Subjective and Objective Executive Function in People With Early Schizophrenia or Psychosis Risk

A Clinical Trial of Goal Management Training

Ingvild Haugen

Innlandet Hospital Trust
&
Department of Psychology
Faculty of Social Sciences
University of Oslo

Innlandet Hospital Trust

UNIVERSITY OF OSLO

Series of dissertations submitted to the
Faculty of Social Sciences, University of Oslo
No. 939

ISSN 1504-3991

Print production: Graphics Center, University of Oslo.

Acknowledgements

First and most important, I owe this thesis to the participants who dedicated their time and energy for the benefit of future patients. I learned so much from you during baseline assessments and the GMT-groups we had. I am also very grateful for the opportunity awarded to me to do this work by Innlandet Hospital and the University of Oslo and to Fekjær Psychiatric Centre for co-operating with us on this study.

Principal investigator and main supervisor, Professor Merete Glenne Øie, is a constant source of inspiration with her knowledge, impressive capacity and outstanding ability to always ask the essential question. Thank you, co-supervisor Associate Professor Elisabeth Haug, for teaching me about psychosis, being a great-role model in your clinical work and making sure I look after myself. Thank you, co-supervisor Associate Professor Jan Stubberud, for your GMT expertise and always remembering to also give positive feedback. Thank you, Associate Professor Torill Ueland for your commitment to this project and valuable insights. Thank you Associate Professor Kjell Tore Hovik, Professor Susan R. McGurk and Professor Dame Til Wykes for sharing your vast knowledge and wise reflections.

The study would not have been possible without the hard work of Evelyn Robsahm and Kari Veisten who drove several miles on a regular basis to collect assessments together with me. I am so impressed by your dedication. Also, a big thank you to Tina Sveum Engh for data entry and Ann-Mari Kvalvik for randomization. Thank you to all the co-therapists who led the GMT groups with me: Håvard Sørlie, Pia Johnsen, Kjell Tore Hovik, Izem Ayati, Vegar Hattestad Jensen, Jorunn Røken, Birgit Rautenberg, Tone Kristin Markussen, Kjersti Nedreskår and Bita Sehsuvari. I am very grateful to Dr. Reza Gihasvand and Cathrine Brunborg at Oslo Centre for Biostatistics and Epidemiology for statistical advice, and Shane "Grammar Genius" Bryson from Scribbr for text editing. The study is indebted to all my colleagues in the clinic that helped inform and recruit participants. In addition, I am grateful for my work-family, my friend-family and my family-family who always have my back.

I hope you will all do me one last favor and help me disseminate the research results to every corner of the hospital and beyond. And to always remember: Stop. Breathe. What's your goal right now?

Table of Contents

Errata

Paper III has been changed after submission of the thesis because of peer-review and publication:

Haugen, I., Ueland, T., Stubberud, J., Brunborg, C., Wykes, T., Øie, M. G., & Haug, E. (2022). Moderators of metacognitive strategy training for executive functioning in early schizophrenia and psychosis risk. *Schizophrenia Research: Cognition*, *31*. https://doi.org/10.1016/j.scog.2022.100275

General Summary

Background

Executive function is a cognitive domain important for daily life function. People with schizophrenia spectrum disorders or with a risk of developing these disorders, often experience challenges with executive function. The present study evaluates Goal Management Training (GMT), a metacognitive strategy training specifically targeting executive function, delivered in early detection and intervention for psychosis clinics. Evidence supporting this type of cognitive remediation as an early intervention for psychosis is limited. Since this is the first study of GMT for early psychosis, knowledge of who benefited the most was investigated.

Methods

A randomized, controlled trial with masked raters was conducted at Innlandet Hospital in Norway comparing the effects of GMT (N =81; GMT n = 39) to treatment as usual (TAU n = 42), among people with early schizophrenia spectrum disorders or psychosis risk syndromes. Outcomes were improved objective executive function (performance on neuropsychological tasks) and subjective (self-reported) executive function from baseline (0 weeks), to after intervention (5 weeks) and follow-up (30 weeks/ six months). In addition, effects on functional capacity, daily life function and clinical symptoms was explored.

