

Cognitive Remediation in Schizophrenia: Progress, Challenges, and Prospects

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DOI: <https://dx.doi.org/10.51584/IJRIAS.2026.11010048>

Received: 20 January 2026; Accepted: 26 January 2026; Published: 02 February 2026

ABSTRACT

Cognitive impairment is a core symptom in schizophrenia that has a significant impact on psychosocial function, but shows a weak response to pharmacological treatment. Consequently, a variety of non pharmacological interventions have tried to find out suitable out come in patients with schizophrenia.

Objectives: The present study aims to review the existing scientific literature on cognitive remediation in schizophrenia. Specifically, it highlights the major structured cognitive remediation protocols developed for schizophrenia and summarizes findings from recent meta-analyses.

Methods: A comprehensive electronic search was conducted in the PubMed and Google scholar database for studies published in year 2015 to 2025. All relevant meta-analyses and review articles on cognitive remediation in schizophrenia were included.

Results: Numerous intervention programs have been developed and evaluated to enhance cognitive functioning in individuals with schizophrenia. Several quantitative reviews have demonstrated that cognitive remediation effectively reduces cognitive deficits and improves functional outcomes. Moreover, current evidence supports its applicability and usefulness during the early phase of schizophrenia and in high-risk populations.

Conclusions: Cognitive remediation represents a promising therapeutic approach for enhancing real-world functioning in schizophrenia and should be regarded as a crucial component of early intervention strategies in psychotic disorder.

Keywords: Schizophrenia, Cognitive Remediation, Non-Pharmacological Interventions

INTRODUCTION

Schizophrenia is a severe mental disorder marked by significant distortions in perception of reality and notable behavioral changes. Core symptoms include persistent delusions (fixed false beliefs), hallucinations (sensory perceptions without external stimuli), and experiences of influence or control, where individuals feel their thoughts or actions are manipulated by external forces. Additionally, individuals may exhibit disorganized thinking (manifested as incoherent speech), disorganized or bizarre behavior, and negative symptoms, such as diminished speech, emotional expression, motivation, and social engagement. Some may also display motor abnormalities, including agitation, slowed movements, or unusual postures. Beyond these symptoms, schizophrenia frequently involves cognitive impairments that affect memory, attention, and problem-solving abilities (WHO, 2025).

In the 1890s, Emil Kraepelin first described schizophrenia as “dementia praecox,” a form of dementia occurring in younger individuals, distinguishing it from Alzheimer’s disease, which predominantly affects older adults. Kraepelin viewed schizophrenia as a neurological disorder and documented impairments in memory, attention, motor function, and perception, observations that continue to align with contemporary

understandings of the condition (Dondeet.al , 2022). Schizophrenia affects an estimated 23 million individuals worldwide, accounting for about 1 in 345 people (0.29%), and approximately 1 in 233 adults (0.43%). The disorder typically emerges in late adolescence or early adulthood, with men often experiencing onset earlier than women (WHO, 2025).

Individuals with schizophrenia often experience moderate to severe impairments in cognitive functioning, which serve as a major contributor to difficulties in occupational, social, and economic functioning and represent a key focus of treatment. These cognitive deficits commonly affect core domains of human cognition, including attention, memory, reasoning, and processing speed (Keefeet.al., 2012). Taken together, cognitive impairments may constitute a fundamental aspect of schizophrenia, potentially predisposing individuals to the later onset of psychosis.(Lewis et al., 2012) . Unsurprisingly, the severity of cognitive deficits is a strong predictor of long-term outcomes and social functioning in individuals with schizophrenia.(Green et al., 1996)

Impairment in attention is widely recognized as a central cognitive disturbance in people with schizophrenia (Fioravanti et al., 2005). Brain imaging research has consistently shown that individuals with schizophrenia exhibit altered brain activity compared to healthy controls when performing attention tasks. These differences are most evident in regions associated with the attentional network, including the dorsolateral prefrontal cortex (DLPFC), insula, anterior cingulate gyrus (ACG), amygdala, hippocampus, ventral striatum, thalamus, and cerebellum (Liddle et al., 2006). Many neuroimaging studies have demonstrated that individuals with schizophrenia often exhibit decreased brain activity compared to healthy controls.(Polli, et al. 2008). However, several studies have also reported increased brain activity in individuals with schizophrenia.(Karch, et al. 2009). Variations in task type, analysis methods, and task difficulty may explain the inconsistent findings across studies (Karch et al., 2009; Manoach, 2003). Notably, patients with schizophrenia show increased cortical activity on easier attention tasks but reduced activity on more difficult ones (Karch et al., 2009).

