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# Cognitive Remediation for Adolescents With Mental Health Disorders: A Systematic Review and Meta-Analysis

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## ABSTRACT

**Introduction:** The effects of cognitive remediation therapy (CRT) in adults with mental health disorders have been widely documented, but its effects in adolescents with mental health disorders remain poorly understood. This review aims to (1) determine the effects of CRT on cognition, symptoms and functioning for adolescents with mental health disorders and (2) evaluate the methodological quality of studies on CRT.

**Methods:** A systematic review and meta-analysis were conducted of randomised controlled trials of CRT involving adolescents with mental health disorders. Searches were conducted in databases for studies pertaining to CRT effects on cognition, social functioning and clinical symptoms. Methodological quality was assessed using the Clinical Trials Assessment Measure.

**Results:** Fourteen studies ($N = 14$) were included, with 11 independent samples ($k = 11$, 592 participants). Participants had various mental health disorders. CRT showed a small significant effect on cognition ($g = 0.14$, $p = 0.02$), particularly on processing speed, working memory and episodic memory. No significant effects were found for clinical symptoms ($g = 0.04$, $p = 0.58$) and social functioning ($g = 0.06$, $p = 0.39$). Methodological quality of included studies was variable, ranging from poor to good quality.

**Conclusion:** Included studies showed a small significant effect of CRT on cognition, and non-significant effects on clinical symptoms and social functioning in adolescents with mental health disorders. The lack of effects may be partly explained by limitations in the methodology of included studies. A critical analysis of current studies is presented and recommendations of core techniques to consider for future CRT studies are discussed.

Adolescence represents a crucial period during which numerous mental health disorders often initiate (Larsen and Luna 2018; Paus et al. 2008). Indeed, nearly half of the mental disorders start around mid-adolescence, with a median age of onset at 14.5 years (Kessler et al. 2007; Solmi et al. 2022). Moreover, approximately 75% of mental disorders develop prior to the mid-twenties (Kessler et al. 2007). Mood and behaviour disorders, including major depression, eating disorders and attention deficit hyperactivity disorder (ADHD), are particularly prevalent among young people (Bitsko et al. 2022; Kessler et al. 2012).

These mental health disorders are associated with cognitive difficulties, which may occur early in the course of the disorder or be present before its onset (East-Richard et al. 2020; Lewandowski et al. 2011). For instance, children and adolescents with ADHD have difficulties in inhibition, vigilance, working memory and

planning (East-Richard et al. 2020; Huang-Pollock et al. 2012; Walshaw et al. 2010; Willcutt et al. 2005). Children and adolescents with major depressive disorder show pronounced deficits in inhibition, phonemic verbal fluency, sustained attention, verbal memory and planning (East-Richard et al. 2020; Wagner et al. 2015). Adolescents with eating disorders (e.g., anorexia nervosa) experience deficits in mental flexibility, inhibition, attention and planning (Iceta et al. 2021; McAnarney et al. 2011). Given the presence of cognitive difficulties associated with most mental health conditions, regardless of age, cognitive difficulties are considered as a transdiagnostic feature (Abramovitch et al. 2021; East-Richard et al. 2020).

Cognitive impairment that is present early in the course of illness is strongly associated with functional outcomes among adolescents and young people. For instance, cognitive impairments are negatively associated with educational achievement (Alloway and Alloway 2010; Biederman et al. 2004, 2006; Bull et al. 2008; Mojtabai, Stuart, Hwang, Eaton, et al. 2015). Cognitive difficulties also affect workplace functioning and are negatively associated with occupational attainment (Biederman et al. 2006; Cowman et al. 2021; Lee et al. 2015, 2018; Mojtabai, Stuart, Hwang, Susukida, et al. 2015; Schnitzler et al. 2006). Given the associations between cognitive difficulties and both social and occupational outcomes, cognition is increasingly considered a relevant treatment target (e.g., Cowman et al. 2021; Lee et al. 2018; Santesteban-Echarri et al. 2017). Cognitive difficulties also emerged as one of the top treatment priorities in a recent survey conducted among 243 young people with mental health conditions (Bryce et al. 2024). This study also showed that there is a considerable treatment gap with less than one third receiving treatment for these difficulties.

Over the years, several approaches have been developed to improve cognitive functioning (Dresler et al. 2019). Among these, there is cognitive remediation therapy (CRT) which is defined as 'a behavioural training-based intervention that aims to improve cognitive processes (attention, memory, executive function, social cognition or metacognition) with the goal of durability and generalization' (Cognitive Remediation Experts Workshop 2010). Most CRT programmes are based on a 'drill and practice' approach or a 'drill, practice and strategy' approach. The former refers to a type of training and practice that solely utilises exercises with gradually increasing difficulty. Meanwhile, the latter includes teaching a strategy use alongside exercises with gradually increasing difficulty. Therapist will also teach strategies to the participant in order to adopt better ways of completing the exercises (e.g., mnemonic tips, division of text into chunks). This incorporation of strategy-learning facilitates the transfer of these skills to the context of daily life (Wykes et al. 2011).

In recent years, literature reviews have investigated the effects of CRT for adults with mental health disorders, notably for psychotic disorders (e.g., Vita et al. 2021; Wykes et al. 2011), eating disorders (e.g., Tchanturia et al. 2014) and mood disorders (e.g., Anaya et al. 2012). All have reported beneficial effects of CRT on cognition or social functioning. However, few reviews included studies that solely included adolescents with mental health disorders. In fact, reviews often include either children or adults (e.g., Cortese et al. 2015; Lindvall Dahlgren and Rø 2014; Rapport et al. 2013). As such, little is known about the nature and the magnitude of effects of CRT among adolescent with mental health disorders.

When considering the evidence in this area, it is important to assess the studies' methodological quality since it could affect the results. To our knowledge, methodological quality has never been assessed in studies of CRT in adolescents with mental health disorders although this has been evaluated in adults (e.g., Wykes et al. 2011; Vita et al. 2021). The active ingredients of effective CRT also remain to be identified within the adolescent population. Given the dynamic phase of development that adolescents are in, they may have unique therapeutic needs. Taken together, there is a gap in knowledge during adolescence when intervention may be most critical.

Additionally, given that cognitive impairments are observed transdiagnostically (East-Richard et al. 2020) and are associated with poorer functioning, CRT may be a promising transdiagnostic treatment in psychiatry for improving functional outcomes. Yet, cognitive remediation studies, which aim to investigate the effects of this intervention on cognition, should rather be interested in targeting common cognitive impairments among several neurodevelopmental and psychiatric disorders, adopting therefore a transdiagnostic approach (East-Richard et al. 2020). This approach aims to gather psychiatric disorders by common aspects between them called "transdiagnostic factors". Thus, in this review, the goal was to examine CRT as a transdiagnostic treatment.

The first objective of this systematic review is to determine the effects of CRT on cognition, symptoms and functioning within adolescent populations with mental health disorders. The second objective is to evaluate the methodological quality of these studies to rigorously assess the evidence and make recommendations for future research.

## 1 | Methods

The systematic review process was conducted according to quality standards (Hemingway and Brereton 2009; Perestelo-Pérez 2013; Schlosser 2007) and following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards (Page et al. 2021).

### 1.1 | Literature Search

Searches were conducted in three different databases (PubMed, PsycINFO and Embase) and covered articles published from January 1970 to January 2024. The following terms were used: *Cognitive remediation*, *neurocognitive remediation*, *neuropsychological remediation*, *cognitive rehabilitation*, *neuropsychological rehabilitation*, *cognitive training*, *attention training*, *memory training*, *concentration training*, *executive functions training*, *remediation strategy*, *computer-assisted therapy*, *cognitive habilitation* and *neuropsychological habilitation*. Controlled vocabulary targeting cognitive remediation was also used. References of retrieved articles were also screened to identify any articles that may have been missed through the search engines. Finally, experts in the field of cognitive remediation were also contacted to ensure that all relevant studies for this systematic review were included.

The first screening of title and abstract was conducted by two independent investigators. If there was a lack of consensus between these two investigators, a third investigator decided if the article was included or not. The same procedure was used for the second screening (full-text screening).

### 1.2 | Selection Criteria

The following inclusion criteria were used: (1) publication in French or English, (2) article published in a peer-reviewed journal, (3) original randomised controlled study, (4) mean age of the population between 12 and 17 years, (5) diagnosis of mental health disorder in both experimental and control groups, (6) CRT as an intervention in the experimental group, (7) control group without CRT and (8) pre- and post-assessments with a cognitive measure (subjective or objective) different than the trained tasks in the CRT. Subjective cognitive measures refer to questionnaires that assess cognitive functions (self-reported or completed by someone else such as a parent or a teacher), while objective cognitive measures refer to standardised neuropsychological tests. Experimental tasks were not included.

Studies were excluded if participants had intellectual disabilities, a neurological disorder (e.g., epilepsy or traumatic brain injury) or any disease that could affect cognitive functioning (e.g., HIV).

### 1.3 | Data Extraction

Data extraction was conducted by two independent reviewers. In cases of disagreement, a third investigator made the final decision. The following items were codified: country in which the study was conducted, year of publication, sample size, reason(s) and rates of attrition, mean age, gender, ethnic group, education, mental health disorder, medication, description of the CRT and quantitative results of pre/post-assessments on cognitive outcomes, clinical symptoms and social functioning. Table 1 provides the list of all neuropsychological tests as well as social functioning and clinical questionnaires. All neuropsychological outcomes in the included studies were categorised into eight cognitive domains: attention, processing speed, working memory, executive functions, social cognition, episodic memory, language and visuospatial skills. This classification was conducted independently by a neuropsychologist (CER) and a PhD student in neuropsychology (AC). It was carried out to facilitate the combination of the different outcomes and to enable comparisons of CRT effects across general cognitive domains.

### 1.4 | Methodological Quality Assessment

Methodological quality of each study was assessed using the Clinical Trials Assessment Measure (CTAM). The CTAM is a 15-item measure of methodological quality for psychological treatment studies (Tarrier and Wykes 2004; Wykes et al. 2008). It considers the following criteria: sample, group allocation to treatment, assessment (standardised instruments, blind assessment), comparison group, conducted analyses, and treatment (description, protocol and therapist fidelity to treatment). CTAM scores range from 0 to 100 points, and a score under 65 indicates a higher risk of bias (Wykes et al. 2008).

Assessments were completed by two independent reviewers and disagreements were resolved by discussion or by a third investigator. Reliability coefficient was high (intraclass coefficient: 0.97). For one study (Ueland and Rund 2004, 2005), scores were based on the assessment already conducted by one of our team members in Wykes et al.'s (2011) paper. Final scores were sent to authors to validate points awarded and to ensure that nothing has been forgotten or overlooked.

