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# Compensatory Interventions for Cognitive Impairments in Psychosis: A Systematic Review and Meta-Analysis

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***Objective.*** **Cognitive compensatory interventions aim to alleviate psychosocial disability by targeting functioning directly using aids and strategies, thereby minimizing the impact of cognitive impairment. The aim was to conduct a systematic review and meta-analysis of cognitive compensatory interventions for psychosis by examining the effects on functioning and symptoms, and exploring whether intervention factors, study design, and age influenced effect sizes.*Methods.*** **Electronic databases (Ovid Medline, PsychINFO) were searched up to October 2018. Records obtained through electronic and manual searches were screened independently by two reviewers according to selection criteria. Data were extracted to calculate estimated effects (Hedge's *g*) of treatment on functioning and symptoms at post-intervention and follow-up. Study quality was assessed using Cochrane Collaboration's risk of bias tool.*Results.*** **Twenty-six studies, from 25 independent randomized controlled trials (RCTs) were included in the meta-analysis (1654 participants, mean age = 38.9 years, 64% male). Meta-analysis revealed a medium effect of compensatory interventions on functioning compared to control conditions (Hedge's $g = 0.46$, 95% CI = 0.33, 0.60, $P < .001$), with evidence of relative durability at follow-up (Hedge's $g = 0.36$, 95% CI = 0.19, 0.54, $P < .001$). Analysis also revealed small significant effects of cognitive compensatory treatment on negative, positive, and general psychiatric symptoms, but not depressive symptoms. Estimated effects did not significantly vary according to treatment factors (ie, compensatory approach, dosage), delivery method (ie, individual/group), age, or risk of bias. Longer treatment length was associated with larger effect sizes for functioning outcomes. No evidence of publication bias was identified.*Conclusion.*** **Cognitive compensatory interventions are associated with robust, durable improvements in functioning in people with psychotic illnesses.**

*Key words:* internal self-management/external strategies/environmental modification/errorless learning/schizophrenia/severe mental illness/functional outcome

## Introduction

Functional recovery is a critical, yet a challenging component of the successful treatment of psychosis. Cognitive impairments are a central feature of psychotic disorders that have significant negative consequences for daily functioning, including activities of daily living, social and vocational roles.[1,2] Accordingly, interventions that address cognitive impairment have been a substantial focus of clinical research for several decades. Cognitive remediation therapies are the most widely researched approach to addressing cognitive impairment in psychotic disorders. Collectively, cognitive remediation has been 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"[3(p472)]. Thus, the primary target of cognitive remediation is cognitive function, with the assumption that improved cognition will facilitate improvements in daily functioning. Meta-analyses have provided robust evidence that cognitive remediation is effective

for improving cognitive outcomes.[3,4] The most comprehensive meta-analysis of 40 studies reported significant moderate improvements in cognition (ES = 0.45), moderate improvements in functioning (ES = 0.41), and small reductions in symptoms (ES = 0.18) following cognitive remediation relative to control conditions.[3] Much larger improvements in functioning are evident when treatment includes a therapist and is combined with psychosocial rehabilitation, rather than delivering either of these interventions alone.[3,5–7] Wykes et al[3] showed that the effect size of cognitive remediation on functioning was small when delivered alone (ES = 0.28), but medium when combined with psychosocial rehabilitation (ES = 0.59).

Cognitive compensatory approaches are a complementary approach to cognitive remediation, for reducing functional disability.[8–12] Compensatory interventions are delivered as stand-alone treatments, in combination with, or as part of cognitive remediation and/or psychosocial interventions, with the primary target of improved community functioning. While cognitive remediation is based on a restorative model that attempts to reduce or eliminate impaired cognition, compensatory techniques aim to compensate for, or circumvent cognitive deficit, with reliance on intact cognitive skills and strategies and supports for working *around* cognitive deficits.[13,14] The broadest conception of compensatory approaches encompasses one or more of the following techniques: (1) internal self-management strategies, (2) external strategies/environmental modification, and (3) errorless learning.[12–17] Internal self-management strategies are taught to facilitate more efficient cognitive processing during task performance,[17–20] such as self-talk during task completion, paraphrasing instructions, using mental imagery or "chunking" information according to categorical relationships to aid memory.[20–23] External strategies or environmental modification involve the use of a physical system of compensation to help reduce cognitive load and guide goal-directed behavior.[17,20,21,24] External/environmental strategies may be applied by the individual themselves, such as using a diary, calendar, or checklist to support memory and organization.[10,20–23] Alternatively, they can be implemented by a third party (eg, therapist, caregiver, employer, vocational specialist) in order to direct a person's attention and prompt goal-directed behavior at the appropriate time, such as using signs, alarms, text messaging, or reorganizing items in one's home/workspace.[10,25] Errorless learning is used to compensate for learning deficits where there is difficulty distinguishing between correct performances and mistakes, even after feedback.[26–28] Typically, a trainer prevents the individual from experiencing errors while learning a specific task (eg, card filing at work), so that only correct responses are allowed.[27]

Research into cognitive compensatory strategies for severe mental illness (SMI) emerged in the late 1990s,[29] with growing evidence from randomized controlled trials (RCTs) indicating that compensatory approaches are effective for improving a range of functional outcomes in schizophrenia.[10,20,30] Teaching and application of compensatory strategies are likely to lead to functional improvements because they are directly tied to an individual's functional goals.[31,32] Other factors may also be important to achieve improvements in functioning including enhanced motivation or self-efficacy following successful strategy use or the nonspecific therapeutic effects of engaging with a supportive therapist.[33,34] Seeing a relationship between compensatory strategy use and functional success may enhance metacognitive awareness, which may further enhance functioning. Evidence suggests that cognitive compensatory interventions may also be effective for reducing symptoms of psychosis.[35] Symptom improvements may occur through supporting an individual to engage more effectively with pharmacological and psychological therapies and through enhanced opportunities for masterful engagement in daily activities. However, there has not been a systematic review synthesizing the existing cognitive compensation research. Furthermore, there is currently little understanding as to the durability of treatment effects and whether improvements are seen on clinical outcomes such as symptoms. Individual and treatment moderators of outcome are also not well understood[36] (eg, completely compensatory approaches vs compensatory interventions that are provided in combination with other approaches, such as cognitive remediation, individual vs group approach, and treatment dose [partially compensatory]). There is therefore a need to synthesize the available evidence in this field to better inform treatment recommendations and future research.

The aim of this systematic review and meta-analysis was to: (1) review the range of compensatory interventions that have been implemented in psychotic disorders; (2) examine the impact of compensatory interventions on functional outcomes and symptoms in psychosis; and (3) explore patient- and intervention-specific moderators of treatment outcome.