The severity of objective executive dysfunction and the discrepancy between objective and subjective executive function, were explored as potential obstacles to successful remediation using GMT.

Symptoms of psychosis, depression, and self-efficacy were explored as potential predictors of the discrepancy between subjective and objective executive function in schizophrenia spectrum disorders.

Results

GMT led to significant and clinically reliable improvement in self-reported executive function for participants in everyday situations. Self-reported symptoms of anxiety and depression significantly improved more after GMT than TAU. Objective executive function, functional capacity and daily life function improved in both treatment groups.

GMT was equally effective in improving subjective executive function regardless of performance on neuropsychological tasks at baseline. Participants with both subjective and objective executive dysfunction, and participants with mostly subjective executive complaints, experienced the largest improvement in subjective executive function after GMT. Participants with mostly objective executive dysfunction showed little improved subjective executive function after GMT.

In participants with a schizophrenia spectrum disorder, a pattern of mostly objective executive function unaccompanied by subjective complaints was associated with having more disorganized symptoms of psychosis, but also better self-efficacy.

Conclusions

The first trial of GMT in people recently diagnosed with schizophrenia spectrum disorders or psychosis risk syndromes found clinically reliable improvement in subjective executive function in everyday situations lasting at least six months after treatment. People with schizophrenia who have more severe disorganized psychotic symptoms are more likely to have a pattern of poor objective executive function, but few subjectively experienced executive difficulties. This pattern of scores may be a challenge GMT, but more evidence is needed to support this finding.

List of Papers

The doctoral thesis is based on the following scientific papers, referred to in the text by their Roman numerals I–III:

Paper I

Haugen I., Stubberud J., Ueland T., Haug E. & Øie M.G. (2021) Executive Dysfunction in Schizophrenia: Predictors of the Discrepancy Between Subjective and Objective Measures. *Schizophrenia Research: Cognition*, 26. https://doi.org/10.1016/j.scog.2021.100201 PMID: 34189060; PMCID: PMC8217703.

Paper II

Haugen I., Stubberud J., Haug E., McGurk, S.R., Hovik, K.T., Ueland T., & Øie M.G. (2022) A Randomized Controlled Trial of Goal Management Training for Executive Functioning in Schizophrenia Spectrum Disorders or Psychosis Risk Syndromes. *In press*, accepted for publication in *BMC Psychiatry* on the 9th of August, 2022. https://doi.org/10.1186/s12888-022-04197-3

Paper III

Haugen I., Ueland T., Stubberud J., Brunborg C., Wykes, T., Øie M.G. & Haug E. (2022) Moderators of Metacognitive Strategy Training for Executive Functioning in Early Schizophrenia and Psychosis Risk. *Submitted* for peer-review to *Schizophrenia Research: Cognition* on the 12th of August, 2022.

Subjective and Objective Executive Function in People With Early Schizophrenia or Psychosis Risk

Individuals with schizophrenia spectrum disorders or a risk of developing these disorders frequently experience cognitive difficulties (Catalan, Salazar de Pablo, et al., 2021; Green et al., 2019). Cognitive difficulties are associated with functional disability, worse prognosis, and poorer quality of life in these patient groups (Cowman et al., 2021; Kadakia et al., 2022; Kim et al., 2019; Seidman et al., 2016). Since successful remediation of daily life function remains a challenge in the current treatment of schizophrenia, cognitive training has become an important potential target of treatment (Castelein et al., 2021; Catalan, Richter, et al., 2021; Ohi et al., 2020).

The executive functions, a set of higher order cognitive processes, are important for daily life function in both people with schizophrenia and those with risk of psychosis (McGurk & Mueser, 2006; Squarcina et al., 2022). The executive functions undergo final development during the same age as psychotic illness is often diagnosed, in late adolescence and early adulthood (Freedman & Brown, 2011). The study of executive function in early schizophrenia is therefore especially important, because executive difficulties can exacerbate challenges in meeting the increased demands adolescents and young adults face in education, work, and independent living (Freedman & Brown, 2011; Shakoor et al., 2016; Zelazo, 2020).