### 1.5 | Statistical Analyses

Effect sizes were computed to estimate the effects of CRT on cognition, social functioning and clinical symptoms. Effect sizes for each cognitive domain were also computed. Given that few studies were included in the meta-analysis, Hedge's *g* was used to avoid the overestimate of the effect sizes with Cohen's *d*. Analyses were made on the mean difference between the pre- and post-scores, or on the *F*-statistic from ANOVA calculated on difference between change scores. Moderator analyses were also conducted to investigate the effects of the type of CRT and the primary mental health disorder. All analyses were performed using the Comprehensive Meta-Analysis (CMA) software (Borenstein et al. 2000) with a random effects model. Cohen's guidelines (Cohen 1988) were used for the interpretation of effect sizes (0.20 = small; 0.50 = moderate; 0.80 = large). As such, positive effect sizes represented greater improvements in the CRT group. To document whether effect sizes were constant across studies, the *Q* homogeneity statistic was calculated. The $I^2$ statistic was also calculated to qualify the proportion of total variance due to heterogeneity. $I^2$ values of 25%, 50% and 75%, respectively, represent small, moderate and high heterogeneity (Higgins et al. 2003). This statistic was considered because it is not affected by the number of included studies.

In a meta-analysis, publication bias is an important aspect to consider. It refers to the fact that the published literature is not representative of all conducted studies and that unpublished studies are more likely to have non-significant effects (Egger and Smith 1998; Rosenthal 1979; Rothstein et al. 2006). To explore possible publication bias, Trim and fill analyses were done (Duval and Tweedie 2000).

Regarding CTAM scores, Spearman's correlations were computed between these scores and the effect sizes computed for cognitive, social functioning and clinical outcomes.

## 2 | Results

### 2.1 | Literature Search Results and Socio-Demographic Data

Literature search yielded 3096 articles. After the initial screening, 336 articles were retained, of which 14 were retained after the full-text screening, with publication years ranging from 2004 to 2022. As such, 322 articles were excluded for the reasons specified in the flowchart (see Figure 1). A list of these excluded studies is available upon request. Fourteen articles ($N = 14$) were

**TABLE 1** | Neuropsychological tests, social functioning and clinical questionnaires.

| Variable | Test |
|---|---|
| Cognitive outcomes | Backward Masking Test (BMT) |
| | Behavior Rating Inventory of Executive Function (BRIEF) |
| | Brief Visuospatial Memory Test—Revised (BVMT-R) |
| | Brixton Test |
| | Cambridge Neuropsychological Test Automated Battery (CANTAB) |
| | Children's Memory Scale (CMS) |
| | Color Stroop Task |
| | Conners' Continuous Performance Test II (CPT-II) |
| | Controlled Oral Word Association Tests (COWAT) |
| | Corsi Block-Tapping Test |
| | Degraded Stimulus Continuous Performance Test (DS-CPT) |
| | Detail and Flexibility Questionnaire (D-FLEX) |
| | Go/No-Go |
| | Hopkins Verbal Learning Test—Revised (HVLT-R) |
| | Kimura Recurring Figures Test |
| | MATRICS Consensus Cognitive Battery (MCCB) |
| | Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) |
| | Rey Auditory Verbal Learning Test (RAVLT) |
| | Rey-Osterrieh Complex Figure test (ROCFT) |
| | Tower of London (ToL) |
| | Trail Making Test (TMT) |
| | Verbal Fluency Task |
| | Wechsler Adult Intelligence Scale—Fourth Edition (WAIS-IV) |
| | Wechsler Adult Intelligence Scale—Third Edition (WAIS-III) |
| | Wechsler Intelligence Scale for Children—Fourth Edition (WISC-IV) |
| | Wechsler Intelligence Scale for Children—Fourth Edition (WISC-IV) Integrated |
| | Wechsler Memory Scale—Third edition (WMS-III) |
| | Wisconsin Card Sorting Test (WCST) |
| Social functioning | Children's Global Assessment Scale (C-GAS) |
| | Global Assessment Scale (GAS) |
| | Health-Related Quality of Life (HRQoL) |
| | Life Skills Profile (LSP) |
| | Personal and Social Performance Scale (PSP) |
| | Rosenberg Self-Esteem Scale (RSES) |
| | Social Communication Questionnaire (SCQ) |
| | Social and Occupational Functioning Assessment Scale (SOFAS) |
| | Social Responsiveness Scale (SRS) |
| | Vineland Adaptive Behavior Scales—Second edition (VABS) |
| Clinical symptoms | Attention-Deficit/Hyperactivity Disorder Rating Scale—Fourth edition (ADHD-RS) |
| | Beck Anxiety Inventory (BAI) |
| | Beck Depression Inventory (BDI) |
| | Behaviour Assessment Scale for Children (BASC-2) |
| | Brief Psychiatric Rating Scale—Expanded version (BPRS) |
| | Child Behavior Check List (CBCL) |
| | Children's Yale-Brown Obsessive Compulsive Scale (CY-BOCS) |
| | Calgary Depression Scale (CDS) |
| | Clinical Global Impression-Severity of Illness Scale and Clinical Global Improvement (CGI) |
| | Conners Rating Scales 3rd edition (CRS-3) |
| | Conners Rating Scales—Revised (CRS-R) |
| | Eating Disorder Examination Questionnaire (EDE-Q) |
| | Health of Nation Outcome Scale for Children and Adolescents (HoNOSCA) |
| | Impact of Event Scale-Revised (IES-R) |
| | Positive and Negative Symptom Scale (PANSS) |
| | Revised Child Anxiety and Depression Scale (RCADS) |
| | Scale for the Assessment of Negative Symptoms (SANS) |
| | Yale-Brown-Cornell Eating Disorder Scale (YBC-EDS) |

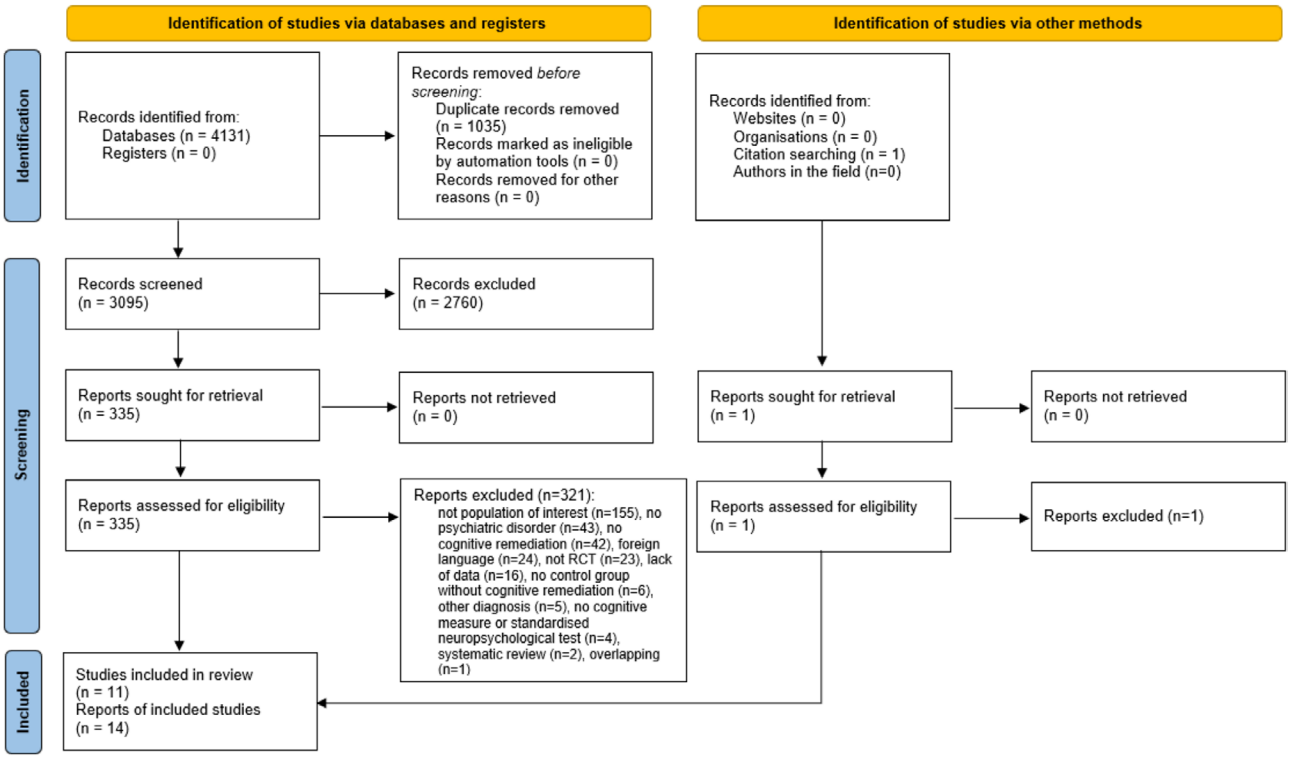


**FIGURE 1** | Flowchart of included studies: Selection process.

included in this review considering 11 independent samples ($k=11$). One study's findings were documented across two articles, each focusing on different outcomes (Hasslinger, Bölte, et al. 2022; Hasslinger, Jonsson, et al. 2022). Additionally, two follow-up studies were included: Ueland and Rund's (2005) study is the 1-year follow-up of a study by Ueland and Rund (2004), and Urben et al. (2012) study is the 6-month follow-up of a study by Holzer et al. (2014). Only the pre- and post-treatment data were included in the meta-analysis, while data from follow-up assessments were only considered qualitatively.

Table 2 presents socio-demographic data for each included study. The final sample sizes included 303 participants in the CRT group (mean age: 14.95 years, $k=8$, range: 12.61–16.70 years) and 289 participants in the control group (mean age: 14.94 years, $k=8$, range: 12.21–16.80 years). Sample sizes were mainly small (mean sample size = 26.91, range = 9–106), and most studies were conducted with outpatients. Most studies focused on psychotic disorders ($k=4$) and ADHD ($k=4$), while the remaining studies examined anorexia nervosa ($k=2$) and post-traumatic stress disorder ($k=1$). Besides the mental health disorders specifically targeted in the studies, participants had various other mental health conditions (see Table 2).

## 2.2 | CRT Programmes

Description of CRT programmes is presented in Table 3. Most studies used individually CRT and used 'drill and practice' intervention ($k=6$, $n=8$), while the remaining studies used a 'drill, practice and strategy coaching' programme ($k=4$, $n=5$) or a 'strategy alone' programme ($k=1$, $n=1$). The number of therapy sessions varied considerably across studies, ranging from 8 to 40 sessions (k = 10). Two programmes were used by more than one study: *Captain's Log* software ($k=2$, $n=3$) and Cognitive Remediation Therapy programme ($k=3$, $n=3$). In addition to CRT, five studies included another therapeutic component ($k=5$, $n=7$) such as family-based treatment, or treatment as usual (TAU) including psychoeducation, medical and psychological follow-up. CRT groups were mainly compared to active control groups ($k=7$, $n=9$, e.g., psychoeducational treatment or computer games). Only four studies ($k=4$, $n=5$) compared their CRT group to a passive control group (waiting list or medication use only).