## Methods

### *Search Strategy*

The systematic review and meta-analysis were preregistered with PROSPERO (CRD42016046176) and conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.[37] PsycINFO and Medline electronic databases were searched from inception to October 18, 2018. Search terms used included: *schizophrenia, schizoaffective, psychosis, psychotic, schizophreniform, delusional disorder* 'AND' *compensa*, adapt*, environmental adj2 support*, environmental adj2 adaptation (NOT cognitive remediation)* 'AND' *cognit*, cognit* adj2 impairment*, cognit*adj2 deficit*, neurocognitive.* A manual search of

the reference lists of included papers and relevant reviews detected in the search,[11,13,38–40] was conducted to identify additional papers for inclusion.

### *Screening and Selection Criteria*

All papers were double-screened in author pairs. Screening occurred in three phases with discrepancies resolved by consensus. In phase 1, titles and abstracts were screened for eligibility. Papers were retained if participants had a psychotic disorder or SMI (including psychosis, major depressive disorder, and bipolar disorder) and there was a focus on cognition and use of compensatory strategies. In phase 2, relevant full text articles were comprehensively reviewed for eligibility according to the following inclusion criteria: (*a*) written in English; (*b*) peer-reviewed; (*c*) original empirical study; (*d*) participants had a diagnosis of psychotic disorder or were reported by the authors to have SMI, with any diagnostic assessment method permitted; (*e*) the study investigated the efficacy of a cognitive compensatory intervention or an intervention that explicitly included a compensatory component (as defined in the Introduction section) compared with a control condition within a RCT; (*f*) the primary or co-primary outcome was functioning (eg, capacity- or performance-based measures of vocational, social, or everyday living domains). Phase 3 screening involved identifying papers with overlapping samples to ensure that the final set of papers included independent samples. When this was unclear, the authors were contacted for confirmation. Overlapping studies were not excluded if the study reported a later follow-up period.

### *Data Extraction and Assessment of Risk of Bias*

Data were independently extracted from all included papers in duplicate among four authors (K.V., K.A., E.P., S.B.). Data extracted included: location/year of the study; premorbid, demographic, clinical, and treatment characteristics of the sample; complete description of the interventions (including comparison interventions); and outcome measures. When means and standard deviations of functioning and symptom measures were not reported, authors were contacted to obtain this information. Each paper was independently assessed for risk of bias in duplicate among four authors (K.V., K.A., E.P., S.B.) using the Cochrane Collaboration's risk of bias tool.[41] Specifically, each study was assessed for random sequence generation method, allocation concealment, blinding of participants and assessors, methods of addressing incomplete outcome data, and potential selective reporting. For the domain of "other potential sources of bias," the independence of the investigators (from those who developed the intervention) and intervention fidelity were evaluated. Discrepancies at all stages of the review were resolved via discussion between the authors.

### *Data Synthesis and Analysis*

Data were analyzed using Comprehensive Meta-Analysis Software version 3 (Biostat, Inc., Englewood, NJ, 2014). Effect sizes (Hedge's *g*) were calculated by using post-intervention mean, *SD*, and *N*[42] to produce a single summary estimate using the random-effects model with 95% CIs. For studies that reported on more than one outcome measure of functioning, the average change across all measures was computed and used in the pooled analysis. For studies that had more than one group receiving cognitive compensatory approaches, these were treated as independent samples and separately included in the meta-analysis and the control group was split ensuring the *N* of the control was not double-counted. To assess the heterogeneity among study point estimates, the *Q* statistic was calculated with the magnitude of heterogeneity evaluated using the $I^2$ statistic (a measure of the proportion of variance in the summary effect size that is attributable to heterogeneity). $I^2$ indicates the percentage of total variation across studies due to heterogeneity rather than chance, with $I^2$ values of 25%, 50%, and 75% considered to represent low, moderate, and high heterogeneity, respectively. Publication bias was assessed by visually inspecting funnel plots. Orwin's[43] fail-safe number (FSN) was computed to generate the number of unpublished studies required to move estimates to a nonsignificant threshold (set at <0.1). Subgroup analyses were conducted to examine the influence of intervention type (completely or partially compensatory), treatment delivery mode (individual or group), and compensatory methods (errorless learning or external strategies/environmental modification or internal self-management + external/environmental strategies) on the overall treatment effect. Meta-regression was used to investigate whether intervention length and dosage and participant age moderated the outcome. Age was examined because it was previously shown to be associated with response to various forms of cognitive rehabilitation[44–47] and as it is correlated with length of illness it could be a proxy for illness chronicity. Other moderators were not examined as cognitive functioning and education were not reported in a sufficient number of studies, diagnosis was reported inconsistently, and gender has not been shown to moderate cognition rehabilitation outcomes. To examine the impact of the risk of bias on treatment outcome, sensitivity analyses were conducted by excluding studies of unclear or high risk of bias in separate analyses.

## Results

### *Study Selection and Characteristics*

The literature search and screening led to the inclusion of 26 RCTs, comprising 25 independent samples, with one of the studies separately reporting long-term follow-up findings[48] (supplementary figure 1). All studies were published from the year 2000 onwards. Studies

were conducted in the United States, Canada, Denmark, Germany, Switzerland, Austria, and Brazil. The sample sizes ranged from 17 to 156. The mean age of participants across the 25 samples was 38.9 years (range 24.9–53.6 years). The percentage of males across studies ranged from 30% to 85%, with males outnumbering females overall (64% male). As per the inclusion criteria, all studies included individuals with psychosis or SMI. Ten studies reported on the proportion of participants with schizophrenia, which was 70% on average. With the exception of one study that involved inpatients,[19] all remaining RCTs involved outpatients. Further details of the included RCTs are shown in table 1.

### *Compensatory Interventions*

The details of the various compensatory interventions investigated in the included RCTs are presented in table 2 and supplementary table 1. Twelve of the 25 studies investigated only a compensatory intervention (ie, completely compensatory); 12 of the studies were considered partially compensatory because they evaluated compensatory interventions in combination with other approaches, such as cognitive remediation, social skills training, cognitive behavioural therapy (CBT), or supported employment; and one four-arm study compared a completely compensatory intervention, a partially compensatory intervention, and two non-compensatory interventions.[35] In 15 out of 25 studies, the compensatory intervention was delivered individually, and in 9 studies in a group format (one study did not report delivery format).[49] The length of interventions varied widely from several hours[50] to 22 months.[31] Some studies also provided "follow-along" compensatory strategies as needed throughout the follow-up period (up to 36 months).[18,23,51]

Supplementary table 1 shows the type and number of cognitive compensatory methods employed within each study according to our previously defined categories. The most common approach used was external strategies and environmental modification, evident in one or more treatment arms of 20 out of 25 studies. The second most common approach was internal self-management strategies, implemented in 10 out of 25 studies. Finally, errorless learning was employed in 6 of the 25 studies. Fifteen studies used only one type of compensatory approach, 9 used two approaches, and 1 study used all three approaches in one of the intervention arms.[19]

