

Neuropsychological and clinical findings of Cognitive Remediation Therapy feasibility randomised controlled trial in young people with anorexia nervosa

Abstract

Objective: Randomised Controlled Trial (RCT) in adults with anorexia nervosa (AN) showed that Cognitive Remediation Therapy (CRT) enhances cognitive flexibility, abstract thinking and quality-of-life. Despite inconsistent findings, CRT has the potential as an adjunct treatment for young people (YP) with AN. A feasibility RCT was conducted in an inpatient setting. The study will also consider the effect of CRT in YP with AN and autistic symptoms.

Methods: Participants were randomly allocated to the Immediate or Delayed condition to receive individual CRT sessions, in addition to standard treatment. A repeated measures design was conducted.

Results: Eighty participants were recruited. The neuropsychological measures were feasible for evaluating individual CRT in YP. Significant improvements in set-shifting and central coherence were found, with no main effect between Immediate and Delayed condition. Significant interactions were found between the condition, and autism spectrum condition (ASC) and No-ASC subgroups, with significant positive impact of CRT on set-shifting in the No-ASC subgroup. There was some evidence that for the No-ASC subgroup, CRT was more effective if delivered at the start of the treatment; and for the ASC subgroup, that CRT was more effective if delivered at the later stage of treatment.

Conclusions: These findings suggest the overall positive effect of CRT in set-shifting and central coherence alongside standard treatment. They also indicate the importance of screening for the presence of ASC which could require tailored CRT.

Keywords: CRT, feasibility RCT, anorexia nervosa, young people, ASC.

Abbreviations: Anorexia Nervosa (AN), Cognitive Remediation Therapy (CRT), young people (YP), randomised controlled trial (RCT), Autism Spectrum Condition (ASC).

Highlights

This feasibility RCT indicates overall positive effect of CRT in set-shifting and central coherence alongside standard treatment for inpatient YP with AN.

The study also indicates the importance of screening for the presence of ASC which could require tailored CRT.

Further RCT studies are needed to confirm the findings and further explore how CRT can benefit YP with ASC and AN.

Introduction

Cognitive remediation therapy (CRT) has been used as an adjunct intervention in the treatment of anorexia nervosa (AN) to target cognitive training of inefficiencies, with a specific focus on flexibility and bigger picture thinking (Tchanturia, 2014; Tchanturia et al., 2017).

In the treatment of adult patients with AN has shown to be effective in improving set-shifting and central coherence (Tchanturia et al., 2014; Lepannen et al., 2018; Dandil et al., 2020). Feedback from patients and clinicians has been positive across studies (Tchanturia et al., 2014; Lang e al., 2015) strengthening the acceptability of CRT.

More recently, feasibility studies have explored the benefits of delivering CRT to adults with AN who have comorbid traits in the autism spectrum condition (ASC) (Tchanturia et al., 2016; Dandil et al., 2020).

The research focused on CRT in young people [(YP) i.e. children and adolescents between 10 and 18 years old] somewhat lags behind that of adults, although the recent focus on CRT as an intervention for YP with AN has been recognized. Studies showed CRT to be feasible and acceptable for AN, particularly among YP receiving inpatient care (Kuge et al., 2017; Giombini et al., 2017a; Harrison et al., 2018). A systematic review of the literature identified small improvements in cognitive performance, especially in central coherence, suggesting that YP had developed their gestalt information processing style following CRT. Less consistency was observed on set-shifting tasks across the different studies, with studies using fewer CRT sessions apparently showing greater improvement. When CRT was conducted in a group format, improvements in self-reported cognitive flexibility and motivation to change were non-significant, with a small effect size. All studies reported positive feedback from service users and clinicians (Tchanturia et al., 2017).

The use of CRT among YP with ASC traits is supported by preliminary findings and requires further exploration (Dandil, et al., 2020).