## 2.3 | Cognitive Outcomes

Tables 4 and 5 show the results of the analyses. Global effect sizes for each study are shown in a forest plot (see Figure 2). A small significant effect of CRT on global cognition was found ($g=0.14$, 95% CI = 0.03–0.25, $p=0.02$). Moderate heterogeneity was found across studies ($Q=28.85$, $p<0.05$, $I^2=65.34$). As part of sensitivity analyses, one study was considered an outlier and subsequently removed (Lock et al. 2018). This had a limited effect on effect size ($g=0.16$, 95% CI = 0.05–0.27, $p<0.05$), as well as on heterogeneity ($Q=23.60$, $p<0.05$, $I^2=61.86$). The Trim and fill analysis did not show any missing studies for cognitive outcomes. The effects on global cognition varied by primary diagnosis: studies of populations with psychotic disorders and PTSD showed small and moderate significant effects respectively, whereas studies of populations with ADHD or anorexia nervosa showed no significant effects (see Table 5). However, it should be noted that only one study was included in the analyses for PTSD. The effects on global cognition also varied according to the type of CRT ('drill and practice', 'drill, practice and strategy' or 'strategy alone'), with slightly higher and significant effects observed for the 'drill and practice' approach ($g=0.18$, $p=0.03$) compared to the

**TABLE 2** | Socio-demographic data.

| Study | Country | Initial sample size (experimental group; control group) | Post-test sample size (experimental group; control group) | Mean age (years) | Male (%) | Primary mental health diagnosis | Mental health comorbidities reported among participants | In/ outpatients | Medication (%) |
|---|---|---|---|---|---|---|---|---|---|
| Ueland and Rund (2004) | Norway | 14; 14 | 14; 12 | 15.30 | 53.85 | Psychotic disorder | Schizotypal personality disorder, bipolar disorder, major depressive disorder | Inpatients | 76.92 |
| Ueland and Rund (2005) (1-year follow-up of Ueland and Rund (2004)) | Norway | 14; 14 | 14; 11 | 16.70 | 52.00 | Psychotic disorder | Schizotypal personality disorder, bipolar disorder, major depressive disorder | Outpatients[a] | 80.00 |
| Steiner et al. (2011) | United States of America | 13; 15 | 11; 15 | 12.40[b] | Not reported[c] | ADHD | — | Outpatients | Not reported |
| Holzer et al. (2014) | Switzerland | 18; 14 | 15; 13 | 15.55 | 56.25 | Psychotic disorder | — | Outpatients | 56.25[d] |
| Urben et al. (2012) (6-month follow-up of Holzer et al. (2014)) | Switzerland | 18; 14 | 12; 10 | 15.59 | 63.64 | Psychotic disorder | — | Outpatients | 72.73 |
| Puig et al. (2014) | Spain | 25; 26 | 15; 14 | 16.75 | 52.00 | Psychotic disorder | — | Outpatients | 100 |
| Schweizer et al. (2017) | Iran | 15; 15 | 15; 15 | 15.43 | 33.33 | PTSD | — | Outpatients | Not reported |
| Bikic et al. (2017) | Denmark | 9; 9 | 9; 8 | 15.60 | 76.50 | ADHD | — | Outpatients | 83.33[e] |
| Ackermann et al. (2018) | Switzerland | 18; 11 | 18; 10 | 13.55 | 82.14 | ADHD | Mood dysregulation, anxiety disorder, obsessive-compulsive disorder, learning disabilities, developmental coordination disorder | Outpatients | 100 |

(Continues)

**TABLE 2** | (Continued)

| Study | Country | Initial sample size (experimental group; control group) | Post-test sample size (experimental group; control group) | Mean age (years) | Male (%) | Primary mental health diagnosis | Mental health comorbidities reported among participants | In/ outpatients | Medication (%) |
|---|---|---|---|---|---|---|---|---|---|
| Lock et al. (2018) | United States of America | 15; 15 | 13; 10 | 14.49 | 10.00 | Anorexia nervosa | Depression, generalised anxiety disorder, obsessive-compulsive disorder, panic disorder, adjustment disorder | Outpatients | Not reported |
| Li et al. (2020) | China | 106; 102 | 106;102 | 16.12 | 52.40 | Psychotic disorder | — | Both | 100 |
| Hasslinger, Bölte, et al. (2022), Hasslinger, Jonsson, et al. (2022) | Sweden | 51; 50 | 47; 50[f] | 12.41 | 77.23 | ADHD | ASD, other comorbid mental health disorders[g] | Outpatients | 67.33[h] |
| Giombini et al. (2022) | United Kingdom | 56; 57 | 40; 40 | 14.49 | 6.25 | Anorexia nervosa | Anxiety disorder, depression, ASD, disorder, obsessive-compulsive disorder, PTSD | Inpatients | 62.50 |

Abbreviations: ADHD, attention deficit hyperactivity disorder; ASD, autism spectrum disorder; PTSD, post-traumatic stress disorder.
[a]Follow-ups were carried out 1 year after discharge.
[b]Mean age of the three groups in this study. Participants were in Grades 6, 7 or 8.
[c]Mean percentage of males of the three groups in this study: 52.2%.
[d]Calculated from the sample at baseline. 56.25% of the participants taking antipsychotic medication.
[e]83.33% received methylphenidate. No further information provided.
[f]47; 49 for Hasslinger, Jonsson, et al. (2022).
[g]Not specified for the two groups included in this review, but in the four groups of their study: mood disorder, anxiety disorder, oppositional defiant disorder, sleeping disorder, learning disorder and speech disorder.
[h]For ADHD medication.

**TABLE 3** | Description of CRT programme.

| Study | Intervention in experimental group | Type of cognitive remediation | Presence of a therapist | Individual/group intervention | Number of sessions | Length of sessions (min) | Frequency (per week) | Duration | Type of comparison group (active or passive) | Global attrition rate (CRT group/control group) |
|---|---|---|---|---|---|---|---|---|---|---|
| Ueland and Rund (2004), Ueland and Rund (2005) (1-year follow-up) | Cognitive training + psychoeducational treatment | Drill, practice and strategy | Yes | Individual | Not reported[a] | 15 | Not reported | 12 weeks (in average) | Active (psychoeducational treatment) | 7.14% (0%/14.29%) |
| Steiner et al. (2011) | Cognitive training (Captain's Log) | Drill and practice | Yes, but minimally active[b] | Individual | At least 19 sessions (average: 23.4) | 45 | 2 | 4 months | Passive (waiting list) | 7.14% (15.38%/0%) |
| Holzer et al. (2014), Urben et al. (2012) (6-month follow-up) | Cognitive training (Captain's Log) + TAU[c] | Drill and practice | Yes | Individual | 16 | 45 | 2 | 8 weeks | Active (computer games) | 12.50% (16.67%/7.14%) |
| Puig et al. (2014) | Cognitive training (Cognitive Remediation Therapy) + TAU[d] | Drill, practice and strategy | Yes | Individual | 40 | Not reported | 2 | Not reported | Active (TAU) | 41.18% (40%/46.15%) |
| Schweizer et al. (2017) | Cognitive training (Affective Working Memory Training) | Drill and practice | No | Group | 20 | 30–45 | Not reported | Not reported | Active (placebo training) | 0% (0%/0%) |
| Bikic et al. (2017) | Cognitive training (Scientific Brain Training) | Drill and practice | No | Individual | 35 | 30 | 5 | 7 weeks | Active (Tetris computer game) | 5.56% (0%/11.11%) |
| Ackermann et al. (2018) | Cognitive training (Cognitive Working Memory Training) | Drill and practice | Yes, but minimally active[e] | Individual | 25 | Not reported | Not reported | 5 weeks | Passive (medication only) | 3.45% (0%/9.09%) |

(Continues)

**TABLE 3** | (Continued)

| Study | Intervention in experimental group | Type of cognitive remediation | Presence of a therapist | Individual/ group intervention | Number of sessions | Length of sessions (min) | Frequency (per week) | Duration | Type of comparison group (active or passive) | Global attrition rate (CRT group/ control group) |
|---|---|---|---|---|---|---|---|---|---|---|
| Lock et al. (2018) | Cognitive training (Cognitive Remediation Therapy) + Family-based treatment | Drill, practice and strategy | Yes | Individual | 15 | 30 | Not reported | 9 months | Active (Family-based treatment + art therapy) | 23.33% (13.33%/33.33%) |
| Li et al. (2020) | Cognitive training (Social Cognition and Interaction Training) | Strategy alone | Yes | Group | 20–24 | 45–60 | 1 | 20–24 weeks | Passive (medication only) | 0% (0%/0%) |
| Hasslinger, Bölte, et al. (2022), Hasslinger, Jonsson, et al. (2022) | Cognitive training (Minneslek Flex) | Drill and practice | Yes | Individual | 25 | 45 | 5 | 5 weeks | Passive (medication only) | 3.96% (7.84%/0%) |
| Giombini et al. (2022) | Cognitive training (Cognitive Remediation Therapy) + TAU for eating disorders[f] | Drill, practice and strategy | Yes | Individual | 8 | Not reported | 2 | 4 weeks | Active (TAU for eating disorders) | 29.20% (28.57%/29.82%) |

Abbreviation: TAU, treatment as usual.
[a]CRT group received 30 h of training.
[b]Research assistants were assigned to two participants simultaneously and were responsible for notifying them if they became distracted. They also assisted participants in setting goals and evaluated their progress. However, they refrained from intervening if the participants were progressing successfully.
[c]In this study, TAU included individual medical and psychological follow-up, special-school attendance, as well as occupational and work therapy.
[d]In this study, TAU included psychoeducation, medical reviews by a psychiatrist and case management by a psychologist and/or a social worker.
[e]A trained psychologist provided weekly phone coaching to the participants. This support aimed to ensure the quality of the training, promote adherence, enhance motivation, and offer feedback to foster engagement during the exercises.
[f]In this study, TAU included nutritional input, as well as multi-disciplinary treatment (medical risk management, nursing, dietetic and psychological interventions).

**TABLE 4** | Effects of cognitive remediation on cognition, clinical symptoms and social functioning.

| Outcome | Number of studies | Effect size (Hedge's *g*) | 95% Confidence intervals | *p* |
|---|---|---|---|---|
| Cognition—Global effect size | **11** | **0.14** | **0.03–0.25** | **0.02** |
| Attention | 5 | −0.07 | −0.25 to 0.11 | 0.43 |
| Processing speed | 2 | 0.33 | 0.03–0.64 | 0.03 |
| Working memory | 5 | 0.31 | 0.09–0.53 | 0.01 |
| Executive functions | 10 | 0.04 | −0.05 to 0.13 | 0.36 |
| Social cognition | 1 | 0.36 | 0.08–0.63 | 0.01 |
| Episodic memory | 4 | 0.18 | 0.02–0.34 | 0.03 |
| Language | 1 | −0.12 | −0.80 to 0.56 | 0.73 |
| Visuospatial skills | 3 | −0.03 | −0.56 to 0.51 | 0.93 |
| Clinical symptoms | 11 | 0.04 | −0.11 to 0.20 | 0.58 |
| Social functioning | 6 | 0.06 | −0.07 to 0.18 | 0.39 |

'drill, practice and strategy' approach ($g = 0.04$, $p = 0.77$). For the 'strategy alone' approach, a small significant effect was found ($g = 0.20$, $p < 0.01$), but only one study was included in the analyses. Regarding analyses of specific cognitive domains, small significant effects were found for processing speed, working memory, episodic memory and social cognition (see Table 4). Given that only one study focused on social cognition, these results should be interpreted with caution.