### *Meta-Analysis Results*

*Meta-Analysis of Functional Outcome*. Twenty-six studies (reporting 25 independent RCTs) involving a total of 1654 individuals with psychosis or SMI were pooled in the primary meta-analysis examining the effect of cognitive compensatory interventions ($N = 919$) on functional outcomes at post-intervention compared with a control condition ($N = 735$). Measurement of functional outcome was highly variable ranging from specific to global measures, including medication adherence, employment variables, functional skills/capacity, and clinician-rated global functioning and disability (see table 1). A medium effect significantly favoring compensatory approaches was found ($k = 30$, Hedge's $g = 0.46$, 95% CI = 0.33, 0.60, $P < .001$; figure 1). There was moderate heterogeneity ($Q = 47.06$, $P = .02$, $I = 38.38\%$). Eleven studies examined follow-up functioning, with follow-up periods ranging from 2.5[30] to 36 months[48] (median = 6; mean = 8.9; $SD = 9.9$). There was a significant small-to-moderate effect favoring compensatory approaches over control conditions, indicating relative durability of effects over follow-up ($k = 13$, Hedge's $g = 0.36$, 95% CI = 0.19, 0.54, $P < .001$; $Q = 16.17$, $P = .18$, $I^2 = 25.79\%$) (supplementary figure 2). There was no evidence of publication bias on funnel plots and Orwin's FSN was 100 and 35 for post-intervention and follow-up functioning, respectively.

We next examined whether the intervention type and participant mean age were related to the functioning outcomes. Subgroup analysis found no significant impact on the magnitude of the effect on functioning when the meta-analysis was based on whether the intervention was partially or completely compensatory, delivered individually or in a group, or the specific types of compensatory methods used (supplementary table 2).

Meta-regression analyses found no significant relationship between mean age of included participants at baseline ($z = 0.56$, $P = 0.57$), nor dosage (total minutes) of the compensatory intervention ($z = -0.31$, $P = 0.76$), on the effect on functioning. However, longer duration of the intervention (total weeks) was associated with significantly larger effects of compensatory interventions on functioning ($z = 2.11$, $P = 0.04$). When the two outlying studies with the longest follow-up were removed,[52,53] this effect became nonsignificant ($z = 0.38$, $P = 0.70$).

*Meta-Analysis of Negative Symptoms*. Compensatory approaches were associated with significant small improvements in negative symptoms ($k = 17$, Hedge's $g = -0.24$, 95% CI = −0.44, −0.03, $P = .02$). There was moderate heterogeneity ($Q = 36.04$, $P < .001$, $I^2 = 56.05\%$; figure 2). The effect for reduced negative symptoms was lost at follow-up ($k = 6$, Hedge's $g = 0.12$, 95% CI = −0.13, 0.37, $P = .338$; $Q = 7.57$, $P = .18$, $I^2 = 33.92\%$; supplementary figure 3). Subgroup analysis found no impact on the magnitude of the effect on negative symptom outcomes based on whether the intervention was partially or completely compensatory, delivered individually or in a group, or the specific types of compensatory methods used (supplementary table 2). There was no evidence of publication bias (Orwin's FSN = 22).

*Meta-Analysis of Positive Symptoms*. Compensatory approaches were also associated with significant small improvements in positive symptoms ($k = 22$, Hedge's $g = -0.24$, 95% CI = −0.38, −0.10, $P < .001$; figure 3).

**Table 1.** Sample and Functioning Measure Characteristics of RCTs Included in the Meta-Analysis

| Study (First Author, Year) | Country of Study | Total *N* | Age, Mean (SD) | Sex, % Male | Recruited Sample (% SZ Diagnosis, if Reported) | Functioning Outcome Measure(s) | Longest Length of Follow-up Post Intervention |
|---|---|---|---|---|---|---|---|
| Christensen, 2014 | Denmark | 117 | 24.95 (3.5) | 54 | FEP (84) | UPSA-B total | 8 months |
| Granholm, 2007 | USA (CA) | 70 | 53.60 (NR) | 79 | SZ/SZA | UPSA total, ILSS total composite | 12 months |
| Grant, 2012 | USA (PA) | 60 | 38.4 (11.6) | 67 | SZ/SZA (80) | GAS | - |
| Hansen, 2012 | Denmark | 62 | 33.0 (10.87) | 65 | FEP (100) | CANAS, GAF, HoNOS | 3 months |
| Kern, 2002 | USA (CA) | 65 | 41.02 (10.7) | 74 | SZ/SZA | Index card filing and toilet tank: accuracy, productivity, speed | 3 months |
| Kern, 2005 | USA (CA) | 60 | 43.57 (10.76) | 72 | SZ/SZA | AIPSS processing, receiving, sending | 3 months |
| Kern, 2009 | USA (CA) | 40 | 47.55 (10.81) | 30 | SZ/SZA | WBI | 10 weeks |
| Kern, 2018 | USA (CA) | 58 | 41.69 (NR) | 85 | SZ/SZA | Competitive employment duration, WBI | — |
| Kidd, 2018 | Canada | 17 | 31.81 (9.84) | 65 | SZ/SZA | BARS, MCAS (caregiver, patient) | — |
| McGurk, 2005[a] | USA (NY) | 44 | 37.6 (9.9) | 55 | SMI (73) | Competitive employment: hours, jobs, weeks | 12 months |
| McGurk, 2007[a] | USA (NY) | 44 | 37.6 (9.9) | 55 | SMI (73) | Competitive employment: hours, jobs, week | 36 months |
| McGurk, 2009 | USA (NY) | 34 | 44.06 (9.22) | 59 | SMI (62) | Competitive employment/ Internship: hours, weeks, | 36 months |
| McGurk, 2015 | USA (IL & NH) | 107 | 44.07 (11.04) | 65 | SMI (23) | Competitive employment: hours, jobs, weeks, duration of first job | 24 months |
| McGurk, 2016 | USA (NY) | 54 | 37.69 (9.46) | 70 | SMI; 83% SZ/SZA | Competitive employment: hours, jobs, weeks, duration of first job | 36 months |
| Mendella, 2015 | Canada | 27 | 24.9 (3.4) | 74 | FEP | UPSA-B total | — |
| Mueller, 2015 | Switzerland, Germany, & Austria | 156 | 34.22 (8.61) | 69 | SZ/SZA | GAF | 6 months |
| Twamley, 2012 | USA (CA) | 69 | 46.32 (9.76) | 65 | Primary psychotic disorder (54) | UPSA, SSPA | 3 months |
| Twamley, 2019 | USA (CA) | 153 | 43.7 (11.69) | 57 | SMI; 38% SZ/SZA | UPSA-B, SSPA, ILSS | — |
| Vauth, 2005 | Germany | 138 | 28.8 (7.1) | 65 | SZ | Successful job placement | — |
| Velligan, 2000 | USA (TX) | 45 | 37.12 (8.99) | 76 | SZ/SZA (84) | GAF, MCAS | — |
| Velligan, 2002 | USA (TX) | 45 | 39.64 (7.82) | 64 | SZ/SZA (69) | GAF, MCAS, SOFAS | — |
| Velligan, 2008a | USA (TX) | 120 | 41 (9.1) | 50 | SZ/SZA | Pill count (compliance), SOFAS | — |
| Velligan, 2008b | USA (TX) | 105 | 39 (10.7) | 57 | SZ/SZA | MCAS, SOFAS | 6 months |
| Velligan, 2013 | USA (TX) | 142 | 42.52 (10.27) | 53 | SZ/SZA | MM-based adherence, SOFAS | — |
| Velligan, 2015 | USA (TX) | 142 | 40.6 (11.8) | 52 | SZ/SZA | MCAS | 15 months |
| Vizzotto, 2016 | Brazil | 29 | 38.62 (NR) | 83 | SZ | DAFS-R Total, ILSS | — |