Recently Hagan et al. (2020) undertook a preliminary systematic review and meta-analysis of existing RCTs focused on CRT for AN, which included studies conducted in adults and one study on adolescents. Overall, improvement in central coherence, measured using the Rey-Osterrieth Complex Figures Test (ROCFT), was non-significant compared with a control treatment group. Mixed conclusions were drawn regarding set-shifting; some studies found no significant improvement following treatment whereas others identified an association. The authors highlighted as limitation of the current literature in CRT the low quality of the RCT studies conducted and the need for further RCT studies especially in YP.

Since, Timko et al. (2020, 2021) have published an RCT protocol to explore the effectiveness of CRT as an intervention employed to supplement family-based treatment (FBT) and improve cognitive flexibility in YP with AN and their parents.

The present design has some notable differences: individual CRT was explored as a supplement to multi-disciplinary treatment rather than FBT; CRT was delivered to patients only and did not involve parents/carers; operationalized measures differ despite some overlap in outcomes (e.g., cognitive flexibility); and it included a secondary focus on the effectiveness of CRT in patients with ASC traits. The present study was a feasibility RCT aimed at determining if it was feasible to recruit 80 participants over the planned 36-month recruitment phase; and if the neuropsychological measures employed were tested for use in evaluating individual CRT in YP. The secondary outcome was to examine if TAU with the addition of CRT was potentially superior to TAU alone for the improvement of set-shifting and central coherence; if CRT could contribute to a decrease of clinical symptoms and influence motivation to change; and to investigate the potential effect of CRT in patients who reported the presence of ASC traits.

Methods

The study's ethics approval was granted by London - Camberwell St Giles Research Ethics Committee, NHS England (17/LO/0876). The trial registration is ISRCTN81736780. The protocol of this trial, supporting CONSORT checklist and flow diagram are available in Giombini et al., 2018. Updated CONSORT checklist and flow diagram are included as supporting documents to the present manuscript.

The study was conducted in a specialist inpatient eating disorder private service commissioned by the NHS England.

The study was a single-centre, pilot, randomised, controlled, blinded, and superiority study. Participants were randomised between the two groups at a 1:1 ratio within 24 hours of informed consent. Stratified randomisation by date of birth and severity of the illness [Weight for Height percentage (WfH%)] was performed within each stratum using random permuted blocks of randomly varying block sizes.

Consenting patients who met the eligibility criteria were randomly allocated to the Immediate condition receiving TAU with the addition of eight, twice weekly individual CRT sessions at the start of the treatment programme (Week 2 to Week 5) and TAU only for rest of the duration of the programme; or to the Delayed condition receiving TAU only at the start of the programme and TAU with the addition of eight, twice-weekly individual CRT in the second part of the programme (Week 7 to Week 10). A repeated measures design was conducted at three time-points: Time 0: Week 1; Time 1: Week 6; Time 2: Week 11.

Participants

The Eligible criteria were the following: 1) Participants' parents written informed consent and participants' informed assent (if below age of 16) or informed consent (if above age of 16); 2) Aged 10-18; 3) Diagnosis of AN or atypical AN (according to DSM-V criteria; APA, 2013); 4) Newly referred to the service; 5) Fluency in English; 6) No visual impairment; 7) No cognitive impairment; 8) No drug or alcohol abuse; 9) Absence of severe comorbidity at the time of intake (e.g., psychosis, severe learning disability, brain injury). Eligible criteria were assessed at the admission visit through a clinical interview. The principles of informed consent and participants' right to withdraw from the study at any time was reiterated throughout the study.

The sample consisted of eighty YP, 75 females (93.8%) and 5 males (6.3%), aged 10-18 years old (Median 13 [min. 10 - max. 17], Mean age 14.49, SD 1.75). Seventy-three YP (91.4%) were White British or Other White; n. 6 (7.5%) Asian or Asian; and n.1 (1.3%) was Mixed White and Black Caribbean.

Participants were stratified for age group [Older Group= 15 – 18 years old (n. 41; 51.25%; Younger Group= 10 – 14 years old (n. 39; 48.75%) and severity of AN, as measured by the WfH% at admission [Mean WfH admission 77.93% (min. 59.5 – max. 110.89) SD 8.2; Very Severe = Below 75% WfH (n. 27; 33.75%) Severe = Above 75% WfH (n. 53; 66.25)]. Clinical characteristics indicating severity of AN are reported in Table 1.