## 2.4 | Clinical Outcomes

All studies ($k = 11$) assessed the effects of cognitive remediation on clinical symptoms. No significant effect was found ($g = 0.04$, 95% CI = −0.11 to 0.20, $p = 0.58$) and results were heterogenous ($Q = 38.01$, $p < 0.01$, $I^2 = 73.69$). Heterogeneity may be partly explained by the results of Schweizer et al.'s (2017) study, which has a considerably higher effect size compared to the others. After excluding this study from the analyses, heterogeneity decreased slightly, but remained significant ($Q = 26.04$, $p < 0.01$, $I^2 = 65.44$). Effect sizes for each study are depicted in a forest plot (Figure 3). The Trim and fill analysis showed three missing studies that would change the effect size from 0.04 to 0.003.

Regarding the moderator analyses (see Table 5), no difference was found between the different types of CRT. Larger effects were observed in the PTSD population, with a large and significant effect size ($g = 1.41$, $p < 0.01$). However, it is important to note that this effect size was based on a single study (Schweizer et al. 2017), which differed markedly from the others in terms of effect size.

## 2.5 | Social Functioning Outcomes

Few studies ($k = 6$) assessed changes in social functioning after CRT. A global effect size was computed, but it must be interpreted with caution given the small number of studies included. No significant effect of CRT on social functioning was found ($g = 0.06$, 95% CI = −0.07 to 0.18, $p = 0.39$). Results were homogeneous across studies ($Q = 4.88$, $p = 0.43$, $I^2 = 0.00$). Effect sizes for each study are depicted in a forest plot (see Figure 4). According to the Trim and fill analysis, three studies are missing, and it would change the effect size from 0.06 to −0.03.

No moderator analyses were significant (see Table 5), either according to primary mental health diagnosis or according to the type of CRT.

## 2.6 | Follow-Up Studies

Among included studies, only two were follow-up studies (Ueland and Rund 2005; Urben et al. 2012). Nevertheless, two other studies included results from a post-CRT follow-up within their article (Puig et al. 2014; Hasslinger, Bölte, et al. 2022; Hasslinger, Jonsson, et al. 2022).

In Ueland and Rund's (2005) study, no significant difference was found between groups at the 1-year follow-up. Both groups improved on almost all cognitive variables at follow-up, as well as on global functioning, global symptomatology and positive symptomatology.

In their study, Urben et al. (2012) conducted a 6-month follow-up. Significant improvements were found between baseline and follow-up only in the CRT group on one measure of executive functioning (Stroop test) and one measure of problem-solving (Block design subtest). Regarding clinical symptoms, both groups improved between baseline and follow-up.

In Puig et al.'s (2014) study, cognitive improvements found in the CRT group at post-test (executive functions, working memory and verbal episodic memory) were maintained at the 3-month follow-up. However, it should be noted that the follow-up assessment was not carried out in the control group, which prevented a comparison of the stability of changes.

Finally, in Hasslinger, Bölte, et al.'s (2022) and Hasslinger, Jonsson, et al.'s (2022) study, inattentive and hyperactivity/impulsivity symptoms were lower in the CRT group at the 6-month

**TABLE 5** | Effects of moderators on cognitive, clinical and functional outcomes.

| Outcome | Number of studies | Effect size (Hedge's *g*) | 95% Confidence intervals | *p* |
|---|---|---|---|---|
| Global cognition | | | | |
| Primary mental health diagnosis | | | | |
| ADHD | 4 | 0.17 | −0.1 to 0.35 | 0.07 |
| Anorexia nervosa | 2 | −0.23 | −0.73 to 0.27 | 0.37 |
| Psychotic disorder | 4 | 0.20 | 0.11–0.29 | < 0.01 |
| PTSD | 1 | 0.53 | 0.12–0.94 | 0.01 |
| Type of CRT | | | | |
| Drill and practice | 6 | 0.18 | 0.02–0.35 | 0.03 |
| Drill, practice and strategy | 4 | 0.04 | −0.22 to 0.30 | 0.77 |
| Strategy alone | 1 | 0.20 | 0.10–0.31 | < 0.01 |
| Clinical symptoms | | | | |
| Primary mental health diagnosis | | | | |
| ADHD | 4 | 0.16 | −0.04 to 0.36 | 0.11 |
| Anorexia nervosa | 2 | −0.26 | −0.89 to 0.37 | 0.42 |
| Psychotic disorder | 4 | −0.08 | −0.24 to 0.09 | 0.36 |
| PTSD | 1 | 1.41 | 0.63–2.19 | < 0.01 |
| Type of CRT | | | | |
| Drill and practice | 6 | 0.21 | −0.07 to 0.49 | 0.14 |
| Drill, practice and strategy | 4 | −0.10 | −0.38 to 0.19 | 0.52 |
| Strategy alone | 1 | −0.05 | −0.24 to 0.14 | 0.60 |
| Social functioning | | | | |
| Primary mental health diagnosis | | | | |
| ADHD | 1 | −0.03 | −0.43 to 0.36 | 0.87 |
| Anorexia nervosa | 1 | −0.04 | −0.23 to 0.16 | 0.69 |
| Psychotic disorder | 4 | 0.15 | −0.03 to 0.33 | 0.09 |
| Type of CRT | | | | |
| Drill and practice | 2 | −0.01 | −0.35 to 0.33 | 0.96 |
| Drill, practice and strategy | 3 | 0.13 | −0.14 to 0.41 | 0.34 |
| Strategy alone | 1 | 0.001 | −0.27 to 0.27 | 0.99 |

Abbreviations: ADHD, attention deficit hyperactivity disorder; CRT, cognitive remediation therapy; PTSD, post-traumatic stress disorder.

follow-up according to all teacher ratings and one parent rating. Regarding metacognitive abilities, greater improvements found in the CRT group at post-test were also found at follow-up (according to teacher ratings). Finally, they also found greater effects of CRT on a spatial working memory task and such effects were observed at both post-test and follow-up.

## 2.7 | Methodological Quality Assessment

CTAM scores for each study ($k = 11$) are presented in Table 6 and Figure 5 (mean score = 66.27, SD = 12.99, range = 49–84). No significant correlation was found between effect sizes and methodological quality ($p > 0.05$). Nearly half of the studies obtained a score below 65 ($k = 5/11$).

Almost all studies were unable to meet all the CTAM criteria. For instance, only five studies met the criteria for sample size ($k = 5$). Regarding adherence to protocol, it was frequently considered, but few studies assessed it directly. Indeed, only Steiner et al. (2011) assessed adherence to protocol by using fidelity checklists to ensure quality of intervention implementation. However, some studies assessed participant's compliance to treatment using the number of logins in the software.

