intervention, every participant in the hospital received therapeutic interventions in addition to CRT: individual therapy, family therapy, and group therapy. The group therapy programme consists of a psychoeducational group about nutrition, a psychoeducation group about eating disorders, a relaxation group, and a relapse prevention strategies group.

Neuropsychological assessment

Rey complex figure test (RCFT)

The Copy and Immediate Recall Trials of the RCFT [28] were administered to assess participants' visuospatial abilities and memory. The Copy Trial was further analysed to obtain a central coherence index (CCI) score using the method described by Booth [34]. For the Copy Trial participants copied, a geometric shape comprised global and local elements. For the Immediate Recall Trials, participants re-drew the shape from memory after a 3-min interval.

Colour-word interference test (CWIT)

The CWIT is part of the Delis–Kaplan Executive Function System (D-KEFS) [29] assessment battery. Participants are asked to read either the word or the colour of the word depending on whether the word is in a box or not. Condition 4 of the CWIT was selected from the battery and administered to the participants to assess their cognitive flexibility.

Behaviour rating inventory of executive functioning—self-report version (BRIEF-SR)

The BRIEF-SR [26] is an 80-item self-report measure of executive functioning in everyday life scenarios. It consists of eight subscales in total. The subscales Inhibit, Behavioural Shift, Cognitive Shift, Emotional Control, and Monitor form the broader index Behavioural Regulation Index (BRI). The subscales Working Memory, Plan/Organize, Organisation of Materials, and Task Completion form the broader index Metacognition Index (MI). The measure produces a total score, the Global Executive Composite (GEC). Raw scores are converted to age and gender corrected t scores, where a lower score indicates better functioning. This was used to measure executive functioning based on the participants' own perception.

Clinical assessment

The eating disorder examination questionnaire

The eating disorder examination questionnaire (EDE-Q) [35, 36] was used to assess the level of eating disorder symptomatology over the past 28 days. It consists of 28 items that are rated on a 7-point scale (from 0 to 6), where a higher score indicates greater pathology. The minimum score on the EDE-Q is 0 and the maximum is 6.

The State/trait anxiety inventory

The State/trait anxiety inventory (STAI) [37] was used to measure levels of anxiety. It consists of 40 items; 20 measuring state anxiety and 20 measuring trait anxiety. These items are rated on a 4-point Likert scale (from 1 to 4). The STAI generates two scores, where a score greater than 70 indicates anxiety pathology. The minimum score is 20 and the maximum score is 80.

Weight for height percentage

The weight for height percentage [38] was measured at the beginning of the CRT sessions to provide clinical information. Weight gain after the CRT course was not included in the analysis due to the nature of the hospital, the study was conducted in, and patients gain weight at a rate of between 0.8 and 1 kg per week. There were no exceptions to this within the participants used in this study. This means that all the participants in this study gained weight via oral eating or nasogastric feeding conducted under the Mental Health Act (2007).

Procedure

The pre-CRT assessment battery was administered within the first 2 weeks of admission to the inpatient ward. Informed consent was obtained from all individual participants included in the study at the admission. The battery was administered sequentially, in the following order:

RCFT, BRIEF-SR, and CWIT. Participants then completed the course of CRT. The assessment battery was then re-administered (post-CRT assessment). The total elapsed time between the pre-CRT assessment and the post-CRT assessment averaged 4 weeks.

Results

Sample characteristics

The final sample consisted of 92 participants; Table 1 details the sample characteristics. The Weight for Height (WfH) percentage and age were measured at the beginning of the CRT course, whereas the EDE-Q and STAI scores were measured at admission. The table below shows the Age, WfH percentage, EDE-Q and STAI scores to provide information on the characteristics of the sample.

Self-report data

All participants completed the BRIEF-SR at both pre- and post-CRT. Each subscale on the BRIEF-SR was entered into Bonferroni-corrected two-tailed repeated-measures *t* tests. Table 2 summarises the results.