Table 1*Clinical characteristics indicating severity of AN*

Clinical characteristic	N	Minimum	Maximum	Mean
WfH Admission (%)	80	59.50	110.89	77.93
Onset Age (years)	80	9	17	13.26
Duration of ED (months)	80	2	96	15.4
Number of previous admissions	80	0	8	1.5
Education Months Missed	80	0	24	.94

WfH: Weight for Height percentage. A healthy Weight for Height percentage is usually between 90 and 110 %; *ED* Eating Disorder

Interventions

Treatment as usual (TAU)

TAU consisted of a 12-week stepped programme. All patients received nutritional input, and were expected to gain weight via eating or nasogastric feeding conducted under the Mental Health Act (2007). Multi-disciplinary treatment was offered consisting of a combination of medical risk management, nursing, dietetic and psychological interventions (i.e. weekly individual cognitive behavioural therapy for eating disorders (CBT-ED)-ED, fortnightly family therapy and psychoeducational group therapy on nutrition, ED, anxiety, and relapse prevention strategies) and provision of school education.

Cognitive Remediation Therapy

CRT adhered to the CRT Manual developed by Tchanturia et al. (2010), and manualised group program (Maiden et al., 2014).

Outcome measures

A full description of the outcome measures can be found in the protocol (Giombini et al., 2018).

Primary outcome measures

- Wisconsin Card Sorting Test Computer version 4 [(WCST) Heaton, 1993].
- Brixton test (Burgess & Shallice, 1997).
- Detail and Flexibility questionnaire [(D-FLEX) Roberts et al., 2011].
- Rey-Osterrieth Complex Figure test [(ROCFT) Osterrieth, 1944].

Secondary outcome measures

- Eating Disorder Examination Questionnaire [(EDEQ) Fairburn & Beglin, 1994].
- Revised Child Anxiety and Depression Scale [(RCADS), Chorpita et al., 2005].
- Motivation Ruler.
- Social Communication Questionnaire, parent version [(SCQ) Rutter et al., 2003].
- Social Responsiveness Scale, parent version [(SRS); Constantino & Gruber, 2005].
- Intelligence Quotient (IQ): Weschler Abbreviated Scale of Intelligence [(WASI) Wechsler & Hsiao-pin, 2011].
- Demographic (age, sex, ethnicity, family structure) and clinical (height, weight, duration of illness, lowest weight, medications, number of previous hospital admissions) were collected through a structured interview.

Statistical methods

All data from the immediate and delayed conditions were approached from the point of view of three main research objectives, described below. References to these three points will be made when reporting the results.

IBM SPSS statistics (version 26.0) software was used for most analysis.

- A. The means of the 3 sets of measurements at times 0, 1, and 2 were compared to identify any general trends over time. One or more relevant factors (e.g., treatments groups, age, ASC groups) were used to reduce variability not explained by time.

- B. To assess whether CRT in addition to TAU was superior to TAU alone, scores at Time 0 and Time 1 were compared. Comparisons of scores at Time 1 and Time 2 were not informative in understanding the efficacy of CRT due to possible carry-over effects of the CRT from time 1 to time 2 for YP allocated to the Immediate condition.
- C. Significance of the treatment group in explaining differences of the data at Time 0 and Time 2 was established to evaluate whether CRT was more effective in the Immediate or Delayed condition.

The SRS-2 (Constantino & Gruber, 2005) was administered to screen for the presence of ASC to evaluate whether CRT impacted differently. A score >59 indicates the possible presence of ASC from mild to severe range. The whole sample was categorised in two groups (Table 2): no-ASC group and the ASC group when the participants reported scores >59 at all three times point.

Table 2

ASC and Non-ASC Group: Sample categorisation based on the screening for the presence of ASC traits conducted with the SRS-2.