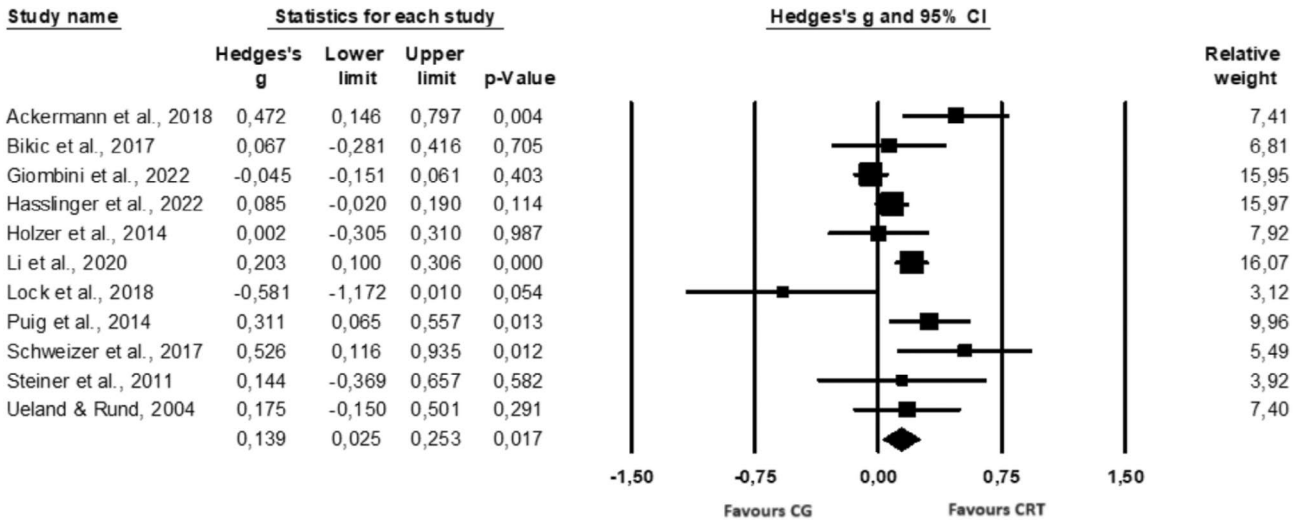


**FIGURE 2** | Forest plot of cognitive outcomes. CG, control group; CRT, cognitive remediation therapy.

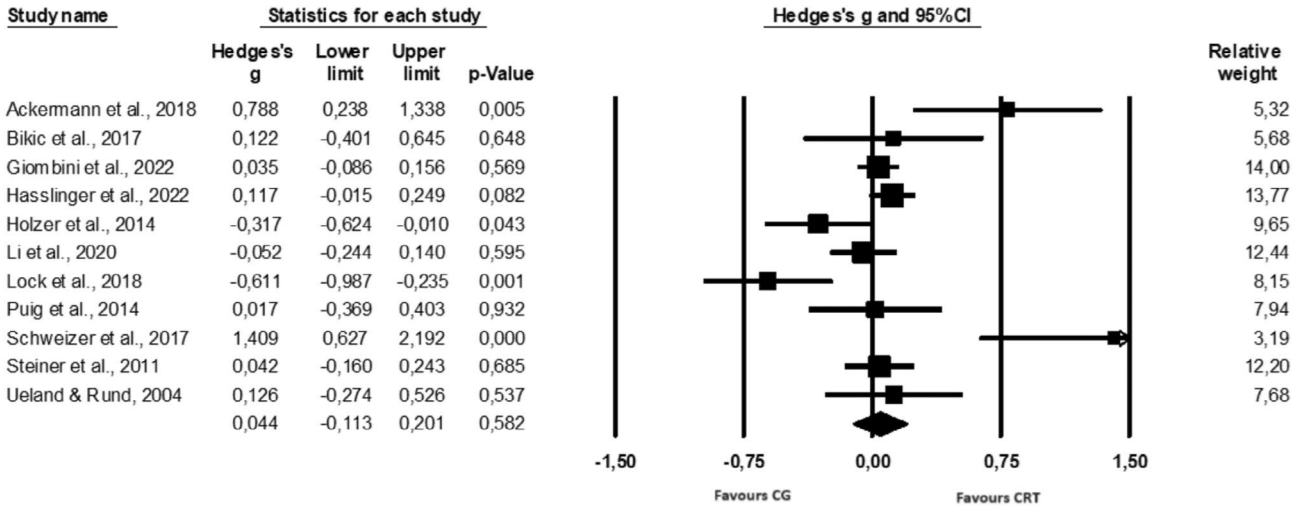


**FIGURE 3** | Forest plot of clinical outcomes. CG, control group; CRT, cognitive remediation therapy.

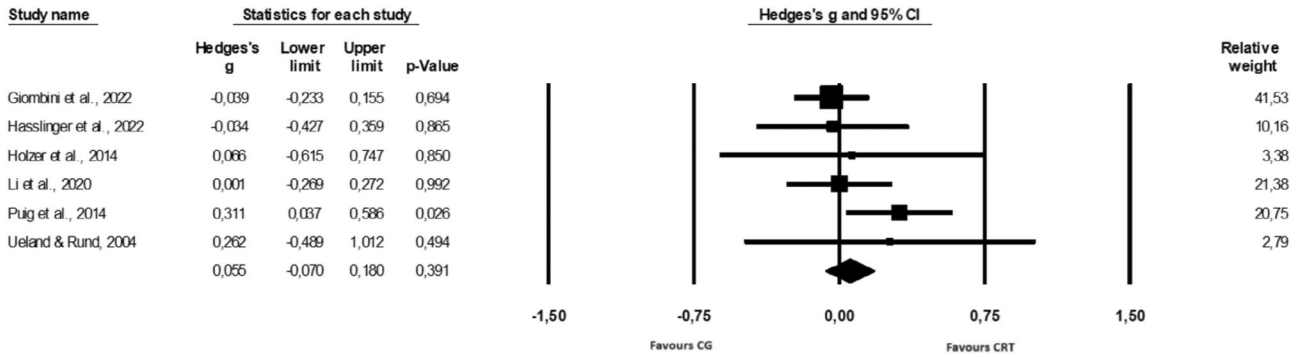


**FIGURE 4** | Forest plot of social functioning outcomes. CG, control group; CRT, cognitive remediation therapy.

It is important to note that some CTAM criteria were met by almost all studies. Indeed, all studies used standardised assessments despite not always specifying whether these assessments were carried out blind to group allocation. Furthermore, in all but one study, the treatment was described adequately in the article. Finally, all studies used appropriate statistical analyses according to the design and to the type of outcome.

## 2.8 | Attrition

Attrition rates are presented in Table 3. Overall, drop-out rates were low across the studies, except in Puig et al.'s (2014) study, which had an attrition rate of 41.18%. According to the authors, these participants were more likely to have higher IQ and schizoaffective disorder diagnosis. However, it is noteworthy that

**TABLE 6** | Clinical Trials Assessment Measure (CTAM) scores.

| Study | Sample (maximum 10) | Allocation procedure (maximum 16) | Assessment (maximum 32) | Comparison (maximum 16) | Analysis (maximum 15) | Treatment description (maximum 11) | CTAM total score (maximum 100) |
|---|---|---|---|---|---|---|---|
| Ueland and Rund (2004, 2005) | 2 | 10 | 6 | 10 | 15 | 6 | 49 |
| Steiner et al. (2011) | 5 | 16 | 6 | 6 | 9 | 11 | 53 |
| Holzer et al. (2014), Urben et al. (2012) | 7 | 16 | 26 | 10 | 15 | 6 | 80 |
| Puig et al. (2014) | 2 | 16 | 29 | 16 | 15 | 6 | 84 |
| Schweizer et al. (2017) | 7 | 10 | 6 | 10 | 15 | 6 | 54 |
| Bikic et al. (2017) | 2 | 16 | 26 | 16 | 9 | 11 | 80 |
| Ackermann et al. (2018) | 2 | 10 | 6 | 16 | 9 | 11 | 54 |
| Lock et al. (2018) | 2 | 13 | 26 | 16 | 11 | 6 | 74 |
| Li et al. (2020) | 7 | 10 | 26 | 6 | 15 | 6 | 70 |
| Hasslinger, Bölte, et al. (2022), Hasslinger, Jonsson, et al. (2022) | 7 | 16 | 9 | 16 | 15 | 11 | 74 |
| Giombini et al. (2022) | 7 | 16 | 6 | 16 | 9 | 3 | 57 |

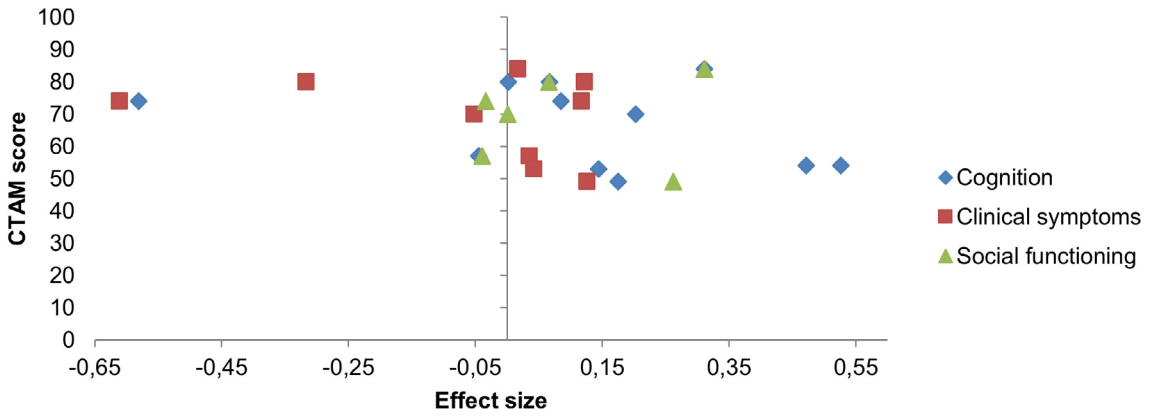


**FIGURE 5** | Effect sizes by study and CTAM score. CTAM, Clinical Trials Assessment Measure.

the attrition rate did not differ between CRT and control groups in this study. In other studies, number of dropouts ranged from 0% to 29.20%.

Overall, dropouts were mainly due to symptom exacerbation and/or pharmacological changes (22.22%). Additional reasons included participant refusal to continue care in the institution

(16.05%), participant starting another treatment which prevented the delivery of CRT (12.35%), and participant moving to another city or institution (6.17%). Reasons of attrition were not reported in 24.69% of cases.

Among the studies that included an active therapist ($k = 7$), four reported lower attrition rates in the CRT group compared to the control group (Giombini et al. 2022; Lock et al. 2018; Puig et al. 2014; Ueland and Rund 2004). In the remaining three studies, either no difference between groups was observed (Li et al. 2020) or the CRT group had a higher attrition rate (Hasslinger, Bölte, et al. 2022; Hasslinger, Jonsson, et al. 2022; Holzer et al. 2014). For studies without a therapist or a minimally active therapist ($k = 4$), two reported lower attrition rates in the CRT group (Ackermann et al. 2018; Bikic et al. 2017), one reported higher attrition in the CRT group (Steiner et al. 2011) and one found no difference between groups (Schweizer et al. 2017). Thus, results on the influence of the presence or absence of a therapist were mixed.

Results were also mixed regarding the type of CRT. For studies with a 'drill and practice' approach ($k = 6$), three reported higher attrition rates in the CRT group (Hasslinger, Bölte, et al. 2022; Hasslinger, Jonsson, et al. 2022; Holzer et al. 2014; Steiner et al. 2011), while three reported higher or identical attrition rates in the control group (Ackermann et al. 2018; Bikic et al. 2017; Schweizer et al. 2017). For studies offering a 'drill, practice and strategy' approach ($k = 4$), all reported lower attrition rates in the CRT group, suggesting that such an approach may lead to better retention. Additionally, almost all studies that included a psychosocial rehabilitation component reported lower attrition rates in the CRT group compared to the control group ($k = 4/5$). The only exception was the study by Holzer et al. (2014), which found higher attrition in the CRT group. This study used a 'drill & practice programme, whereas the other studies used a 'drill, practice' and strategy' programme (Giombini et al. 2022; Lock et al. 2018; Puig et al. 2014; Ueland and Rund 2004).

## 3 | Discussion

The aims of this systematic review and meta-analysis were twofold: to determine the effects of cognitive remediation on cognition, symptoms and functioning among adolescents with mental health disorders, and to evaluate the methodological quality of these studies. Fourteen articles were included in the systematic review with 11 independent samples ($k = 11$, 592 participants) with various mental health disorders.

The results showed a significant small benefit of CRT on global cognition in adolescents with mental health disorders, with a slightly stronger effect for studies using a 'drill and practice' approach. Significant small effects were observed for processing speed, working memory and episodic memory. It is interesting to note that these three cognitive processes are among those most affected in children and adolescent populations with mental health disorders or in first-episode populations (East-Richard et al. 2020). Therefore, there may have been more scope to intervene with these more pronounced cognitive deficits.

While meta-analyses with adults demonstrate significant beneficial effects of CRT across various mental health disorders (e.g., Anaya et al. 2012; Tchanturia et al. 2014; Wykes et al. 2011), the effects found in the present meta-analysis were not as strong. One could argue that adolescents with mental health disorders may be less affected by their mental health conditions in terms of cognitive/social skills and clinical symptoms than adult psychiatric populations who have lived with the consequences of their disorder for much longer (East-Richard et al. 2020). Additionally, very few studies included in this review considered the presence of cognitive impairments as an inclusion criterion in their studies. Indeed, only two studies reported having used such a criterion (Holzer et al. 2014; Puig et al. 2014). Therefore, without significant cognitive deficits at baseline, improvements may be harder to achieve than in a chronic population. This is corroborated by Revell et al. (2015), who conducted a meta-analysis on CRT in early-onset schizophrenia and obtained a non-significant global effect of CRT on cognition (effect size = 0.13, $p = 0.14$). In our meta-analysis, although the global effect on cognition was small for populations with psychotic disorders, it was significant and greater than the effect observed in populations with ADHD or anorexia nervosa. Given that psychotic disorders are characterised by cognitive deficits present from the onset of the disorder (East-Richard et al. 2020; Lewandowski et al. 2011), this may help explain the more pronounced effects on cognition in these populations compared to those with ADHD or anorexia nervosa, whose cognitive impairments are less severe (East-Richard et al. 2020; Stedal et al. 2022).

Regarding the effects on clinical symptoms, the results were mixed and there was no global beneficial effect. Moreover, no effect was observed according to the type of CRT or primary mental health diagnosis. Cognitive remediation studies in adult populations also reported mixed results which varied according to type of clinical symptoms (e.g., Cella et al. 2014; Gharaeipour and Scott 2012; Wykes et al. 2011).