The present study evaluates Goal Management Training (GMT), a metacognitive strategy training specifically targeting executive function, as an early intervention in psychosis. Even though the evidence of improved cognition after cognitive remediation among individuals with schizophrenia is strong, less is known about cognitive remediation as early intervention (Allott, van-der-El, et al., 2020; Glenthøj et al., 2017; Lejeune et al., 2021; Vita et al., 2021). The potential for change might be greater among younger people who have not yet experienced long-term effects of life with psychosis (Bowie et al., 2014; Deste et al.,

2019; Lewandowski, 2016). Thus, it is important to establish whether cognitive remediation in early intervention can improve executive functioning during an important phase of life when work, social, and family life begins to be established (Bellani et al., 2019; Glenthøj et al., 2017; Zhang et al., 2022).

As this is the first GMT study in early schizophrenia, an exploration of who benefits the most from the intervention is pertinent. Knowledge about those who are most likely to benefit from cognitive remediation can improve the precision of personalized treatment and help avoid experiences of treatment failure for patients, their families, and staff (Bowie et al., 2020; Cella et al., 2015; Wykes & Spaulding, 2011). The identification of reliably replicated moderators that influence the efficacy of cognitive remediation in schizophrenia has been challenging due to heterogeneity across studies in sample characteristics and intervention type (Seccomandi et al., 2020). Few studies have been done on the moderators of treatment outcomes in remediation studies aimed at young people with early schizophrenia, even fewer in psychosis risk (Glenthøj et al., 2017; Vita et al., 2021).

Severe difficulties with executive components such as attentional control or working memory interfering fundamentally with strategy learning, may limit the effect of GMT (Cicerone et al., 2019; Emmanouel et al., 2018). Even though cognitive remediation in schizophrenia appears to be most effective for individuals with more severe cognitive difficulties, studies report contradictory findings, and few have executive functioning as the key outcome (Vita et al., 2021).

Another potential obstacle to GMT efficacy this study investigates, is the discrepancy between self-reported (subjective) executive function and neuropsychological task performance (objective executive function) (Cella et al., 2014; Medalia et al., 2008; Twamley et al., 2011). Since subjective cognitive complaints are associated with self-reported depression and lower self-esteem, high levels of subjective complaints may imply negative

thought patterns, which might interfere with treatment engagement (Allott, Steele, et al., 2020; Beck et al., 2018). On the other hand, few subjective complaints coupled with poorer test results may indicate inaccurate self-assessment of cognitive difficulties, which could also negatively influence participants' engagement with treatment (Harvey & Pinkham, 2015). The existing evidence that discrepancy between subjective and objective cognition is an obstacle for successful remediation is sparse and contradictory (Saperstein et al., 2020; Seccomandi et al., 2020).

In addition, what characterizes individuals with schizophrenia with larger discrepancies between subjective and objective cognition in either direction is not fully understood. In particular, psychological variables have seldom been investigated (Cella et al., 2014). One potentially relevant psychological variable is self-efficacy. Self-efficacy represents an individual's belief in their capacity to perform the actions necessary to achieve a goal. It is emerging as a potential mediator of the relationship between cognition, negative symptoms, and real-world function in schizophrenia (Beck et al., 2018; Chang et al., 2017). Thus, differing levels of self-efficacy may help to explain why some individuals with schizophrenia experience few cognitive difficulties in everyday life, but perform poorly when solving neuropsychological tasks in the lab. Several studies have investigated symptoms of psychosis as predictors of the discrepancy between subjective and objective cognition, but the results have been contradictory (Homayoun et al., 2011). Most previous studies have focused on positive and negative symptoms, but there are some indications that disorganized and depressive symptoms may be more strongly associated with discrepancy (Baliga et al., 2020; Harvey et al., 2017). A five-factor model of psychotic symptoms including positive, negative, depressive, disorganized, and excited symptoms may improve the prediction of discrepancy between subjective and objective cognition (Wallwork et al., 2012).