A meta-analysis indicated that learning and memory showed the greatest degree of dysfunction, with the largest effect sizes observed in these cognitive domains.(Heinrichs et al. ,2005) Memory shows the greatest impairment, especially in working and episodic memory functions (Weiss et al., 2001) while verbal short-term and procedural memory remain relatively preserved (Al-Uzri et al., 2006). The prefrontal cortex is among the most extensively studied regions in functional imaging research on working memory. Reduced activation in the dorsolateral prefrontal cortex (DLPFC) during working memory tasks is one of the most consistently replicated findings in schizophrenia, with the degree of reduction closely linked to poorer task performance.(Glahn et al., 2005). Episodic memory impairment is a key feature of cognitive dysfunction in schizophrenia, apparent from the onset of the illness and closely linked to functional disability. Recent cognitive neuroscience research indicates that individuals with schizophrenia show marked episodic memory deficits under high-demand relational encoding conditions, but perform comparatively well during itemspecific encoding tasks. These difficulties are associated with abnormal activation and connectivity within frontal–medial temporal brain networks, particularly involving dysfunction in the dorsolateral prefrontal cortex (DLPFC), relatively preserved ventrolateral prefrontal cortex activity, and variable hippocampal findings. Overall, these memory impairments reflect broader deficits in DLPFC-related cognitive control, which may contribute to dysfunction across multiple cognitive domains.(Guoet al., 2019) .

Widespread cognitive deficits may be seen in individuals with schizophrenia, particularly those involving executive functioning. (Reichenberg et al., 2007) One key aspect of executive functioning that has drawn attention, especially in relation to delusional thinking, is reasoning ability. As cognitive-behavioral treatments for delusions and schizophrenia rely partly on patients' reasoning processes, a comprehensive understanding of reasoning impairments in schizophrenia is essential for improving therapeutic outcomes.(Rathod et al., 2005) . The study reported new evidence of impaired inferential reasoning in individuals with schizophrenia, which appears to be unrelated to overall symptom severity, including delusions. These results strengthen the view that a distinct deficit in reasoning may be a core feature of schizophrenia-spectrum disorders (Kruck et al., 2011).

Karbasforoushan et al. (2015) investigated whether processing speed impairments in schizophrenia are linked to white matter (WM) integrity using diffusion tensor imaging (DTI). The study compared individuals with schizophrenia and healthy controls on cognitive performance and WM integrity, focusing on fractional anisotropy (FA) across major brain tracts. Results showed that patients exhibited significantly reduced WM integrity, particularly in the corpus callosum, cingulum, frontal, and parietal regions. Mediation analyses

revealed that lower FA significantly accounted for slower processing speed in schizophrenia, whereas WM integrity did not mediate deficits in other cognitive domains such as working memory or verbal learning. These findings suggest that disrupted white matter connectivity underlies core processing speed deficits in schizophrenia, providing neurobiological evidence for a fundamental cognitive impairment that contributes to broader functional difficulties.

Cognitive Remediation

Cognitive remediation (CR) originated during World Wars I and II, when techniques were developed to improve attention and memory difficulties observed in military veterans following brain injury (Boake., 1991). CR aims to enhance cognitive functioning and rehabilitate individuals with cognitive impairments. It does so by strengthening deficient cognitive functions or fostering new cognitive strategies to compensate for deficits. Remediation implies that a cognitive skill may not fully recover to its previous level and might have deteriorated over time (Medalia et al., 2009). Across definitions, CR consistently emphasizes improving cognitive processes through structured techniques designed to restore or compensate for impaired cognitive functions. According to Medalia et al. (2009), CR is a behavioral intervention for individuals whose cognitive impairments interfere with everyday functioning. Similarly, Dandil et al. (2020) define CR as a broad category of psychological interventions employing cognitive training exercises to address difficulties in social cognition and neuropsychological functioning.

Schwalbe and Medalia (2007) noted that cognitive remediation (CR) techniques were initially developed to enhance cognitive performance in individuals with neurological injuries. As research later demonstrated that neuropsychological impairments also occur in mental illnesses such as schizophrenia, researchers and clinicians began to explore and apply various CR approaches among individuals with psychiatric and psychological disorders. Many CR models used in these populations are adaptations of the original methods designed for patients with brain injuries

Cognitive remediation (CR) focuses on improving, restoring, retrieving, and developing cognitive skills to enhance cognitive efficiency, independence, adaptability, and overall quality of life (Demily et al., 2016). It aims to help individuals adapt to daily life challenges by strengthening their abilities and focusing on their personal strengths (Demily et al., 2016). This may involve training impaired cognitive functions or teaching patients strategies to optimize the use of their remaining abilities, thereby improving their capacity to manage everyday tasks. Furthermore, the skills acquired through CR can be transferred to enhance daily functioning (Benaissa., 2023).