With regards to social functioning, the effect size was not significant, and no effect was observed according to the type of CRT or primary mental health diagnosis. However, these results must be interpreted with caution given that only six studies were included in the analyses. Previous meta-analyses have found that effects on functioning are stronger when CRT is paired with psychiatric rehabilitation, such as psychoeducation or supported employment programmes (Revell et al. 2015; Vita et al. 2021, 2024; Wykes et al. 2011). In our review, only five studies ($k = 5$ out of 11) included another treatment in addition to CRT, which may explain the lack of effect of CRT on social functioning, or mitigated results shown in the included studies. That being said, it is worth noting that studies incorporating an additional treatment alongside CRT with a 'drill, practice and strategy' approach observed lower attrition rates in the CRT group compared to the control group. This may suggest that including a psychosocial rehabilitation component with a 'drill, practice and strategy' approach may improve participant retention in CRT groups.

The use of a 'drill and practice' approach in several studies may also explain the lack of observed effects on social functioning. While such an approach may lead to cognitive improvements, it appears to have no advantage over the strategic approach regarding social functioning, as demonstrated in our

meta-analysis. As shown in other meta-analyses, its impact on functioning is generally more limited or less pronounced than a strategic approach, particularly when a strategic approach is offered alongside adjunctive rehabilitation (e.g., Wykes et al. 2011).

An interesting and complementary avenue for future CRT studies would be to include measures of individuals' functional recovery goals. One such measure is Goal Attainment Scaling (GAS) (Kiresuk et al. 2014), which captures a person's goals and aspirations (Wykes et al. 2023). Such measures could make it possible to detect improvements or gains personalised to the participant themselves, that would not necessarily be detectable using standardised scales. Measures assessing academic functioning may also be relevant for adolescent populations. For example, Kidd et al. (2014) used such a measure, which assessed six domains rated from 1 to 4: contributions, attitude, preparedness, focus on the task, professionalism and effort. The use of such measures could contribute to a clearer understanding of the tangible effects of CRT on adolescents' daily lives.

### 3.1 | Clinical Considerations

A personalised and targeted cognitive remediation approach to cognitive impairments of participants might seem promising, as suggested by Medalia et al. (2018). However, a broader, top-down approach may also be relevant, particularly in a developmental context. A broad-based approach that focuses on strengths and goals while also addressing difficulties might offer a more comprehensive and effective strategy for promoting long-term improvements. A balanced approach that integrates both cognitive deficits and strengths could also help to promote greater engagement and motivation in personal and functional recovery (Allott et al. 2020).

Intrinsic motivation is also linked to larger improvements (Choi and Medalia 2010; Medalia et al. 2018; R.-Mercier et al. 2018; Saperstein and Medalia 2015). For instance, Holzer et al. (2014) found that participants with higher motivation showed higher improvements in their attention scores. According to these authors, cognitive improvements may be enhanced by the participant's motivation during treatment.

The therapeutic alliance may also represent an important factor to consider, since clients who have a positive perception of their relationship with the therapist have been shown to observe more positive effects and stay in therapy longer (Cella and Wykes 2019; Huddy et al. 2012). Moreover, according to an expert working group, the presence of a CRT therapist has been identified as a core feature of CRT for schizophrenia population (Bowie et al. 2020). Vita et al. (2021) even showed that interventions involving an active and trained therapist had a greater effect on cognition and functioning compared to those without such a therapist. In the present meta-analysis, the level of support provided to participants varied across studies, ranging from no support to substantial support with an active therapist. Four studies involved CRT sessions delivered without a therapist or with minimally active therapists. As such, this may have partly contributed to the results obtained, particularly, the lack of improvement in cognitive and social functioning outcomes.

In addition to the presence of a therapist, the expert working group identified three other techniques as core features of CRT: (1) the use of cognitive exercises (intensive drill and practice, increasing in difficulty), (2) facilitation of cognitive and problem-solving strategies (development of meta-cognitive skills) and (3) the use of techniques that allow transfer of cognitive gains to real world functioning (Bowie et al. 2020). While these techniques have been identified within the context of CRT studies in schizophrenia, they could still be relevant to consider in future studies with adolescent mental health populations with the goal of potentiating the effects of CRT. In the present meta-analysis, few studies use all four of these techniques, or at least, authors do not specify if they have done so. Indeed, few include strategy learning as a core feature of their programme and, without a CRT therapist, it may be more difficult to identify or self-generate useful strategies. Moreover, very few included studies reported using techniques to facilitate transfer of cognitive gains to real world functioning. Although some CRT programmes included techniques that permit transfer of gains (e.g., Cognitive Remediation Therapy; Wykes and Reeder 2005), most authors did not explicitly report using any of these techniques in their papers. In fact, it was mentioned in only one study (Hasslinger, Bölte, et al. 2022). The absence of several of the core techniques of cognitive remediation in the included studies carried out with adolescent populations could partly explain the lack of beneficial effects on cognition, social functioning and clinical symptoms in the current meta-analysis.

### 3.2 | Methodological Considerations

The second objective of this systematic review, which aimed to assess the methodological quality of CRT studies involving adolescent populations, showed variable results, ranging from poor to good quality. Compared to previous reviews of CRT using CTAM (e.g., Tsapekos et al. 2020; Vita et al. 2021; Wykes et al. 2011), the mean CTAM score in our review is slightly higher, with a narrower range of scores. Therefore, overall, the methodological quality of the studies included in our review is slightly better, although this varies across individual studies. Although there was no significant correlation between effect sizes and methodological quality, nearly half of the studies potentially harbour a high risk of bias. Hence, it is advisable to approach the interpretation of the findings with caution.

While some quality standards were met by most studies (standardised assessments, description of the intervention and appropriate statistical analyses), other important standards were not met (fidelity to protocol, blind assessments and sample size). Regarding sample sizes, although studies were randomised controlled trials, they were mostly feasibility studies, which explains the small sample sizes within studies. This reflects the extent to which the field of research with adolescent psychiatric populations is still in its nascent stage.

Finally, in addition to the methodological assessment carried out by the CTAM, it is important to note that several studies did not report certain information essential for understanding

the population studied or the scope of their results (e.g., information on the intensity of treatment or the presence of comorbidities). Future studies should adhere to guidelines such as the CONSORT Statement (Boutron et al. 2017), which identify relevant information to report.

### 3.3 | Limitations

This systematic review and meta-analysis included a few studies with small sample sizes. Some analyses included only one or two studies. There was also considerable methodological heterogeneity between studies, particularly in the choice of cognitive tests. Therefore, it is essential to be cautious when interpreting and generalising these results.

## 4 | Conclusion

Current studies show a small significant effect of CRT on cognition in adolescents with mental health disorders, with specific effects on processing speed, working memory and episodic memory. Non-significant effects were found for clinical symptoms and social functioning. Effects of CRT in adolescent populations with mental health disorders should be further investigated, particularly given the role of cognition in academic functioning (Alloway and Alloway 2010; Biederman et al. 2004, 2006; Bull et al. 2008; Mojtabai, Stuart, Hwang, Eaton, et al. 2015). However, some limitations have been highlighted in the studies included in the present meta-analysis, such as the lack of active therapist, no real-word transfer of cognitive gains, no blind assessments, small sample sizes and the absence of cognitive impairment as an inclusion criterion. Some of these limitations represent core features for CRT for the schizophrenia population as identified by an expert working group (Bowie et al. 2020). For future studies, we suggest considering the core factors identified by the expert group (Bowie et al. 2020). Effects of CRT may also be potentiated with a personalised, strengths-based approach, addressing intrinsic motivation in addition to another treatment such as psychoeducation or adjunctive psychiatric rehabilitation. Previous studies found that young people with mental health disorders showed preference for psychoeducation, compensatory strategies, sleep interventions, as well as interventions focusing on cognitive strengths (Bryce et al. 2023, 2024). Finally, innovative measures should be considered, in terms of pertinence to the functional recovery objectives of the adolescent population.

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**Conflicts of Interest**

The authors declare no conflicts of interest.

**Data Availability Statement**

The data that support the findings of this study are available from the corresponding author upon reasonable request.

**References**

Abramovitch, A., T. Short, and A. Schweiger. 2021. "The C Factor: Cognitive Dysfunction as a Transdiagnostic Dimension in Psychopathology." *Clinical Psychology Review* 86: 102007.

Ackermann, S., O. Halfon, E. Fornari, S. Urben, and M. Bader. 2018. "Cognitive Working Memory Training (CWMT) in Adolescents Suffering From Attention-Deficit/Hyperactivity Disorder (ADHD): A Controlled Trial Taking Into Account Concomitant Medication Effects." *Psychiatry Research* 269: 79–85. https://doi.org/10.1016/j.psychres.2018.07.036.

Allott, K., P. Steele, F. Boyer, et al. 2020. "Cognitive Strengths-Based Assessment and Intervention in First-Episode Psychosis: A Complementary Approach to Addressing Functional Recovery?" *Clinical Psychology Review* 79: 101871.

Alloway, T. P., and R. G. Alloway. 2010. "Investigating the Predictive Roles of Working Memory and IQ in Academic Attainment." *Journal of Experimental Child Psychology* 106, no. 1: 20–29. https://doi.org/10.1016/j.jecp.2009.11.003.

Anaya, C., A. Martinez Aran, J. L. Ayuso-Mateos, T. Wykes, E. Vieta, and J. Scott. 2012. "A Systematic Review of Cognitive Remediation for Schizo-Affective and Affective Disorders." *Journal of Affective Disorders* 142, no. 1–3: 13–21. https://doi.org/10.1016/j.jad.2012.04.020.

Biederman, J., C. Petty, R. Fried, et al. 2006. "Impact of Psychometrically Defined Deficits of Executive Functioning in Adults With Attention Deficit Hyperactivity Disorder." *American Journal of Psychiatry* 163, no. 10: 1730–1738. https://doi.org/10.1176/ajp.2006.163.10.1730.

Biederman, J., M. C. Monuteaux, A. E. Doyle, et al. 2004. "Impact of Executive Function Deficits and Attention-Deficit/Hyperactivity Disorder (ADHD) on Academic Outcomes in Children." *Journal of Consulting and Clinical Psychology* 72, no. 5: 757–766. https://doi.org/10.1037/0022-006X.72.5.757.

Bikic, A., T. Ø. Christensen, J. F. Leckman, N. Bilenberg, and S. Dalsgaard. 2017. "A Double-Blind Randomized Pilot Trial Comparing Computerized Cognitive Exercises to Tetris in Adolescents With Attention-Deficit/Hyperactivity Disorder." *Nordic Journal of Psychiatry* 71, no. 6: 455–464. https://doi.org/10.1080/08039488.2017.1328070.

Bitsko, R. H., A. H. Claussen, J. Lichstein, et al. 2022. "Mental Health Surveillance Among Children—United States, 2013–2019." *Morbidity and Mortality Weekly Report. Supplements* 71, no. 2: 1–42. https://doi.org/10.15585/mmwr.su7102a1.

Borenstein, M., L. V. Hedges, J. Higgens, and H. Rothstein. 2000. *Comprehensive Meta-Analysis*. Biostat.