*Note*: AIPSS, Assessment of Interpersonal Problem-Solving Skills; BARS, Brief Adherence Rating Scale; CANAS, Camberwell Assessment of Need; DASF-R, Direct Assessment of Functional Status-Revised; GAF, Global Assessment of Function; GAS, Global Assessment Scale; HoNOS, Health of the Nation Outcome Scale; ILSS, Independent Living Skill Survey; MCAS, Multnomah Community Ability Scale; MM, Med-eMonitor; NR, Not Reported; SMI, Severe mental illness; SOFAS, Social and Occupational Functioning Assessment Scale; SSPA, Social Skills Performance Assessment; SZ, Schizophrenia; SZA, Schizoaffective disorder; UPSA, UCSD Performance-based Skills Assessment; UPSA-B, UCSD Performance-based Skills Assessment-Brief; WBI, Work Behaviour Index.
[a]McGurk, 2007 is a follow-up of McGurk, 2005.

There was low heterogeneity ($Q = 28.40$, $P = .13$, $I^2 = 26.05\%$). This effect for positive symptoms was maintained at follow-up ($k = 10$, Hedge's $g = -0.19$, 95% CI = −0.36, −0.03, $P = .02$; $Q = 4.35$, $P = .89$, $I^2 = 0.00\%$; supplementary figure 4). Subgroup analysis found that positive symptom outcome did not significantly differ based on whether the intervention was partially or completely compensatory, delivered individually or in a group, or the specific types of compensatory methods used (supplementary table 2). There was no evidence of publication bias (Orwin's FSN = 32).

**Table 2.** Characteristics of Compensatory, Adjunctive and Control Interventions of RCTs Included in the Meta-Analysis

| Study (First Author, Year) | Completely or Partially Compensatory | Intervention Name | Specific Compensatory Elements | Additional Intervention Components (if Applicable) | Individual or Group Delivery | Total Length of Intervention (weeks) | Total Dose[a] (min) | Manualized (Yes/No) | Control Condition |
|---|---|---|---|---|---|---|---|---|---|
| Christensen, 2014 | Partially | NEUROCOM | External strategies/ environmental modification; errorless learning | Cognitive remediation; competence dialogs (to increase motivation and bridge training to functioning); OPUS early intervention services (eg, medication, social skills training and psychoeducation) | Individual | 16 | 2280 | No | OPUS early intervention services alone (TAU) |
| Granholm, 2007 | Partially | CBSST | External strategies/ environmental modification | Social skills training; CBT skills | Group | 24 | 2880 | Yes | TAU |
| Grant, 2012 | Partially | Cognitive Therapy | External strategies/ environmental modification | CBT skills | Individual | 78 | 3900 | Yes | TAU |
| Hansen, 2012 | Partially | CAT | External strategies/ environmental modification | ACT | Individual | 24 | NR | No[d] | ACT alone |
| Kern, 2002 | Completely | Errorless Learning | Errorless Learning | — | Group | 1 | 45–60 | Yes | Conventional instruction |
| Kern, 2005 | Completely | Errorless Learning | Errorless Learning | — | Group | NR (6 hours / 2 days) | 360 | Yes | Symptom management |
| Kern, 2009 | Completely | Errorless Learning | Errorless Learning | — | Individual | 2 | 30–40 | Yes | Conventional instruction and work experience |
| Kern, 2018 | Partially | Errorless Learning | Errorless Learning | Supported employment | NR | NR | NR | Yes | Supported employment alone |
| Kidd, 2018 | Completely | Family CAT | External strategies/ environmental modification | — | Individual | NR | NR | Yes | Family support-manual alone |
| McGurk, 2005, 2007 | Partially | TSW | Internal self-management strategies; External strategies/ environmental modification | Cognitive remediation; supported employment | Individual | NR[b] | NR[b] | No | Supported employment alone |
| McGurk, 2009 | Partially | TSW | Internal self-management strategies; External strategies/ environmental modification | Cognitive remediation; vocational rehabilitation | Group | NR[b] | NR[b] | No | Vocational rehabilitation alone |

**Table 2.** *Continued*

| Study (First Author, Year) | Completely or Partially Compensatory | Intervention Name | Specific Compensatory Elements | Additional Intervention Components (if Applicable) | Individual or Group Delivery | Total Length of Intervention (weeks) | Total Dose[a] (min) | Manualized (Yes/No) | Control Condition |
|---|---|---|---|---|---|---|---|---|---|
| McGurk, 2015 | Partially | TSW | Internal self-management strategies; External strategies/ environmental modification | Cognitive remediation; enhanced supported employment | Individual | NR[b] | 1686[c] | Yes | Enhanced supported employment alone |
| McGurk, 2016 | Partially | TSW | Internal self-management strategies; External strategies/ environmental modification | Cognitive remediation; enhanced vocational rehabilitation | Individual | NR[b] | NR[b] | Yes | Enhanced vocational rehabilitation alone |
| Mendella, 2015 | Completely | CCT | Internal self-management strategies; External strategies/ environmental modification | — | Group | 12 | 2880 | Yes | TAU |
| Mueller, 2015 | Partially | INT | Internal self-management strategies; External strategies/ environmental modification | Cognitive remediation | Group | 15 | 2700 | Yes | TAU |
| Twamley, 2012 | Completely | CCT | Internal self-management strategies; External strategies/ environmental modification | — | Group | 12 | 1440 | Yes | TAU |
| Twamley, 2019 | Partially | CCT | Internal self-management strategies; External strategies/ environmental modification | Supported employment | Individual | 12 | 720 | Yes | Supported employment alone |
| Vauth, 2005 | Partially | CAST | Internal self-management strategies; External strategies/ environmental modification; errorless learning | Cognitive remediation; vocational rehabilitation | Group | 8 | 1440 | NR | Vocational rehabilitation alone |
| | Partially | TSSN | External strategies/ environmental modification; errorless learning | Motivational techniques; training in emotional management and communication; vocational rehabilitation | Group | 8 | 1440 | NR | |
| Velligan, 2000 | Completely | CAT | External strategies/ environmental modification | — | Individual | 36 | NR | Yes | 1) TAU; 2) TAU plus adaptions unrelated to cognition or functioning |