Group	Condition		
	Immediate	Delayed	Total
ASC Group	9	9	18
Non-ASC Group	31	31	62
	Age		
	Older	Younger	Total
ASC Group	10	8	18
Non-ASC Group	31	31	62
	Severity		
	Severe	Very Severe	Total
ASC Group	14	4	18
Non-ASC Groups	39	23	62

ASC: autistic spectrum condition

Results

Primary Outcome results

The recruitment phase duration was 30 months. Within this period 113 YP who met the eligibility criteria were consecutively admitted. Eighty participants completed the study. Amongst the 33 participants who dropped out from the study, 12 (36%) self-discharged against medical advice; 10 (30%) received a specifically individualised treatment which did not allow the delivery of all CRT sessions; 4 (12%) disengaged with the broader therapy programme, receiving only nutritional treatment; 3 (9%) were transferred to another service; 1 (3%) disengaged from CRT session and 3 (9%) disengaged from CRT assessment.

Secondary Outcome results

In the outcomes of the computerised tests (WCST and Brixton), problems with outliers were identified. In particular, YP n. 96 seemed to have completed WCST test at time 0 completely at random, resulting in the score being 51 times standard deviation (SD) above the mean and almost 10 times interquartile range above the 3rd quartile, while the scores at Times 1 and 2 were very close to the means of the corresponding datasets. Since winsorizing such a value in a positively skewed dataset would create an extremely influential observation, this score was instead replaced by the mean of the scores in the corresponding randomisation stratum (Old*Sev). A similar argument was used for Brixton Time 0 entry for YP n. 81. Also, scores of YP n. 4 were outliers at all three time points in some of the measures. In the case of WCST, all three scores for YP n. 4 were extreme outliers (all of them being beyond more than 37 times SD above the mean) and therefore were winsorized (using 97.5% values).

The Wisconsin Card Sorting Test Computer version 4

A. Perseverative errors (PE) were considered. Repeated measures ANOVA (for log scores) showed a significant effect of time [$F(2,152) = 6.755, p < .002, \eta_p^2 = .082$]. Bonferroni pairwise comparisons showed that PE scores were lower at Time 1 compared to Time 0 ($p < .037$), and at Time 2 compared to Time 0 ($p < .005$). There were no significant differences between Time 1 and Time 2 ($p < .629$). A significant 3-way interaction between time, treatment group, and ASC group [$F(2,152) = 3.445, p = .034, \eta_p^2 = .043$] was found. Plots are reported in the Appendix (Fig.1).

B. ANCOVA taking the log scores at Time 0 as response, scores at baseline as covariate, and group, age and ASC condition as factors, was used. We found a significant 3-way interaction between treatment groups, age, and ASC group [$F(1,71)=4.134$, $p<.046$, $\eta_p^2=.055$], while neither the main effects nor the 2-way intersection effects were significant. Follow up analyses showed that ASC and No-ASC subgroups were affected differently by CRT. Simple effects analysis showed that YP in the Older group without ASC responded positively to CRT ($p=.040$, $\eta_p^2=.058$), while YP in the Older group with ASC and YP in the Younger Group didn't show any significant effect.

C. ANCOVA, taking the log scores as response at Time 2, scores at baseline as covariate, and treatment group and ASC group as factors, was conducted. Neither the main nor the intersection effects involving age were significant. A significant intersection effect between treatment group and ASC group [$F(1,75)=5.411$, $p<.023$, $\eta_p^2=.067$.] was found. Simple effects analysis showed that CRT is more effective for YP in the No-ASC subgroup in the Immediate condition ($p<.037$, $\eta_p^2=.057$).

Brixton test

A. Total number of errors (B) was considered. Repeated measures ANOVA showed a significant effect of time [$F(2,152)=31.995$, $p<.000$, $\eta_p^2=.296$.]. The scores for patient 4 and patient 111 were outliers. However, the analysis w/o those patients gave almost identical results, therefore the results for the full dataset are reported. Bonferroni pairwise comparisons showed reductions of mean error scores from Time 1 to Time 0, Time 2 to Time 1, and Time 2 to Time 0 (in all three cases, $p<.012$). There also was a significant 3-way interaction between time, treatment group, and ASC group [$F(2,152)=4.002$, $p<.020$, $\eta_p^2=.050$.]. Plots are reported in the Appendix (Fig.2).