Together, the papers in this doctoral thesis expand the understanding of executive function in people recently diagnosed with schizophrenia spectrum disorders or psychosis risk syndromes. The papers provide a thorough description of self-reported behavioral symptoms of executive difficulties, performance on neuropsychological tasks, and measures of functional capacity. The thesis evaluates the results of a pre-registered, randomized, controlled trial (RCT) of stand-alone GMT for people with schizophrenia spectrum disorders and psychosis risk syndromes (Paper II). Moreover, baseline objective executive function and discrepancy between subjective and objective executive function are explored as moderators of GMT efficacy (Paper III). Furthermore, self-efficacy and symptoms of psychosis are examined as predictors of the discrepancy between subjective and objective executive function in schizophrenia (Paper I).

The remainder of this introduction will offer a brief overview of schizophrenia spectrum disorders and psychosis risk syndromes. Following that, an outline of current knowledge about executive function in early schizophrenia and risk will be presented. Certain challenges to the assessment of executive function are highlighted. Finally, GMT is presented in the context of existing knowledge about cognitive remediation in schizophrenia and the unanswered questions addressed by the thesis are summarized.

Schizophrenia Spectrum Disorders and Psychosis Risk Syndromes

Taxonomy

Schizophrenia Spectrum Disorders. The term "schizophrenia spectrum disorders" is meant as a broad term encompassing the mental disorders schizophrenia, schizoaffective disorder, and other non-affective psychotic disorders, but it does not include affective psychosis or psychosis due to substance abuse (Andreasen, 1989; Spaulding et al., 2017). Schizophrenia spectrum disorders are primarily characterized by psychotic symptoms such as

hallucinations or delusions, but may also include experiences of disorganized thought, speech, and behavior, as well as disturbances of affect, motor functions, and willed actions (Fiedorowicz et al., 2008; McKenna, 2007). Schizophrenia spectrum disorders are frequently diagnosed in late adolescence or early adulthood, but psychotic symptoms vary in expression and severity between individuals and over time (McKenna, 2007). Cognitive difficulties and anomalous self-experiences are not reflected in the current diagnostic criteria for schizophrenia spectrum disorders, but both are frequently present and begin before the debut of psychotic symptoms (Burgin et al., 2022; Catalan, Salazar de Pablo, et al., 2021; Green et al., 2019). The disorders are often also accompanied by other distressing symptoms, such as co-morbid substance use, anxiety, mood disturbances, and sleep disturbances (Buckley et al., 2009; Krebs et al., 2021; Laskemoen et al., 2019).

The term schizophrenia has been shrouded in controversy for over a century, and debates continue over the validity, labelling, and boundaries of the diagnoses in the schizophrenia spectrum (Guloksuz & van Os, 2018; Ritsner & Gottesman, 2011; van Os, 2009). To allow for comparison with other studies, the present study used the diagnostic criteria according to the Diagnostic and Statistical Manual of Mental Disorders, DSM-IV (American Psychiatric Association, 2000). Despite much valid criticism, diagnostic categories have the advantage of supplying widely used operational definitions for clinical research (Harvey et al., 2012). When used for diagnosis by mental health professionals, the DSM-IV diagnosis of schizophrenia has good inter-rater reliability, whereas schizoaffective disorder has moderate inter-rater reliability (Harvey et al., 2012; Santelmann et al., 2016). Diagnostic stability in the schizophrenia spectrum disorders is high, though an initial diagnosis of psychosis not otherwise specified is sometimes changed into a diagnosis of schizophrenia over time (Fusar-Poli et al., 2016).