Boutron, I., D. G. Altman, D. Moher, K. F. Schulz, and P. Ravaud. 2017. "CONSORT Statement for Randomized Trials of Nonpharmacologic Treatments: A 2017 Update and a CONSORT Extension for Nonpharmacologic Trial Abstracts." *Annals of Internal Medicine* 167, no. 1: 40–47.

Bowie, C. R., M. D. Bell, J. M. Fiszdon, et al. 2020. "Cognitive Remediation for Schizophrenia: An Expert Working Group White Paper on Core Techniques." *Schizophrenia Research* 215: 49–53. https://doi.org/10.1016/j.schres.2019.10.047.

Bryce, S., A. de Winter, L. Phillips, N. Cheng, M. Alvarez-Jimenez, and K. Allott. 2023. "Cognitive Strengths in First-Episode Psychosis: Perspectives From Young People With Lived Experience." *Psychosis* 15, no. 3: 240–251. https://doi.org/10.1080/17522439.2022.2044895.

Bryce, S., N. Cheng, A. Dalton, et al. 2024. "Cognitive Health Treatment Priorities and Preferences Among Young People With Mental Illness:

The Your Mind, Your Choice Survey." *Early Intervention in Psychiatry* 18, no. 2: 94–101. https://doi.org/10.1111/eip.13436.

Bull, R., K. A. Espy, and S. A. Wiebe. 2008. "Short-Term Memory, Working Memory, and Executive Functioning in Preschoolers: Longitudinal Predictors of Mathematical Achievement at Age 7 Years." *Developmental Neuropsychology* 33, no. 3: 205–228. https://doi.org/10.1080/87565640801982312.

Cella, M., and T. Wykes. 2019. "The Nuts and Bolts of Cognitive Remediation: Exploring How Different Training Components Relate to Cognitive and Functional Gains." *Schizophrenia Research* 203: 12–16.

Cella, M., C. Reeder, and T. Wykes. 2014. "It Is All in the Factors: Effects of Cognitive Remediation on Symptom Dimensions." *Schizophrenia Research* 156, no. 1: 60–62. https://doi.org/10.1016/j.schres.2014.03.032.

Choi, J., and A. Medalia. 2010. "Intrinsic Motivation and Learning in a Schizophrenia Spectrum Sample." *Schizophrenia Research* 118, no. 1–3: 12–19. https://doi.org/10.1016/j.schres.2009.08.001.

Cognitive Remediation Experts Working Group (CREW). 2010. April, Florence, Italy.

Cohen, J. 1988. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Lawrence Erlbaum Associates.

Cortese, S., M. Ferrin, D. Brandeis, et al. 2015. "Cognitive Training for Attention-Deficit/Hyperactivity Disorder: Meta-Analysis of Clinical and Neuropsychological Outcomes From Randomized Controlled Trials." *Journal of the American Academy of Child & Adolescent Psychiatry* 54, no. 3: 164–174. https://doi.org/10.1016/j.jaac.2014.12.010.

Cowman, M., L. Holleran, E. Lonergan, K. O'Connor, M. Birchwood, and G. Donohoe. 2021. "Cognitive Predictors of Social and Occupational Functioning in Early Psychosis: A Systematic Review and Meta-Analysis of Cross-Sectional and Longitudinal Data." *Schizophrenia Bulletin* 47, no. 5: 1243–1253. https://doi.org/10.1093/schbul/sbab033.

Dresler, M., A. Sandberg, C. Bublitz, et al. 2019. "Hacking the Brain: Dimensions of Cognitive Enhancement." *ACS Chemical Neuroscience* 10, no. 3: 1137–1148. https://doi.org/10.1021/acschemneuro.8b00571.

Duval, S., and R. Tweedie. 2000. "Trim and Fill: A Simple Funnel-Plot-Based Method of Testing and Adjusting for Publication Bias in Meta-Analysis." *Biometrics* 56, no. 2: 455–463. https://doi.org/10.1111/j.0006-341X.2000.00455.x.

East-Richard, C., A. R.-Mercier, D. Nadeau, and C. Cellard. 2020. "Transdiagnostic Neurocognitive Deficits in Psychiatry: A Review of Meta-Analyses." *Canadian Psychology/Psychologie Canadienne* 61, no. 3: 190–214. https://doi.org/10.1037/cap0000196.

Egger, M., and G. D. Smith. 1998. "Bias in Location and Selection of Studies." *British Medical Journal* 316, no. 7124: 61–66. https://doi.org/10.1136/bmj.316.7124.61.

Gharaeipour, M., and B. J. Scott. 2012. "Effects of Cognitive Remediation on Neurocognitive Functions and Psychiatric Symptoms in Schizophrenia Inpatients." *Schizophrenia Research* 142, no. 1–3: 165–170. https://doi.org/10.1016/j.schres.2012.09.018.

Giombini, L., S. Nesbitt, R. Kusosa, et al. 2022. "Neuropsychological and Clinical Findings of Cognitive Remediation Therapy Feasibility Randomised Controlled Trial in Young People With Anorexia Nervosa." *European Eating Disorders Review* 30, no. 1: 50–60. https://doi.org/10.1002/erv.2874.

Hasslinger, J., S. Bölte, and U. Jonsson. 2022. "Slow Cortical Potential Versus Live Z-Score Neurofeedback in Children and Adolescents With ADHD: A Multi-Arm Pragmatic Randomized Controlled Trial With Active and Passive Comparators." *Research on Child and Adolescent Psychopathology* 50, no. 4: 447–462. https://doi.org/10.1007/s10802-021-00858-1.

Hasslinger, J., U. Jonsson, and S. Bölte. 2022. "Immediate and Sustained Effects of Neurofeedback and Working Memory Training on Cognitive Functions in Children and Adolescents With ADHD: A Multi-Arm Pragmatic Randomized Controlled Trial." *Journal of Attention Disorders* 26, no. 11: 1492–1506. https://doi.org/10.1177/10870547211063645.

Hemingway, P., and N. Brereton. 2009. *What Is a Systematic Review?* Hayward Medical Communications.

Higgins, J. P. T., S. G. Thompson, J. J. Deeks, and D. G. Altman. 2003. "Measuring Inconsistency in Meta-Analyses." *British Medical Journal* 327, no. 7414: 557–560. https://doi.org/10.1136/bmj.327.7414.557.

Holzer, L., S. Urben, C. M. Passini, et al. 2014. "A Randomized Controlled Trial of the Effectiveness of Computer-Assisted Cognitive Remediation (CACR) in Adolescents With Psychosis or at High Risk of Psychosis." *Behavioural and Cognitive Psychotherapy* 42, no. 4: 421–434. https://doi.org/10.1017/S1352465813000313.

Huang-Pollock, C. L., S. L. Karalunas, H. Tam, and A. N. Moore. 2012. "Evaluating Vigilance Deficits in ADHD: A Meta-Analysis of CPT Performance." *Journal of Abnormal Psychology* 121, no. 2: 360–371. https://doi.org/10.1037/a0027205.

Huddy, V., C. Reeder, D. Kontis, T. Wykes, and D. Stahl. 2012. "The Effect of Working Alliance on Adherence and Outcome in Cognitive Remediation Therapy." *Journal of Nervous and Mental Disease* 200, no. 7: 614–619. https://doi.org/10.1097/NMD.0b013e31825bfc31.

Iceta, S., C. Rodrigue, M. Legendre, et al. 2021. "Cognitive Function in Binge Eating Disorder and Food Addiction: A Systematic Review and Three-Level Meta-Analysis." *Progress in Neuro-Psychopharmacology and Biological Psychiatry* 111: 110400. https://doi.org/10.1016/j.pnpbp.2021.110400.

Kessler, R. C., G. P. Amminger, S. Aguilar-Gaxiola, J. Alonso, S. Lee, and T. B. Üstün. 2007. "Age of Onset of Mental Disorders: A Review of Recent Literature." *Current Opinion in Psychiatry* 20, no. 4: 359–364.

Kessler, R. C., S. Avenevoli, E. J. Costello, et al. 2012. "Prevalence, Persistence, and Sociodemographic Correlates of DSM-IV Disorders in the National Comorbidity Survey Replication Adolescent Supplement." *Archives of General Psychiatry* 69, no. 4: 372–380. https://doi.org/10.1001/archgenpsychiatry.2011.160.

Kidd, S. A., J. Kaur, G. Virdee, T. P. George, K. McKenzie, and Y. Herman. 2014. "Cognitive Remediation for Individuals With Psychosis in a Supported Education Setting: A Randomized Controlled Trial." *Schizophrenia Research* 157, no. 1–3: 90–98.

Kiresuk, T. J., A. Smith, and J. E. Cardillo. 2014. *Goal Attainment Scaling: Applications, Theory, and Measurement*. Psychology Press.

Larsen, B., and B. Luna. 2018. "Adolescence as a Neurobiological Critical Period for the Development of Higher-Order Cognition." *Neuroscience & Biobehavioral Reviews* 94: 179–195. https://doi.org/10.1016/j.neubiorev.2018.09.005.

Lee, R. S. C., D. F. Hermens, S. L. Naismith, et al. 2015. "Neuropsychological and Functional Outcomes in Recent-Onset Major Depression, Bipolar Disorder and Schizophrenia-Spectrum Disorders: A Longitudinal Cohort Study." *Translational Psychiatry* 5, no. 4: e555. https://doi.org/10.1038/tp.2015.50.

Lee, R. S., D. F. Hermens, S. L. Naismith, et al. 2018. "Clinical, Neurocognitive and Demographic Factors Associated With Functional Impairment in the Australian Brain and Mind Youth Cohort Study (2008–2016)." *BMJ Open* 8, no. 12: e022659. https://doi.org/10.1136/bmjopen-2018-022659.

Lewandowski, K. E., B. M. Cohen, and D. Öngur. 2011. "Evolution of Neuropsychological Dysfunction During the Course of Schizophrenia and Bipolar Disorder." *Psychological Medicine* 41, no. 2: 225–241. https://doi.org/10.1017/S0033291710001042.

Li, Y., K. Sun, D. Liu, et al. 2020. "The Effects of Combined Social Cognition and Interaction Training and Paliperidone on Early-Onset Schizophrenia." *Frontiers in Psychiatry* 11: 525492. https://doi.org/10.3389/fpsyt.2020.525492.

Lindvall Dahlgren, C., and Ø. Rø. 2014. "A Systematic Review of Cognitive Remediation Therapy for Anorexia Nervosa—Development, Current State and Implications for Future Research and Clinical Practice." *Journal of Eating Disorders* 2, no. 1: 26. https://doi.org/10.1186/s40337-014-0026-y.

Lock, J., K. K. Fitzpatrick, W. S. Agras, N. Weinbach, and B. Jo. 2018. "Feasibility Study Combining Art Therapy or Cognitive Remediation Therapy With Family-Based Treatment for Adolescent Anorexia Nervosa." *European Eating Disorders Review* 26, no. 1: 62–68. https://doi.org/10.1002/erv.2571.