B. ANOVA was used taking the differences between scores at Time 0 and Time 1 as response, and treatment group and ASC group as factors. A significant interaction between treatment group and ASC group [$F(1,76)=4.869$, $p<.030$, $\eta_p^2=.060$] was found, while the main effects were not significant. Simple effects analysis revealed a significant effect of ASC group in the Immediate condition. In

particular, YP in the No-ASC group were more positively affected by CRT than the YP in the ASC group [$p < .032$, $\eta_p^2 = .059$].

C. ANOVA was conducted taking the differences between scores at Time 0 and Time 2 as response, and treatment group and ASC group as factors. A significant interaction effect between Treatment group and ASC group [$F(1,76) = 5.809$, $p < .018$, $\eta_p^2 = .071$] was found. Simple effects analysis revealed for YP in the ASC subgroup that CRT was more effective when delivered at the later stage of the treatment, $p < .041$, $\eta_p^2 = .054$.

The Detail and Flexibility questionnaire (DFLEX)

A. Total score was considered. Repeated measures ANOVA did not show any significant main effect of time, but showed a significant 3-way interaction of time, treatment group, and ASC group [$F(1.8, 134.2) = 3.386$ (Greenhouse-Geisser), $p < .042$, $\eta_p^2 = .043$]. The interaction effect was largely caused by the presence of high D-Flex baseline scores in YP in the ASC group. Plots are reported in the Appendix (Fig.3 and Fig. 4). YP in the ASC group reported higher D-Flex score at the baseline than YP in the No-ASC subgroup ($F(1,78) = 8.072$, $p < .006$, $\eta_p^2 = .094$)

B. Two regression lines - Time 1 vs. Time 0 for the Immediate and Delayed condition- were compared (Appendix Fig.3), showing a significant difference ($p < .03$) with the point of intersection $x = 87.86$ (Time 0) $y = 88.75$ (Time 1). In the D-Flex, a score of 87.5 indicates the ED norm, which was considered to define two sub-groups High D-Flex Group (Time 0 score > 87.5) and Low D-Flex Group (Time 0 score < 87.5), as reported in Table 3.

Table 3

D-Flex Sub-groups: Sample categorisation based on D-Flex score of 87.5 indicating the clinical norm for eating disorders.

D-Flex Sub-Groups			Immediate	Delayed	Total
Low	D-Flex	Group	23	21	44
(Time 0 score < 87.5)					
High	D-Flex	Group	17	19	36
(Time 0 score > 87.5)					
Total			40	40	80

ANOVA was used with differences between the scores at Time 0 and Time 1 as response, and treatment group and D-flex group, as factors. A significant interaction between treatment group and D-flex group [$F(1,76) = 7.794, p < .007, \eta_p^2 = .093$] was found. Simple effects analysis revealed that YP in Low D-flex group showed significantly higher scores (indicating greater difficulties) after CRT [$p < .019, \eta_p^2 = .070$]. In the Immediate group there was a significantly different effect of CRT on YP in D-flex groups ($p < .000, \eta_p^2 = .159$). The scores increased for YP in the Low D-flex group patients, and reduced (indicating an improvement) for YP in the High D-flex group.

C. ANOVA was conducted with the differences between scores at Time 0 and Time 2 as response, and treatment groups and D-flex groups as factors. A significant interaction between treatment group and D-flex Group [$F(1,76) = 4.097, p = .046, \eta_p^2 = .051$.] was found. Simple effects analysis revealed that in the Immediate group there was a significantly different effect of CRT on YP in D-flex groups ($p < .001, \eta_p^2 = .138$). In the Immediate group, the increase for YP in the Low D-flex group and the reduction for YP in the High D-flex group were more pronounced than in the Delayed group. Plots are reported in the Appendix (Fig.3).

Rey-Osterrieth Complex Figure Test

A. The central coherence index was considered (for patient 96, the score at time 2 was winsorised). Repeated measures ANOVA showed a significant main effect of time [$F(2,158) = 6.874, p < .001, \eta_p^2 = .08$]. Bonferroni pairwise comparisons did not reveal any significant differences between the mean CR scores at Time 0 and Time 1 ($p < .438$), and at Time 1 and Time 2 ($p < .088$). It showed an increase in the mean score at Time 2 compared to Time 0 ($p < .001$).