Pre-CRT the Shift, Behavioural shift, and Emotional control subscales fell into the 'borderline' range, and the Inhibit and Organisation of Materials subscales fell in the above average range; all remaining subscales fell within the 'average' range. Post-CRT the Shift, Behavioural Shift, and Emotional Control subscales improved significantly, moving to the 'average' range [26].

All subscales improved after CRT. In addition, there was a statistically significant improvement between the pre- and post-CRT assessment for the following scales: Shift, $t(91) = 4.10$, $p < .001$; Cognitive Shift, $t(91) = 3.17$, $p = .002$; Behavioural Shift, $t(91) = 3.94$, $p < .001$; Emotional Control, $t(91) = 4.74$, $p < .001$; Working Memory, $t(91) = 3.56$, $p = .001$; plan/organize, $t(91) = 3.87$, $p < .001$; monitor, $t(91) = 3.32$, $p = .001$; BRI, $t(91) = 4.74$, $p < .001$; MI, $t(91) = 3.30$, $p = .001$; and GEC, $t(91) = 4.22$, $p < .001$.

Table 1 Sample characteristics—Means, Standard deviations (SD), and Ranges for Age, WfH percentage, EDE-Q, and STAI scores

	Mean	SD	Range
Age	14.80	1.60	11–17
WfH percentage pre-CRT	78.11	7.82	63.90–110.10*
WfH percentage post-CRT	86.10	6.95	72.2–110.2*
EDE-Q global score	3.77	1.60	0.00–5.67
STAI state score	54.43	13.66	27–78
STAI trait score	59.95	12.36	28–77

A healthy weight for height percentage is usually between 90 and 110 %

* Some participants were admitted to the unit at a healthy weight due to being transferred from other paediatric units, where nasogastric feeding had been undertaken to maintain weight

Test data

All participants completed the RCFT at both pre- and post-CRT. Bonferroni-corrected two-tailed repeated-measures *t* tests were used to examine differences. Table 3 summarises the results.

There was a significant improvement between pre- and post-CRT scores for the central coherence index $t(91) = 4.86$, $p < .001$, $d = .44$. There was also a significant difference for the immediate recall condition $t(91) = 5.73$, $p < .001$, $d = .51$. The results for both central coherence index and immediate recall denote an improvement following the course of CRT.

All participants completed Condition 4 of the Colour-Word Interference Test at both pre- and post-CRT. A two-tailed repeated-measures *t* test was used to examine time taken data. A two-tailed Wilcoxon signed-rank test was used to examine error rate, as the data were non-normally distributed.

There was a significant difference between pre- and post-CRT scores for time taken, $t(91) = 7.20$, $p = <.001$, $d = .59$. Scores were lower at pre-CRT ($M = 10.48$, SD = 2.58) than at post-CRT ($M = 11.92$, SD = 2.25). There was also a significant difference in ranked error rate *t* score, $Z = 293$, $p = .003$, $r = 0.17$. Scores were lower pre-CRT ($M = 10.35$, SD = 2.40) than post-CRT ($M = 11.12$, SD = 2.06), indicating an improvement in error rate.

Weight data

A Pearson's correlation was used to examine the relationship between weight for height percentage (WfH %) pre-CRT and the test and self-report data pre-CRT.

On the BRIEF-SR, a significant positive correlation was found between WfH % and the inhibit scale, $r(92) = .257$, $p = .013$. The higher the WfH %, the greater the level of problems with inhibition. A significant positive correlation was found between WfH % and the Emotional Control scale, $r(92) = .224$, $p = .032$. The higher the WfH %, the greater the level of problems with emotional control. Finally, a significant positive correlation was found between WfH % and the Working Memory scale, $r(92) = .261$, $p = .012$. The higher the WfH %, the greater the level of problems with Working Memory. There were no other significant correlations between WfH % and the