McAnarney, E. R., J. Zarcone, P. Singh, et al. 2011. "Restrictive Anorexia Nervosa and Set-Shifting in Adolescents: A Biobehavioral Interface." *Journal of Adolescent Health* 49, no. 1: 99–101. https://doi.org/10.1016/j.jadohealth.2010.11.259.

Medalia, A., A. M. Saperstein, M. C. Hansen, and S. Lee. 2018. "Personalised Treatment for Cognitive Dysfunction in Individuals With Schizophrenia Spectrum Disorders." *Neuropsychological Rehabilitation* 28, no. 4: 602–613. https://doi.org/10.1080/09602011.2016.1189341.

Mojtabai, R., E. A. Stuart, I. Hwang, et al. 2015. "Long-Term Effects of Mental Disorders on Employment in the National Comorbidity Survey Ten-Year Follow-Up." *Social Psychiatry and Psychiatric Epidemiology* 50, no. 11: 1657–1668. https://doi.org/10.1007/s00127-015-1097-z.

Mojtabai, R., E. A. Stuart, I. Hwang, W. W. Eaton, N. Sampson, and R. C. Kessler. 2015. "Long-Term Effects of Mental Disorders on Educational Attainment in the National Comorbidity Survey Ten-Year Follow-Up." *Social Psychiatry and Psychiatric Epidemiology* 50, no. 10: 1577–1591. https://doi.org/10.1007/s00127-015-1083-5.

Page, M. J., J. E. McKenzie, P. M. Bossuyt, et al. 2021. "The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews." *British Medical Journal* 372: n71. https://doi.org/10.1136/bmj.n71.

Paus, T., M. Keshavan, and J. N. Giedd. 2008. "Why Do Many Psychiatric Disorders Emerge During Adolescence?" *Nature Reviews Neuroscience* 9: 947–957. https://doi.org/10.1038/nrn2513.

Perestelo-Pérez, L. 2013. "Standards on How to Develop and Report Systematic Reviews in Psychology and Health." *International Journal of Clinical and Health Psychology* 13, no. 1: 49–57. https://doi.org/10.1016/S1697-2600(13)70007-3.

Puig, O., R. Penadés, I. Baeza, et al. 2014. "Cognitive Remediation Therapy in Adolescents With Early-Onset Schizophrenia: A Randomized Controlled Trial." *Journal of the American Academy of Child & Adolescent Psychiatry* 53, no. 8: 859–868. https://doi.org/10.1016/j.jaac.2014.05.012.

R.-Mercier, A., J. Fredricks, and C. Cellard. 2018. "Le rôle de l'engagement dans la remédiation cognitive chez les adolescents." In *Traité de réhabilitation psychosociale*, edited by D. N. Franck, 255–262. Elsevier-Masson.

Rapport, M. D., S. A. Orban, M. J. Kofler, and L. M. Friedman. 2013. "Do Programs Designed to Train Working Memory, Other Executive Functions, and Attention Benefit Children With ADHD? A Meta-Analytic Review of Cognitive, Academic, and Behavioral Outcomes." *Clinical Psychology Review* 33, no. 8: 1237–1252. https://doi.org/10.1016/j.cpr.2013.08.005.

Revell, E. R., J. C. Neill, M. Harte, Z. Khan, and R. J. Drake. 2015. "A Systematic Review and Meta-Analysis of Cognitive Remediation in Early Schizophrenia." *Schizophrenia Research* 168, no. 1–2: 213–222. https://doi.org/10.1016/j.schres.2015.08.017.

Rosenthal, R. 1979. "The File Drawer Problem and Tolerance for Null Results." *Psychological Bulletin* 86, no. 3: 638–641. https://doi.org/10.1037/0033-2909.86.3.638.

Rothstein, H. R., A. J. Sutton, and M. Borenstein, eds. 2006. *Publication Bias in Meta-Analysis Prevention, Assessment and Adjustments*. John Wiley & Sons.

Santesteban-Echarri, O., M. Paino, S. Rice, et al. 2017. "Predictors of Functional Recovery in First-Episode Psychosis: A Systematic Review and Meta-Analysis of Longitudinal Studies." *Clinical Psychology Review* 58: 59–75. https://doi.org/10.1016/j.cpr.2017.09.007.

Saperstein, A. M., and A. Medalia. 2015. "The Role of Motivation in Cognitive Remediation for People With Schizophrenia." In *Behavioral Neuroscience of Motivation*, edited by E. H. Simpson and P. D. Balsam, vol. 27, 533–546. Springer International Publishing. https://doi.org/10.1007/7854_2015_373.

Schlosser, R. W. 2007. "Appraising the Quality of Systematic Reviews." *Focus: Technical Briefs* 17: 1–8.

Schnitzler, A., A.-C. D'Apolito, and C. Vallat. 2006. "Troubles des fonctions cognitives et évaluation des conséquences sur l'activité professionnelle." In *Évaluation des troubles neuropsychologiques en vie quotidienne*, edited by P. Pradat-Diehl and A. Peskine, 137–144. Springer.

Schweizer, S., Z. Samimi, J. Hasani, A. Moradi, F. Mirdoraghi, and M. Khaleghi. 2017. "Improving Cognitive Control in Adolescents With Post-Traumatic Stress Disorder (PTSD)." *Behaviour Research and Therapy* 93: 88–94. https://doi.org/10.1016/j.brat.2017.03.017.

Solmi, M., J. Radua, M. Olivola, et al. 2022. "Age at Onset of Mental Disorders Worldwide: Large-Scale Meta-Analysis of 192 Epidemiological Studies." *Molecular Psychiatry* 27, no. 1: 281–295. https://doi.org/10.1038/s41380-021-01161-7.

Stedal, K., R. Scherer, S. Touyz, P. Hay, and C. Broomfield. 2022. "Research Review: Neuropsychological Functioning in Young Anorexia Nervosa: A Meta-Analysis." *Journal of Child Psychology and Psychiatry* 63, no. 6: 616–625.

Steiner, N. J., R. C. Sheldrick, D. Gotthelf, and E. C. Perrin. 2011. "Computer-Based Attention Training in the Schools for Children With Attention Deficit/Hyperactivity Disorder: A Preliminary Trial." *Clinical Pediatrics* 50, no. 7: 615–622. https://doi.org/10.1177/0009922810397887.

Tarrier, N., and T. Wykes. 2004. "Is There Evidence That Cognitive Behaviour Therapy Is an Effective Treatment for Schizophrenia? A Cautious or Cautionary Tale?" *Behaviour Research and Therapy* 42, no. 12: 1377–1401. https://doi.org/10.1016/j.brat.2004.06.020.

Tchanturia, K., N. Lounes, and S. Holttum. 2014. "Cognitive Remediation in Anorexia Nervosa and Related Conditions: A Systematic Review." *European Eating Disorders Review* 22, no. 6: 454–462. https://doi.org/10.1002/erv.2326.

Tsapekos, D., B. Seccomandi, T. Mantingh, M. Cella, T. Wykes, and A. H. Young. 2020. "Cognitive Enhancement Interventions for People With Bipolar Disorder: A Systematic Review of Methodological Quality, Treatment Approaches, and Outcomes." *Bipolar Disorders* 22, no. 3: 216–230.

Ueland, T., and B. R. Rund. 2004. "A Controlled Randomized Treatment Study: The Effects of a Cognitive Remediation Program on Adolescents With Early Onset Psychosis." *Acta Psychiatrica Scandinavica* 109, no. 1: 70–74. https://doi.org/10.1046/j.0001-690X.2003.00239.x.

Ueland, T., and B. R. Rund. 2005. "Cognitive Remediation for Adolescents With Early Onset Psychosis: A 1-Year Follow-Up Study." *Acta Psychiatrica Scandinavica* 111, no. 3: 193–201. https://doi.org/10.1111/j.1600-0447.2004.00503.x.

Urben, S., S. Pihet, L. Jaugey, O. Halfon, and L. Holzer. 2012. "Computer-Assisted Cognitive Remediation in Adolescents With Psychosis or at Risk for Psychosis: A 6-Month Follow-Up." *Acta Neuropsychiatrica* 24, no. 6: 328–335. https://doi.org/10.1111/j.1601-5215.2012.00651.x.

Vita, A., S. Barlati, A. Ceraso, et al. 2021. "Effectiveness, Core Elements, and Moderators of Response of Cognitive Remediation for Schizophrenia: A Systematic Review and Meta-Analysis of Randomized Clinical Trials." *JAMA Psychiatry* 78, no. 8: 848–858. https://doi.org/10.1001/jamapsychiatry.2021.0620.

Vita, A., S. Barlati, A. Ceraso, et al. 2024. "Durability of Effects of Cognitive Remediation on Cognition and Psychosocial Functioning in

Schizophrenia: A Systematic Review and Meta-Analysis of Randomized Clinical Trials." *American Journal of Psychiatry* 181, no. 6: 520–531.

Wagner, S., C. Müller, I. Helmreich, M. Huss, and A. Tadić. 2015. "A Meta-Analysis of Cognitive Functions in Children and Adolescents With Major Depressive Disorder." *European Child & Adolescent Psychiatry* 24, no. 1: 5–19. https://doi.org/10.1007/s00787-014-0559-2.

Walshaw, P. D., L. B. Alloy, and F. W. Sabb. 2010. "Executive Function in Pediatric Bipolar Disorder and Attention-Deficit Hyperactivity Disorder: In Search of Distinct Phenotypic Profiles." *Neuropsychology Review* 20, no. 1: 103–120. https://doi.org/10.1007/s11065-009-9126-x.

Willcutt, E. G., A. E. Doyle, J. T. Nigg, S. V. Faraone, and B. F. Pennington. 2005. "Validity of the Executive Function Theory of Attention-Deficit/Hyperactivity Disorder: A Meta-Analytic Review." *Biological Psychiatry* 57, no. 11: 1336–1346.

Wykes, T., and C. Reeder. 2005. *Cognitive Remediation Therapy for Schizophrenia: Theory and Practice*. Routledge.

Wykes, T., C. Steel, B. Everitt, and N. Tarrier. 2008. "Cognitive Behavior Therapy for Schizophrenia: Effect Sizes, Clinical Models, and Methodological Rigor." *Schizophrenia Bulletin* 34, no. 3: 523–537. https://doi.org/10.1093/schbul/sbm114.

Wykes, T., D. Stringer, J. Boadu, et al. 2023. "Cognitive Remediation Works but How Should We Provide It? An Adaptive Randomized Controlled Trial of Delivery Methods Using a Patient Nominated Recovery Outcome in First-Episode Participants." *Schizophrenia Bulletin* 49, no. 3: 614–625.

Wykes, T., V. Huddy, C. Cellard, S. R. McGurk, and P. Czobor. 2011. "A Meta-Analysis of Cognitive Remediation for Schizophrenia: Methodology and Effect Sizes." *American Journal of Psychiatry* 168, no. 5: 472–485. https://doi.org/10.1176/appi.ajp.2010.10060855.