**Table 2.** *Continued*

| Study (First Author, Year) | Completely or Partially Compensatory | Intervention Name | Specific Compensatory Elements | Additional Intervention Components (if Applicable) | Individual or Group Delivery | Total Length of Intervention (weeks) | Total Dose[a] (min) | Manualized (Yes/No) | Control Condition |
|---|---|---|---|---|---|---|---|---|---|
| Velligan, 2002 | Completely | CAT | External strategies/ environmental modification | — | Individual | 36 | 1080 | Yes | 1) TAU; 2) TAU plus adaptions unrelated to cognition or functioning |
| Velligan, 2008a | Completely | CAT | External strategies/ environmental modification | — | Individual | 96 | 1530–1800 | Yes | TAU |
| | Completely | GES | External strategies/ environmental modification | — | Individual | 96 | NR | Yes | |
| Velligan, 2008b | Completely | CAT | External strategies/ environmental modification | — | Individual | 36 | 1080–1620 | Yes | TAU |
| | Completely | Pharm-CAT | External strategies/ environmental modification | — | Individual | 36 | 1080–1620 | Yes | |
| Velligan, 2013 | Completely | Pharm-CAT | External strategies/ environmental modification | — | Individual | 36 | 1080 | Yes | TAU |
| | Completely | Med-eMonitor | External strategies/ environmental modification | — | Individual | 84 | NR | Yes | |
| Velligan, 2015 | Completely | CAT | External strategies/ environmental modification | — | Individual | 36 | 2280 | Yes | (1) CBT for psychosis alone and (2) TAU |
| | Partially | CAT | External strategies/ environmental modification | CBT for psychosis | Individual | 36 | 2280 | Yes | |
| Vizzotto, 2016 | Completely | Occupational Goal Intervention | Internal self-management strategies | — | Group | 15 | 2700 | NR | Craft activities |

*Note*: NR, not reported; TAU, treatment as usual; CBSST, Cognitive Behavioural Social Skills Training; CBT, Cognitive Behavioural Therapy; CAT, Cognitive Adaptation Training; ACT, Assertive Community Treatment; TSW, Thinking Skills for Work; CCT, Compensatory Cognitive Training; TSSN, Training of self-management skills for negative symptoms; CAST, Computer Assisted cognitive Strategy Training, INT, Integrated Neurocognitive Therapy; GES, Generic Environmental supports.

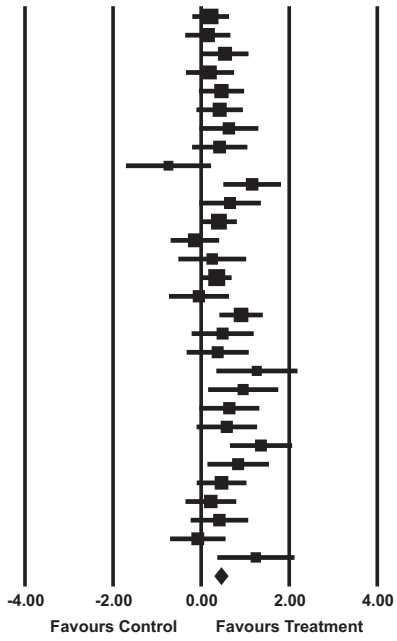
[a]Calculated as the total number of treatment sessions multiplied by session length.

[b]Only length and exposure to cognitive remediation component described.

[c]Calculated using the mean reported contact with the cognitive specialist.

[d]Delivered an adapted version of CAT.

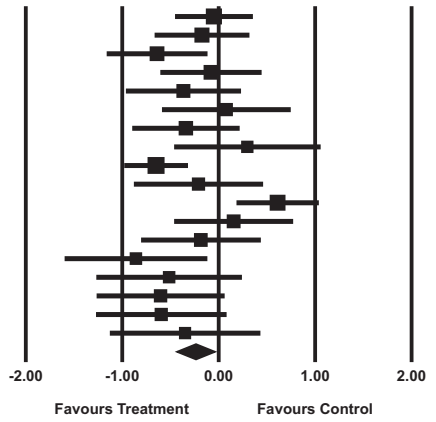
| Study name | Outcome | Hedges's g | Standard error | Variance | Lower limit | Upper limit | Z-Value | p-Value |
|---|---|---|---|---|---|---|---|---|
| Christensen (2014) | UPSA-B total | 0.217 | 0.201 | 0.040 | -0.177 | 0.611 | 1.080 | 0.280 |
| Granholm (2007) | Combined | 0.151 | 0.251 | 0.063 | -0.341 | 0.643 | 0.602 | 0.547 |
| Grant (2012) | GAS | 0.544 | 0.260 | 0.068 | 0.034 | 1.054 | 2.092 | 0.036 |
| Hansen (2012) | Combined | 0.200 | 0.268 | 0.072 | -0.325 | 0.725 | 0.746 | 0.456 |
| Kern (2002) | Combined | 0.462 | 0.250 | 0.063 | -0.028 | 0.952 | 1.848 | 0.065 |
| Kern (2005) | Combined | 0.421 | 0.258 | 0.067 | -0.085 | 0.927 | 1.632 | 0.103 |
| Kern (2009) | WBI | 0.630 | 0.330 | 0.109 | -0.017 | 1.277 | 1.909 | 0.056 |
| Kern (2018) | Combined | 0.421 | 0.309 | 0.095 | -0.185 | 1.027 | 1.362 | 0.173 |
| Kidd (2018) | Combined | -0.742 | 0.482 | 0.232 | -1.687 | 0.203 | -1.539 | 0.124 |
| McGurk (2005) | Combined | 1.159 | 0.322 | 0.104 | 0.528 | 1.790 | 3.599 | 0.000 |
| McGurk (2009) | Combined | 0.658 | 0.345 | 0.119 | -0.018 | 1.334 | 1.907 | 0.056 |
| McGurk (2015) | Combined | 0.406 | 0.195 | 0.038 | 0.024 | 0.788 | 2.082 | 0.037 |
| McGurk (2016) | Combined | -0.142 | 0.269 | 0.072 | -0.669 | 0.385 | -0.528 | 0.598 |
| Mendella (2015) | UPSA-B total | 0.252 | 0.381 | 0.145 | -0.495 | 0.999 | 0.661 | 0.508 |
| Mueller (2015) | GAF | 0.354 | 0.161 | 0.026 | 0.038 | 0.670 | 2.199 | 0.028 |
| Twamley (2012) | Combined | -0.049 | 0.336 | 0.113 | -0.708 | 0.610 | -0.146 | 0.884 |
| Twamley (2019) | Combined | 0.908 | 0.240 | 0.058 | 0.438 | 1.378 | 3.783 | 0.000 |
| Vauth (2005-1) | Job Placement | 0.489 | 0.348 | 0.121 | -0.193 | 1.171 | 1.405 | 0.160 |
| Vauth (2005-2) | Job Placement | 0.376 | 0.348 | 0.121 | -0.306 | 1.058 | 1.080 | 0.280 |
| Velligan (2000) | Combined | 1.266 | 0.458 | 0.210 | 0.368 | 2.164 | 2.764 | 0.006 |
| Velligan (2002) | Combined | 0.954 | 0.395 | 0.156 | 0.180 | 1.728 | 2.415 | 0.016 |
| Velligan (2008-a1) | Combined | 0.642 | 0.335 | 0.112 | -0.015 | 1.299 | 1.916 | 0.055 |
| Velligan (2008-a2) | Combined | 0.584 | 0.339 | 0.115 | -0.080 | 1.248 | 1.723 | 0.085 |
| Velligan (2008-b1) | Combined | 1.360 | 0.349 | 0.122 | 0.676 | 2.044 | 3.897 | 0.000 |
| Velligan (2008-b2) | Combined | 0.842 | 0.345 | 0.119 | 0.166 | 1.518 | 2.441 | 0.015 |
| Velligan (2013-1) | Combined | 0.464 | 0.276 | 0.076 | -0.077 | 1.005 | 1.681 | 0.093 |
| Velligan (2013-2) | Combined | 0.220 | 0.283 | 0.080 | -0.335 | 0.775 | 0.777 | 0.437 |
| Velligan (2015-1) | MCAS | 0.416 | 0.322 | 0.104 | -0.215 | 1.047 | 1.292 | 0.196 |
| Velligan (2015-2) | MCAS | -0.075 | 0.310 | 0.096 | -0.683 | 0.533 | -0.242 | 0.809 |
| Vizzotto (2016) | Combined | 1.243 | 0.435 | 0.189 | 0.390 | 2.096 | 2.857 | 0.004 |
| | | 0.461 | 0.069 | 0.005 | 0.327 | 0.596 | 6.709 | 0.000 |