At present, psychiatric pharmacotherapies are largely ineffective in addressing persistent cognitive deficits (Goldberg et al., 2007). In contrast, cognitive rehabilitation has shown greater promise. Early studies applied operant conditioning procedures to improve behavioral performance (Cohen., 1956). A second wave of research in the early 1990s integrated various approaches under the collective term cognitive remediation (CR). CR programs are highly heterogeneous, differing in whether they emphasize drill-and-practice or compensatory strategy learning, therapist facilitation, computer-based training, or variations in treatment length and intensity. (Medalia et al., 2002)

Cognitive Remediation in Schizophrenia Patients

Cognitive remediation (CR) is a behavioral training–based intervention aimed at improving cognitive processes in individuals diagnosed with schizophrenia (Wykes et al., 2011). Research from recent systematic reviews and meta-analyses demonstrates that CR produces significant improvements not only in cognitive performance but also in real-world psychosocial functioning (Kambeitz-Illankovic et al., 2019; Lejeune et al., 2021; Vita et al., 2021), including among individuals with greater clinical impairment (Vita et al., 2021). Therefore, CR is considered an important approach in helping individuals with schizophrenia achieve their recovery goals.

Over the past four decades, numerous cognitive remediation (CR) programs have been developed and evaluated to address cognitive impairments in individuals with schizophrenia. These interventions employ a range of techniques, including drill-and-practice exercises to enhance specific cognitive skills, the teaching of cognitive strategies to improve information processing, and the use of compensatory approaches to mitigate the

impact of enduring cognitive deficits. Many CR programs also incorporate group discussions and therapist guided sessions to facilitate the generalization of cognitive gains to everyday functioning (McGurk et al., 2007)

METHODS AND MATERIAL

Search Strategy

A comprehensive electronic search was conducted using the PubMed and Google Scholar databases. The search included the following key terms and their combinations: *schizophrenia*, *cognitive remediation*, *cognitive training*, *neurocognitive enhancement*, *cognitive rehabilitation*, *functional outcome*, *meta-analysis*, *neurobiological correlates*, *cognitive deficit in schizophrenia*. Detailed combinations of these search terms are available from the authors upon request. In addition, the reference lists of the included studies were manually reviewed to identify any additional publications of potential relevance.

Selection Criteria

All original research articles, meta-analyses, and review papers on cognitive remediation in schizophrenia published up to year 2015 were included. Studies were selected based on the following criteria: (a) publication in a peer-reviewed journal and (b) the use of a cognitive remediation technique involving participants diagnosed with schizophrenia. Studies focusing solely on psychological, psychosocial, or psychoeducational interventions without the use of any cognitive remediation approach or technique were excluded from the review.

Table: Cognitive Remediation in Schizophrenia — RCTs, Reviews & Meta-Analyses (2021–2025)

Authors (Year)	Study Design	Sample Size (N)	Intervention	Control	Outcome Measures	Main Findings / Effect Sizes
Skokou et al. (2025)	Systematic Review of RCTs	35 studies identified (varied N)	Various CRT programs (computerized/strategy-based)	RCT controls in included trials	Cognitive symptoms, negative/positive symptoms, mood/anxiety	Consistently positive effects on negative symptoms ; mixed results on positive, mood, and anxiety outcomes. CR shown as significant intervention for cognitive and symptom domains overall.
Wen et al. (2025)	Meta-analysis of Remote CRT RCTs	20 RCTs (dropout data)	Remotely delivered CRT	Control groups (non-CRT)	Treatment discontinuation	No significant difference in dropout between remotely delivered CRT and controls (OR = 0.99; p = 0.901). Strategy development and full CRT components associated with better retention.
Melville et al. (2024)	Meta-analysis – Negative Symptoms	69 controlled trials (5319 participants)	Cognitive remediation (various formats)	Controls in included trials	Negative symptoms (summary, subdomains)	Small effect on summary negative symptoms (g = 0.179); small-to-moderate on alogia (g = 0.312). Experimental components (bridging to daily function) improved effect sizes.
Wen et al. (2025)	Randomized Controlled Trial	79 participants.	mHealth app-based CRT	Treatment as usual	Cognitive function + mediators (self-efficacy, emotion)	Mobile CRT showed cognitive benefits versus usual care; investigated mediation by self-efficacy and emotion
Levine (2022)	Meta-Analysis of RCTs	Aggregated RCTs (varied N)	Traditional CRT programs	Control groups (TAU or active)	Attention, memory, exec. function, social cognition	Meta-analytic synthesis of RCTs showing overall effectiveness of CRT for cognitive domains compared to controls; moderators like session duration and therapist involvement discussed.
Frederick (2023)	Meta-Analysis of RCTs	Aggregated RCTs (varied N)	CRT across domains	Treatment as usual/supportive therapy	Cognition & function	Confirms CRT's efficacy in improving cognitive performance across RCTs; moderators explored.