Table 2 Participant BRIEF-SR scores pre- and post-CRT

	Pre-CRT *M* (SD)	Post-CRT *M* (SD)	*M* difference	*t*	*P*	Cohen's *d*
Inhibit	49.29 (10.82)	48.70 (12.13)	−0.59	0.80	.424	0.05
Shift	63.48 (13.88)	58.54 (15.00)	−4.95	4.10	<.001*	0.34
Cognitive shift	58.76 (13.51)	54.89 (13.99)	−3.87	3.17	.002*	0.28
Behavioural shift	64.42 (12.54)	59.62 (14.94)	−4.80	3.94	<.001*	0.35
Emotional control	60.77 (12.90)	55.97 (12.90)	−4.80	4.74	<.001*	0.37
Working memory	55.05 (13.71)	51.38 (13.12)	−3.67	3.56	.001*	0.27
Plan/organize	53.26 (11.88)	49.52 (13.29)	−3.73	3.87	<.001*	0.30
Organisation of materials	49.92 (12.66)	48.82 (12.89)	−1.10	1.86	.177	0.09
Task completion	55.57 (13.15)	53.15 (14.04)	−2.42	2.50	.014	0.18
Monitor	52.07 (11.39)	49.22 (11.50)	−2.84	3.32	.001*	0.25
BRI	58.06 (12.18)	53.81 (13.16)	−4.25	4.74	<.001*	0.34
MI	54.28 (13.67)	51.19 (14.24)	−3.09	3.30	.001*	0.22
GEC	56.56 (13.31)	52.68 (14.21)	−3.88	4.22	<.001*	0.28

BRI behaviour rating inventory, *MI* metacognition index, *GEC* global executive composite

* $p \leq .004$. Cohen's effect sizes (*d*) are defined as small ($d = 0.2$), medium ($d = 0.5$) and large ($d = 0.8$)

Table 3 Participant RCFT scores pre- and post-CRT

	Pre-CRT *M* (SD)	Post-CRT *M* (SD)	*M* difference	*t*	*P*	Cohen's *d*
Central coherence index	1.31 (.35)	1.45 (.29)	.14	4.86	<.001*	.44
Immediate recall	46.38 (11.86)	52.10 (10.45)	5.72	5.73	<.001*	.51

* $p \leq .025$. Cohen's effect sizes (*d*) are defined as small ($d = 0.2$), medium ($d = 0.5$), and large ($d = 0.8$)

self-report data. No significant correlations were found on any of the test data.

A Pearson's correlation was used to examine the relationship between WfH % post-CRT and the test and self-report data post-CRT. No significant correlations were found on any of the data.

Discussion

On the basis of results obtained with adult literature (for review [21]), it was hypothesised that children and adolescents with a diagnosis of AN would benefit from an individual eight session CRT format. Specifically, the benefit was hypothesised to come through an improvement in cognitive flexibility and central coherence which are implicated in both the onset and maintenance of AN [5, 9, 39]). This study lends support to the finding that CRT provides measurable cognitive benefits, both on a subjective level, as measured by the BRIEF-SR [25], and on a behavioural level, as measured by the remainder of the assessment battery [17–19, 21, 22].

Results from the BRIEF-SR indicated that participants report a statistically significant improvement in relation to Shift, Cognitive Shift, Behavioural Shift, Emotional Control, Working Memory, Plan/Organize, Monitor, BRI, MI, and GEC. The improvement in Shift, Cognitive Shift, and Behavioural Shift suggests an increase in flexibility. Given the poor flexibility that characterises AN [4, 5, 9, 14], these results provide the evidence of improvement in these domains; however, further studies are needed to clarify whether weight gain alone can improve flexibility in children and adolescents [12, 40].