B and C. There were no significant effects of treatment groups or any interaction effects.

Eating Disorder Examination Questionnaire [(EDEQ)

A. Global score was considered. Friedman's test revealed significant differences between the 3 sets of measurements ($p < .000$). Bonferroni pairwise comparisons showed trends towards reduction at Time 1 compared to Time 0 ($p < .000$), and between Time 2 compared to Time 0 ($p < .000$). There was no significant change between Time 1 compared to Time 0.

B and C. Treatment groups did not show any significant effect.

The Revised Child Anxiety and Depression Scale [(RCADS)

Global anxiety and depression (ADS) score were considered. A, B and C - There was no significant main effect of time nor treatment group.

The Motivation Ruler

Ability to Change

A. Friedman's test showed significant differences between the 3 sets of measurements ($p < .042$). This significance was due to the increased trend between Time 0 and Time 2 ($p < .033$, but Bonferroni adjusted $p < .098$).

B and C. Treatment groups did not show any significant effect.

Importance to Change

A. Friedman's test didn't show any significant differences between the three sets of measurements ($p < .971$)

B and C. Treatment groups did not show any significant effect.

Discussion

The study investigated the feasibility of individual CRT in a specialist inpatient setting for YP with AN, and its potential to enhance TAU (Time 0- Time 1) in improving set-shifting and central coherence, evaluating also whether it would be more beneficial delivering CRT at the initial or later stage of the treatment (Time 0- Time 2). Whether CRT might impact differently in YP with possible presence of ASC traits was also evaluated.

The findings showed that it was feasible to recruit eighty participants within the planned 36-month phase. The neuropsychological measures employed were feasible for use in evaluating individual CRT in YP. Several outliers in the computerized WCST and Brixton Tests were identified. These YP were observed to complete the test with poor attention and were easily distracted, giving at random answers. The rest of the YP did not present any difficulties.

In regards to set-shifting, as measured by the WCST and Brixton Test, a significant improvement overtime was found. No main effect between the Immediate and Delayed condition was found, however there were significant interactions between the condition and ASC/No-ASC subgroups, suggesting that CRT may impact them differently. Further analysis showed that CRT had a significant impact in YP in the No-ASC subgroup. In the WCST this was more pronounced in particular for the older group in the No-ASC group when compared to older and younger YP in the ASC group.

In regards to the self-perceived cognitive flexibility, as measured by the D-Flex questionnaire, no significant differences were found overtime and between Immediate and Delayed condition. However, our analysis led to the categorization of the sample in two subgroups: High D-Flex Group and Low D-Flex Group. Our findings showed significant differences between the High D-Flex and the Low D-Flex subgroups. In particular, YP in the Low D-Flex subgroup showed significantly higher scores, indicating greater difficulties, in the D-Flex after CRT. Also, YP in the ASC group tend to have higher D-Flex score at the baseline than YP in the No-ASC subgroup. Given that the D-Flex questionnaire is a self-report measure, the results can be interpreted considering the level of self-awareness that YP had of their cognitive flexibility skills. This may suggest that YP with ASC traits may have been more self-aware of their difficulties with the cognitive flexibility and may feel more confident to use their skills after CRT, while YP with no ASC traits may not have been self-aware

of their difficulties and after CRT are more able to report on their struggles. When comparing the Immediate and Delayed condition, in the Immediate condition the increase for YP in the Low D-flex group and the reduction for YP in the High D-flex group were more pronounced than in the Delayed condition. This may suggest the positive effect of the delivery of the TAU for additional six weeks (the Delayed condition starts at Week 7) which seems to enhance the effect of CRT and even out the differences in the self-perceived cognitive flexibility.

In regards to the central coherence, as measured by the Rey-Osterrieth Complex Figure test, a significant improvement overtime was found, with no main effect between Immediate and Delayed condition. However, a significant improvement was found at Time 2 compared to Time 0, possibly suggesting the enhancing effect of the provision of the TAU alongside CRT.