Meta Analysis

**Fig. 1.** Primary meta-analysis forest plot: compensatory intervention vs control at post-intervention, functional outcome.

| Study name | Outcome | Hedges's g | Standard error | Variance | Lower limit | Upper limit | Z-Value | p-Value |
|---|---|---|---|---|---|---|---|---|
| Christensen (2014) | PANSS-Negative | -0.050 | 0.201 | 0.040 | -0.443 | 0.344 | -0.247 | 0.805 |
| Granholm (2007) | PANSS-Negative | -0.173 | 0.246 | 0.060 | -0.655 | 0.308 | -0.705 | 0.481 |
| Grant (2012) | SANS-Negative | -0.638 | 0.262 | 0.068 | -1.151 | -0.125 | -2.439 | 0.015 |
| Hansen (2012) | PANSS-Negative | -0.080 | 0.262 | 0.069 | -0.595 | 0.434 | -0.306 | 0.760 |
| McGurk (2005) | PANSS-Negative | -0.365 | 0.299 | 0.089 | -0.951 | 0.221 | -1.222 | 0.222 |
| McGurk (2009) | PANSS-Negative | 0.079 | 0.336 | 0.113 | -0.578 | 0.737 | 0.237 | 0.813 |
| McGurk (2016) | PANSS-Negative | -0.340 | 0.279 | 0.078 | -0.887 | 0.207 | -1.218 | 0.223 |
| Mendella (2015) | PANSS-Negative | 0.297 | 0.382 | 0.146 | -0.451 | 1.046 | 0.779 | 0.436 |
| Mueller (2015) | PANSS-Negative | -0.649 | 0.164 | 0.027 | -0.969 | -0.328 | -3.964 | 0.000 |
| Twamley (2012) | PANSS-Negative | -0.209 | 0.336 | 0.113 | -0.869 | 0.450 | -0.622 | 0.534 |
| Twamley (2019) | PANSS-Negative | 0.611 | 0.212 | 0.045 | 0.195 | 1.028 | 2.878 | 0.004 |
| Vauth (2005-1) | Combined | 0.156 | 0.309 | 0.096 | -0.451 | 0.762 | 0.502 | 0.615 |
| Vauth (2005-2) | Combined | -0.184 | 0.312 | 0.097 | -0.795 | 0.427 | -0.591 | 0.555 |
| Velligan (2000) | NSA-Total | -0.857 | 0.372 | 0.138 | -1.587 | -0.128 | -2.304 | 0.021 |
| Velligan (2002) | Combined | -0.514 | 0.380 | 0.144 | -1.259 | 0.231 | -1.352 | 0.176 |
| Velligan (2008-a1) | NSA-Motivation subscale | -0.602 | 0.333 | 0.111 | -1.255 | 0.052 | -1.805 | 0.071 |
| Velligan (2008-a2) | NSA-Motivation subscale | -0.595 | 0.340 | 0.116 | -1.262 | 0.071 | -1.750 | 0.080 |
| Vizzotto (2016) | PANSS-Negative | -0.348 | 0.393 | 0.154 | -1.118 | 0.421 | -0.887 | 0.375 |
| | | -0.235 | 0.099 | 0.010 | -0.428 | -0.042 | -2.383 | 0.017 |




Meta Analysis

**Fig. 2.** Meta-analysis forest plot: compensatory intervention vs control at post-intervention, negative symptoms.

*Meta-Analysis of Depressive and General Symptoms*. Fewer studies examined depressive and general symptom outcomes. Relative to control interventions, compensatory interventions were associated with significant improvements in general symptoms post-intervention ($k = 5$, Hedge's $g = -0.31$, 95% CI = −0.55, −0.07, $P = .01$, $Q = 1.88$, $P = .76$, $I^2 = 0.00\%$), but not depressive symptoms ($k = 6$, Hedge's $g = -0.17$, 95% CI = −0.37, 0.04, $P = .11$; $Q = 3.44$, $P = 0.63$, $I^2 = 0.00\%$) (supplementary figures 5 and 6).

*Risk of Bias of RCTs and Sensitivity Analyses*. The risk of bias assessments within and across the 25 RCTs is displayed in supplementary figure 7 (group-level) and supplementary table 3 (study-level). There was no evidence of reporting bias across the 25 trials. In contrast, selection bias (ie, insufficient random sequence generation and