The results on the RCFT indicate an improvement on the central coherence index (CCI), as well the immediate recall score. This suggests that there has been an increase in the participants' ability to "see the bigger picture" following a course of CRT. There is some evidence that weak central coherence is an endophenotype of AN, although further studies are needed [3]. An improvement in this domain could, therefore, lead to the improvements in outcomes for patients with AN. The improvement in the immediate recall score suggests an improvement in short-term memory. The improvement in this score could also be due to the improvement in central coherence, because when the figure is drawn in a coherent style ('bigger picture'), the individual is required to remember fewer items than if the figure is drawn in a fragmented style ('detail focused'). In addition, as the same figure was used at pre- and post-CRT assessments, practice effects could be

present, and as such, this result should be interpreted with caution.

The results from the CWIT indicate an improvement in participants' speed of execution (time taken), and their accuracy (Error rate). Given that the CWIT tests the ability to shift the attention rapidly between stimuli, such results corroborate the subjective accounts on flexibility reported on the BRIEF-SR, where both the Cognitive Shift and the Behavioural Shift subscales significantly improved. Weak central coherence and poor cognitive flexibility have been suggested to contribute to both the development and maintenance of AN through an excessive focus of details (e.g., nutritional content and calorie count) and rigidity in eating behaviours and thought patterns [9]. The results are in line with the previous studies investigating the effectiveness of CRT for adults with AN, which found an improvement in flexibility and central coherence post-CRT [17–19, 21, 22], although this study does not have a control group to confirm the improvements.

Finally, the finding that WfH % pre-CRT is correlated with self-reported ability in inhibition, Emotional Control, and Working Memory suggests that those who are dramatically underweight perceive themselves to be functioning well in these areas. This seems to be related to the general presentation of young people suffering from AN, where they perceive their symptoms to be functional to their life and self-image [9]. The fact that WfH % both pre-CRT and post-CRT was not correlated with measures of central coherence or flexibility lends support to the hypothesis that inefficiencies in these areas are endophenotype of AN; however, this study cannot confirm this hypothesis [12].

To the authors' knowledge, this is the first study to use a large sample size to investigate the effects of individual CRT in adolescents, and as such, the study makes an important contribution to the emerging body of research on the effectiveness of CRT for the young age group with AN. A further strength of the study was that the structure of the CRT course was the same for all participants; each participant received the same number of sessions and at the same point of their admission. There is some inconsistency in the previous studies with regard to the structure of the CRT course; specifically with the number of sessions delivered, the duration of the sessions, at what point in the treatment it is delivered, and the frequency of the sessions [21, 25].

The main limitation of this study is the absence of a control group. This severely limits the ability to draw conclusions, regarding the effect of CRT on the improvements noted above. It is plausible that the effects seen are due to other factors, for example, concurrent therapeutic interventions or practice effects on the assessment battery rather than through the CRT treatment. In addition, this study did not measure IQ, which limits the interpretation of cognitive tests. A further weakness of the study is that it did not include any wider measures of functioning in relation to eating disorder symptoms, for instance, motivation, eating behaviours, weight gain, and quality-of-life.

To address these limitations, future studies should most importantly use a control group to investigate the effectiveness of CRT for children and adolescents with AN. As few studies to date have investigated the cognitive profile or the effectiveness of CRT for children and adolescents with AN, it is important that future studies also address any potential developmental factors on task performance. Future studies should also investigate whether any improvements in cognitive functioning are related to an improvement in eating disorder psychopathology, motivation, and quality-of-life.

Overall, this study lends support to the idea that CRT promotes measurable improvements in the domains of both cognitive and behavioural flexibility, central coherence, and emotional control; however, the results need to be interpreted with a high degree of caution due to the lack of control group. Nevertheless, the size of the present sample is indicative of a pattern that appears worthy of further investigation.

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Compliance with ethical standards

Disclosure of potential conflicts of interest All authors declare that they have no conflict of interest.

Ethical approval For this study, formal ethical approval is not required, as the therapy and assessments were a part of the standard treatment programme. The assessments were conducted to inform the content of the Cognitive Remediation Therapy sessions and to provide feedback to the patients.

Informed consent Informed consent was obtained from all parents or guardians and individual participants included in the study at the admission.

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