Bertali et al. (2021)	Systematic Review & Meta-Analysis	130 studies, n ≈ 8851	CRT across cognitive domains	Various controls	Global cognition & functioning	Small-to-moderate improvement in global cognition (d = 0.29) and functioning (d = 0.22); role of therapist, strategy training, and integration with rehab highlighted.
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RESULTS

To date, multiple meta-analyses have provided evidence that cognitive remediation effectively improves the cognitive domains it is designed to target. The first study on cognitive remediation in adolescents during the early course of psychosis was conducted by Ueland and Rund (2004). This randomized controlled trial indicated that cognitive remediation may yield beneficial effects on certain specific cognitive domains and potentially exert an indirect influence on functional outcome measures within this patient group.

In 2011 meta-analysis of 40 randomized controlled trials (RCTs) reported that cognitive remediation therapy (CRT) demonstrated low-to-moderate efficacy and some degree of persistence in improving overall cognition (Effect Size, $ES = 0.45$) and functioning ($ES = 0.42$) among individuals with schizophrenia. Although CRT showed a limited impact on psychiatric symptoms, this effect was not sustained at follow-up. The findings further indicated that CRT combined with other rehabilitation interventions produced greater improvements in functional outcomes. Additionally, treatment parameters—such as cognitive modification type, treatment duration, and computer-based delivery—were not significantly related to cognitive outcomes, and CRT appeared to be more effective for patients in the stable phase of illness (Wykes et al., 2011).

In 2015, another meta-analysis that included 11 randomized controlled trials (RCTs) reported that cognitive remediation therapy (CRT) had no significant effect on overall cognitive functioning in individuals with first-episode schizophrenia. However, it demonstrated a small but measurable effect on a specific cognitive domain—visual learning and memory ($ES = 0.23$). The study also found that CRT had limited efficacy in improving psychiatric symptoms ($ES = 0.19$) and social functioning ($ES = 0.18$) in this population. (Revell et al., 2015).

In a meta-analysis conducted by Grynszpan et al. (2011) computer-assisted cognitive remediation (CACR) techniques—which allow for the targeted training of specific cognitive domains—were found to significantly enhance a broad range of cognitive functions as well as social cognition in individuals with schizophrenia.

In recent years, numerous quantitative reviews have firmly established that cognitive remediation is effective in reducing cognitive deficits and enhancing functional outcomes, with sustained long-term benefits in individuals with schizophrenia. (Grynszpan et al., 2011).

CONCLUSIONS AND FUTURE DIRECTIONS

Cognitive remediation (CR) is now an evidence-based intervention for cognitive impairment in schizophrenia. Across randomized trials and multiple meta-analyses, CR produces small-to-moderate, reliable improvements in neurocognitive domains (attention, memory, executive function) and—when delivered with active therapist involvement, strategy coaching, and integration with psychosocial rehabilitation—yields meaningful improvements in real-world functional outcomes that can be durable over time (Wykes et al., 2011; Vita et al., 2021; Lejeune et al., 2021). Computer-assisted approaches allow selective targeting of cognitive domains and have been shown to improve a broad range of cognitive functions including social cognition, although optimal delivery (standalone digital vs. therapist-supported) remains important for transfer to everyday functioning (Grynszpan et al., 2011; Shu et al., 2024). Overall, the literature supports CR as a core component of comprehensive recovery-oriented care for people with schizophrenia.

Future research should more systematically examine the neurobiological effects of cognitive remediation, both as a standalone intervention and in combination with various classes of antipsychotic medications, across different phases of the illness. Particular attention should be given to its potential role in mitigating or counteracting the progressive brain changes commonly associated with schizophrenia. (van Haren et al., 2012). Further research should aim to clarify which patient characteristics influence responsiveness to cognitive remediation and to identify reliable predictors of individual treatment outcomes (Vita et al., 2013). Furthermore, future research on cognitive training in schizophrenia should seek to address several still

unresolved or debated questions, including the differentiation between specific and nonspecific effects of treatment, the identification of its active components, and the mechanisms—both mediating and moderating—through which its effects occur. Additional attention should be devoted to examining the persistence and generalization of cognitive improvements over time, as well as the influence of factors such as motivation, metacognition, and social cognition on treatment outcomes (Genevsky et al., 2010). The future research should aim to standardize the delivery parameters of cognitive remediation—such as treatment timing, duration, intensity, and instructional methods—and incorporate this knowledge into theoretical models that promote effective, efficient, and personalized care. In addition, studies should evaluate the feasibility and cost-effectiveness of implementing cognitive remediation within routine clinical practice to support its broader integration into mental health services.

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