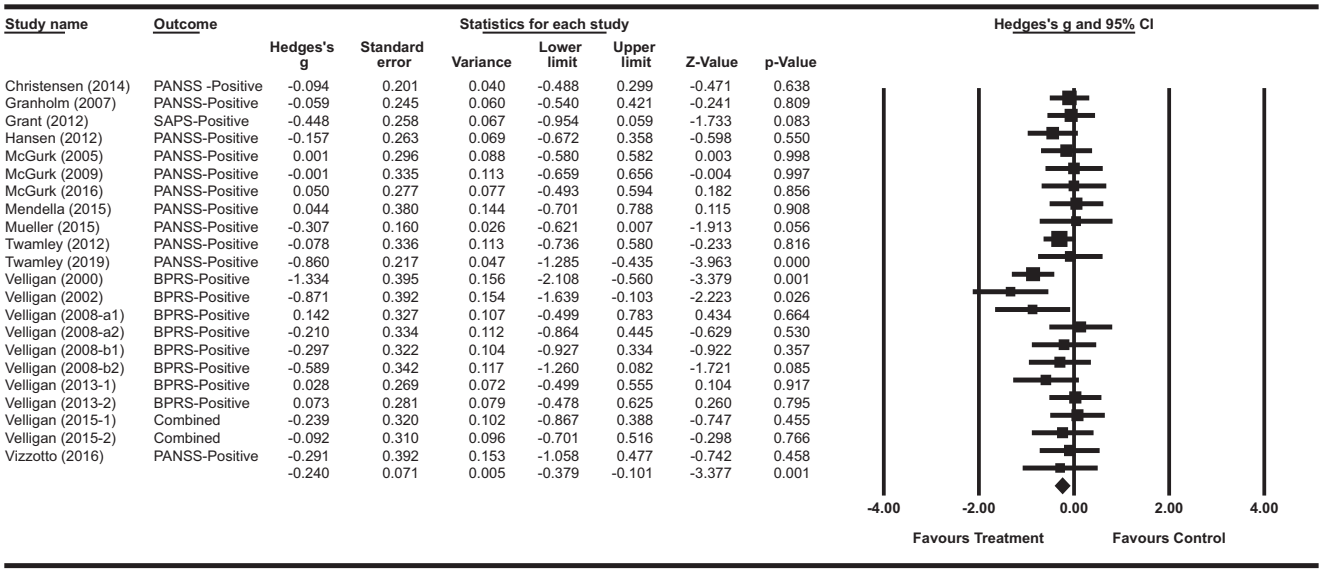



**Fig. 3.** Meta-analysis forest plot: compensatory intervention vs control at post-intervention, positive symptoms.

allocation concealment) was present or could not be ruled out in up to 40% of trials; detection bias (ie, insufficient blinding of outcome assessment) was present or could not be ruled out in 12% of trials; and attrition bias (eg, high or unequal dropout) was present or could not be ruled out in 24% of trials. As is often unavoidable in RCTs of psychosocial interventions, 100% of trials had evidence of performance bias (ie, participants and clinicians were not blind to treatment allocation). Finally, 96% had evidence of other bias, primarily because investigators were the developers of the interventions being trialed or treatment fidelity was not conducted or reported.

Separate sensitivity subgroup analyses on post-intervention functioning, including only studies that were rated as low risk in relation to selection bias (random sequence generation, allocation concealment), detection bias (blinded outcome assessment), and attrition bias did not alter the findings (supplementary table 4). When we removed studies high on risk for allocation concealment and random sequence generation heterogeneity was reduced.

## Discussion

This is the first systematic review and meta-analysis on compensatory interventions for cognitive impairment in psychosis. Twenty-six studies from 25 separate RCTs involving 1654 participants were identified and included in the meta-analysis. The most common compensatory techniques used were external strategies/environmental modification, followed by internal self-management strategies, with the least common being errorless learning. Several studies delivered interventions that included more than one type of compensatory approach. The meta-analysis revealed a significant moderate effect of compensatory interventions on functioning outcomes (including medication adherence, employment outcomes, functional capacity, global functioning) at post-intervention and a small-to-moderate effect at follow-up. Compensatory interventions also had significant small effects on negative, positive, and general symptomatology post-intervention, with durability of effects on positive symptoms. While there was no indication of publication bias, heterogeneity was evident, which was somewhat reduced when studies of high/unclear risk of bias were removed. The findings remained unchanged following sensitivity analysis, supporting conclusions that compensatory interventions yield robust effects.

Compensatory interventions were shown to be beneficial regardless of treatment components (completely/partially compensatory or specific compensatory methods used) and mode of delivery (individual or group). Although longer interventions (total weeks) were associated with larger effects on functioning, this effect was attenuated when the two longest studies were removed. Previous meta-analyses have shown that cognitive remediation combined with psychosocial interventions are associated with larger effects on functioning than cognitive remediation delivered alone.[3,4] Given cognitive remediation focuses on cognitive enhancement, it is not surprising that effects on functioning were smaller when delivered alone, with or without therapist involvement, or opportunities to acquire and practice functioning skills. The current review showed that similar moderate positive effects on functioning are achieved regardless of whether a completely compensatory intervention is delivered or compensatory techniques are delivered in combination with other interventions such as cognitive remediation,

CBT, or supported employment. This suggests that completely compensatory interventions are as effective as combined (partially compensatory) interventions for achieving functional enhancement. However, there are important caveats to this notion that must be considered. There was moderate heterogeneity evident in the findings, which was likely driven in part by the different types of functioning outcomes measured, the different combinations of compensatory and other approaches, and the different types and combinations of compensatory strategies used. Meta-analyses of cognitive remediation have shown that strategy coaching, which involves the supplementation of drill-and-practice with trained facilitation (vs drill-and-practice alone), was associated with stronger effects on cognitive outcomes.[3] RCTs of the Thinking Skills for Work program further suggest that compensatory strategies combined with cognitive remediation are important for boosting the effects of supported employment.[18,22] Our subgroup analysis of the specific compensatory methods used across studies found similar moderate positive effects on functioning post-intervention for errorless learning ($g = 0.47$), external strategies/environmental modification ($g = 0.47$), and internal self-management plus external/environmental strategies ($g = 0.44$).

There was a wide range in dosage of compensatory interventions (30–2880 min [48 h]), but dosage did not moderate functional outcomes. Similarly, treatment dose was not found to be a significant moderator of outcome in previous meta-analyses of cognitive remediation.[3,4] In the current review, tentative evidence suggested that the *duration* of the intervention (weeks) may moderate functioning outcome, such that particularly longer interventions were associated with larger effects on functioning,[52,53] supporting the notion that functional improvements can take time, particularly in individuals with pronounced functional disability.[52] In their meta-analysis of cognitive remediation combined with psychosocial rehabilitation, van Duin et al[5] found that a higher intensity of intervention (hours per week) was associated with a lower employment rate, suggesting that a balance must be struck between the benefits and opportunity costs of cognitive interventions for functional recovery. Our findings suggest that support via compensatory interventions over an extended period of time may be more important than the total dose (and intensity) for improving functioning in psychosis; further investigation of this supposition is required.