Overall CRT seemed to enhance the effect of TAU in improving both set-shifting and central coherence. This replicates findings from previous studies in both adults and YP (Tchanturia et al., 2014; Lang et al., 2015; Tchanturia et al., 2017; Leppanen et al., 2018; Dandil et al., 2020). This was not confirmed when cognitive flexibility was measured through a self-report measure (DFlex) confirming the findings in adults (van Passel et al., 2020, Lounes et al., 2011).

The ASC group performed better in the Brixton test in the Delayed condition when CRT was delivered at a later stage of the treatment; while the No-ASC group performed better in the WCST in the Immediate condition when CRT was delivered at the initial stage of the treatment. This suggests the importance of screening for the presence of ASC traits, which seem to require tailored CRT. It also replicates the findings in a study conducted in adults (Tchanturia et al., 2016), where those without ASC traits were observed to improve significantly following group CRT in measures of self-perceived cognitive flexibility, bigger picture thinking and self-reported ability to change, compared to ASC patients whose advancements at end-of-treatment were non-significant. However, conclusions drawn throughout more recent study in adults (Dandil et al., 2020) is somewhat inconsistent. In line with previous research, patients with low and high ASC traits both demonstrated improvement in set-shifting and cognitive flexibility, despite discrepancies between performance-based tasks and self-reported measures arising in the high ASC group regarding bigger picture thinking and cognitive rigidity.

No significant differences were found on the clinical measures although the ED symptoms and the ability to change showed significant improvements over time, suggesting the overall positive effect of TAU alongside CRT irrespective of the conditions. This confirms data reported in the systematic review (Tchanturia et al., 2017) where differences in the motivation to change were non-significant, with a small effect size. This is also consistent with CRT literature in other conditions such as schizophrenia where improvements are observed in the cognitive functions but not in the psychological symptoms which are not the main target of this intervention (Pillet et al., 2015).

This study confirms that CRT is a feasible and acceptable intervention in an inpatient setting for the treatment of YP with AN. No main effect was found although significant interactions between the ASC and No-ASC subgroups were observed indicating a different impact of CRT on those subgroups. Although the study wasn't powered to look at these differences as a feasibility trial some improvements were shown, highlighting the importance of a larger definitive trial.

Future RCT studies should consider a larger longitudinal design with a definite distinction between TAU and TAU + CRT, also investigating for the longitudinal effect of CRT with follow-up assessments.

The significant differences between the ASC and No-ASC group suggest that YP with AN and comorbid ASC traits would require a tailored CRT, as also indicated in Tchanturia et al. (2016). However, the ASC subgroup in this study was small and was defined only through the SRS scores and not based on a formal assessment. Although SRS proved to be a useful and reliable tool for the screening of ASC traits in adults with AN (Kerr-Gaffney et al., 2020), this finding has not been replicated yet in YP. It would be important that future studies could screen the presence of ASC in YP with AN and explore tailored interventions, including CRT.

Although conducted on a single centre, which impacts on the generalisability of the data, the study suggests the overall positive effect of CRT in set-shifting and central coherence alongside standard treatment. As highlighted by Hagan et al., (2020) the effects of CRT for AN are not well understood in YP despite promising preliminary case studies and case series. Their systematic review and meta-analysis included only one with an adolescent-only sample. Larger definitive RCT studies in young people are therefore warranted to confirm these findings.