It is important to note that a passive control condition, such as treatment-as-usual, or an intervention that was delivered in both groups (eg, supported employment) was utilized in a majority of the included studies. While this does not negate the finding that compensatory interventions are effective, it does make it difficult to disentangle nonspecific factors, such as time with a therapist and therapeutic alliance or non-compensatory elements, from the specific effects of the compensatory components. The use of both passive and active comparison groups is the most rigorous approach to addressing this problem. This has been recommended in the cognitive remediation literature.[3] Only a few RCTs included in the meta-analysis were designed to test the specific effects of compensatory "ingredients" over generic or other types of therapeutic approaches, allowing the detection of incremental or specific effects of each condition. The study by Vauth et al.[19] compared Computer Assisted cognitive Strategy Training (CAST), which included all three types of compensatory methods plus vocational rehabilitation, with Training of Self-management Skills for Negative symptoms (TSSN), which included two compensatory approaches plus vocational rehabilitation, and vocational rehabilitation alone. They found that CAST outperformed the other two groups in terms of successful job placement at a 12-month follow-up. However, CAST also included cognitive remediation, so it remains unclear whether compensatory strategies were a necessary ingredient for the observed effects. Velligan et al have conducted a number of trials that have compared a completely compensatory intervention (eg, Cognitive Adaptation Training [CAT]) against passive and active control conditions.[10,31,35,53–55] The most recent of these was a four-arm trial comparing CAT, CBT for psychosis, CBT plus CAT, and treatment-as-usual. Groups receiving CAT showed the greatest improvements in functioning, suggesting that the compensatory methods employed within CAT rather than general therapeutic involvement, such as that in CBT, produced the improved functional outcomes.[35]

With respect to participant-specific factors that may moderate compensatory intervention outcomes, we found that age was not significantly associated with functional outcomes. Age was also not found to moderate outcomes in meta-analyses of cognitive remediation and psychiatric rehabilitation.[3,5] The mean ages of participants in the current meta-analysis were relatively narrow, ranging from 24 to 53 years, which may have reduced the ability to detect an age-related effect. Further research is needed in younger and older groups before firm conclusions about age can be made. Phase of illness may also be important to consider. A meta-analysis of cognitive remediation in early schizophrenia found that the effects on cognition and functioning were lower[6] than what has been shown in chronic schizophrenia.[3] In the current review, only two RCTs included people with first-episode psychosis and both found nonsignificant improvements in functioning (measured by the University of California San Diego Performance-based Skills Assessment [UPSA-B]) post intervention.[56,57] Thus, further work is needed to confirm whether phase of illness is an important consideration with respect to both outcomes and functioning target.

Another participant-specific factor that may be important in selecting suitable candidates for compensatory interventions is baseline level of cognition or functioning. We were unable to examine whether baseline

cognition was a moderator as it was not consistently reported in studies; functioning could not be assessed as a moderator because the functioning measures used across studies were too variable to allow subgroup analyses of specific measures. It could be speculated that those with poorer baseline functioning may have greater potential for improvement following compensatory interventions or are less likely to use compensatory strategies to start with. Indeed, Twamley et al[36] examined predictors of response to Compensatory Cognitive Training (CCT) and found that CCT-associated improvement was greater in those with poorer baseline functioning. Qualitative observations in the pilot study of family CAT by Kidd et al[58] also suggested that lower-functioning individuals may derive greatest benefit. Individuals with lower baseline functioning may therefore have more scope for improvement. Higher levels of positive and negative symptoms at baseline were also associated with greater improvements following CCT, suggesting that active symptoms should not exclude participation in compensatory interventions.[36]

Our findings indicate that compensatory interventions have small effects on positive, negative, and general symptoms of psychosis. Negative symptoms are notoriously difficult to treat, so these findings are encouraging and not inconsequential. Psychological factors such as defeatist beliefs have been found to mediate the relationship between cognition, negative symptoms, and poor functioning in schizophrenia.[33] Perhaps compensatory approaches help individuals focus on goals that are important to them, while providing them with considerable support and opportunities for engaging successfully in daily activities, which may in turn increase motivation and further functional engagement.[31,32,52] As the effects on negative symptoms were lost at follow-up, the role of the therapist in negative symptom improvement may be especially important in maintaining effects. The mechanisms by which compensatory approaches lead to reductions in positive symptoms are not clear. It is possible that enhanced medication compliance through the use of external strategies such as alarms and pillboxes may be one pathway, or that such supports reduce levels of stress.[35,53,54] Nevertheless, research exploring potential mechanisms of symptomatic change following compensatory interventions are still needed.

Few of the included studies examined psychological factors that may mediate response to compensatory interventions. These may include defeatist beliefs, as well as level of insight or self-awareness and other psychological processes such as intrinsic motivation, expectancy, and self-efficacy,[51,59] which have received attention in the cognitive remediation literature,[14] but rarely in the compensatory literature. It could be speculated that training in using internal or external compensatory strategies may be optimized when the individual has awareness of the need to use a strategy and can identify contexts in which the strategy should be used. However, one study showed that poor insight into objective cognitive impairment did not prevent participants from engaging with and benefiting from CCT.[60] Kern et al[61] have suggested that errorless learning may be advantageous because the experience of failure is prevented, with a strong focus on incremental mastery, which may in turn promote self-efficacy. Further, investigation into the mechanisms by which compensatory approaches might improve functional outcome is an important future direction for the field.[13]

The current findings indicate that the effects of compensatory approaches on functioning are durable beyond the intervention phase. However, further work is needed to confirm this finding, as only a subset of studies conducted follow-up assessments and most of these were less than 12 months. In addition to being applied in a conscious and deliberate way, it is possible that with practice and habitual application, some compensatory techniques can lead to desired behaviors that become internalized and automatic. This premise is supported by evidence for more intact implicit relative to explicit memory in schizophrenia.[62–65] Restitution of cognitive function may also play a role in functional gains made following compensatory approaches.[8,66] Most of the RCTs employing completely compensatory approaches did not examine cognitive change, so we were unable to examine whether compensatory approaches were associated with cognitive gains in the current review or whether baseline cognitive level moderated outcome. One recent study indicated cognitive improvements associated with compensatory strategies.[66] We recommend that future trials of compensatory interventions measure cognitive function, even if cognition is not a direct treatment target.

This review has some limitations. First, the compensatory interventions included in this review varied considerably in the type, number, and dose of compensatory strategies used, which may have contributed to the moderate heterogeneity in findings. Furthermore, categorization of the intervention "ingredients" was based on author consensus, but could be considered somewhat subjective. There may be some studies that used compensatory approaches as part of their intervention, but did not describe them as compensatory or in sufficient detail to be identified as such within our search. For example, we did not use the term "strategy coaching" to ensure there was minimal overlap with previous systematic reviews of cognitive remediation. This may have resulted in the exclusion of some relevant studies. The moderate heterogeneity may have also been affected by the wide variability in functioning outcome measures, which prevented a more fine-grained analysis of specific functioning outcomes and moderating effects of baseline functioning. Different functioning outcome measures (eg, competitive employment, functional capacity, global functioning, social functioning, medication adherence, etc.) may vary in their sensitivity to change or response to specific

compensatory approaches. Some outcomes, such as employment, may represent a more significant functional change than a proxy, or other measures of functioning. Studies targeting competitive employment included here used a combined restorative and compensatory strategy approach, leaving open the question of the potential role of restorative vs compensatory practice in these studies.

In conclusion, compensatory interventions for cognitive impairment in psychotic disorders were found to be effective in improving functioning, as well as positive, negative, and general symptoms. The findings also support the durability of effects on functioning and positive symptoms. Longer compensatory interventions were associated with larger improvements in functioning. Risk of bias, intervention type, dose, mode of delivery, and age did not alter the effects observed. Additional research is required to better understand the mechanisms of improvement and who is most likely to benefit from compensatory approaches in order to move the field toward tailored precision-based treatments for functional recovery in psychotic disorders.

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