Appendix

Fig. 1 - The Wisconsin Card Sorting Test Computer version 4

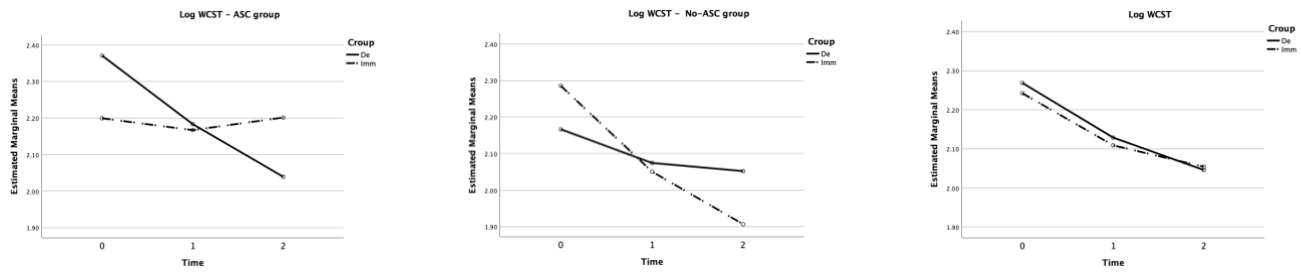


Fig. 2 - Brixton test

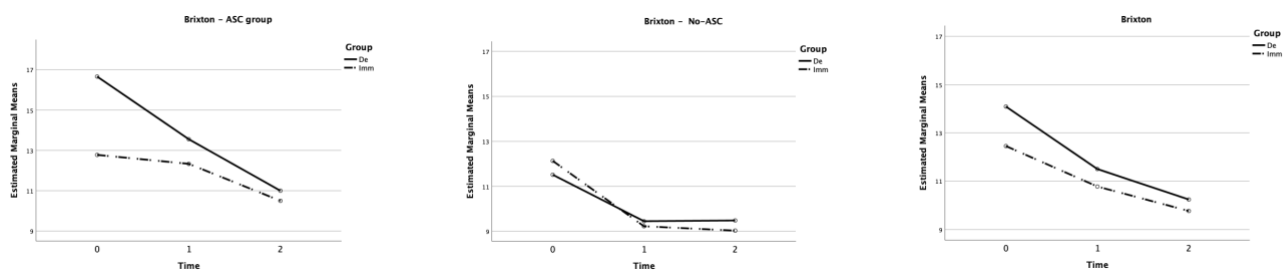


Fig. 3 - The Detail and Flexibility questionnaire (DFLEX)

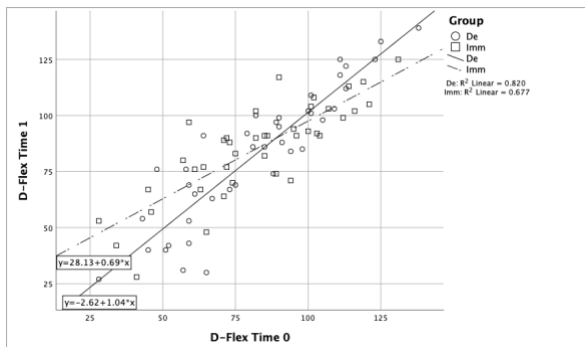
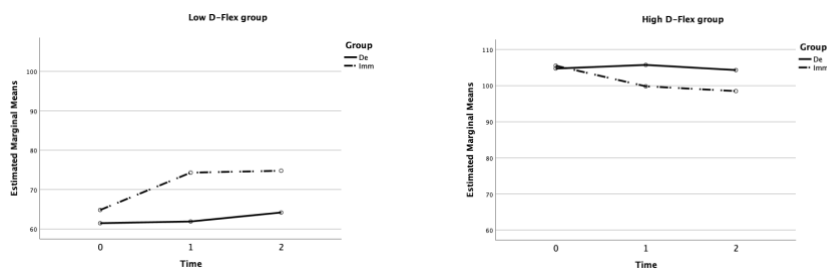


Fig. 4 - The Detail and Flexibility questionnaire (DFLEX)



Acknowledgments and funding sources

Dr Giombini is supported by Elysium Healthcare.

Dr Easter, King's College London, is supported by the National Institute for Health Research (NIHR) Applied Research Collaboration South London (NIHR ARC South London) at King's College Hospital NHS Foundation Trust.

Professor Tchanturia was supported from MRC-MRF Fund (MR/S020381/1; Biomarkers for Anorexia Nervosa and autism spectrum Disorders- longitudinal study).

The funders played no role in the design, analysis or preparation of the manuscript for the present study. The views expressed are those of the authors and not those of NIHR, or the Department of Health and Social Care, King's College London and Elysium Healthcare.

The authors would like to thank all the young people, their carers and staff at Rhodes Wood Hospital.

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