Psychosis Risk Syndromes. Psychosis risk syndromes are characterized by psychotic symptoms that are either less severe or of shorter duration than the symptoms that qualify for a diagnosis of a psychotic episode (Miller et al., 1999; Yung et al., 1998). Psychosis risk syndromes also include other well-known risk factors for developing psychosis, such as having a first-order genetic relative with a schizophrenia spectrum disorder combined with a recent dramatic fall in role-function (e.g., a drop in scholastic or social participation; Miller et al., 1999; Yung et al., 1998). Individuals with a psychosis risk syndrome are at higher risk of developing schizophrenia spectrum disorders than is the general population. According to the latest meta-analysis of longitudinal studies, 25% of study participants with psychosis risk syndromes experience a psychotic episode within three years and 35% within ten years (Salazar de Pablo, Radua, et al., 2021). Cognitive difficulties are common among people with psychosis risk syndromes (Catalan, Salazar de Pablo, et al., 2021). Persons with psychosis risk syndromes also exhibit poorer role function, for example at school or work, as compared to healthy controls (Fusar-Poli et al., 2015). Thus, the at-risk state itself may be considered a disorder in need of treatment (Fusar-Poli et al., 2015).

Epidemiology

An estimated 0.75% of people in the world experience a psychotic episode in the schizophrenia spectrum during their lifetime (Moreno-Kustner et al., 2018). Schizophrenia currently affects approximately 23.6 million people in the world: 0.32% of the global population (Institute of Health Metrics and Evaluation, 2019). In recent years, sex differences in prevalence of schizophrenia have not been consistently detected globally (Charlson et al., 2018). The latest global estimates show a point prevalence of 0.34% for men and 0.30% for women across all ages. However, men often become diagnosed at a younger age than women, making schizophrenia more prevalent among men in late adolescence and early adulthood (Institute of Health Metrics and Evaluation, 2019). The prevalence of schizophrenia spectrum

disorders is harder to calculate than for schizophrenia, due to heterogeneity in epidemiological studies, but meta-analyses estimates a global point-prevalence of 0.46% (Moreno-Kustner et al., 2018). Psychosis risk has been detected in approximately 1.7% of the general population (Salazar de Pablo, Woods, et al., 2021).

Etiology

Current etiological theories for schizophrenia spectrum disorders emphasize the interaction of vulnerabilities and stressors at the biological, psychological, and social level. On the biological level, the cardio metabolic, immune, endocrinal, and central nervous systems all show alterations in persons with first episode psychosis, but pathophysiological mechanisms remain elusive (Pillinger et al., 2019). Current evidence supports risk factors for schizophrenia including genetic vulnerability, prenatal exposures, obstetric complications, childhood trauma, urban living, migration, discrimination, and low socio-economic status (Brown & Lau, 2016; Davies et al., 2020; Radua et al., 2018; Varchmin et al., 2021). Heritability estimates are high — in some large twin-studies, as high as 79% for schizophrenia and 73% for schizophrenia spectrum disorders (Hilker et al., 2018; Sullivan et al., 2003). Still, schizophrenia spectrum disorders are complex and involve many genes making many small contributions to interactions with environmental factors. The available evidence supports genetic variants involved in disturbances of neuronal transmission, neurodevelopment, and the immune system (Smeland et al., 2020).

Debilitation: Burden of Disease

Despite low prevalence, the burden of disease from schizophrenia spectrum disorders is substantial for the affected individuals, their families, and society. Schizophrenia causes an estimated 15.1 million years of life with lived disability globally (Institute of Health Metrics and Evaluation, 2019). The economic cost of treatment and loss of productivity is among the highest of all health conditions, ranking alongside cancer and heart disease in the Western

world (Spaulding et al., 2017). One of the reasons for the high societal cost may be that disability is largest in the age group 25–54 years, most likely to be financially productive (Charlson et al., 2018). Disability is present before the emergence of psychotic episodes, and at-risk states are associated with pronounced suffering (Falkenberg et al., 2015; Fusar-Poli et al., 2015). School failures and unemployment occur more often among persons with psychosis risk and among those who have recently been diagnosed with schizophrenia, as compared to healthy controls (Cornblatt et al., 2003; Crespo-Facorro et al., 2021). Quality of life is also poorer than among healthy young people (Fusar-Poli et al., 2015; Velthorst et al., 2018).

The life expectancy of individuals with schizophrenia spectrum disorders is 15–20 years shorter than that of the general population (Correll et al., 2022; Spaulding et al., 2017). Higher mortality is mostly due to high co-morbidity with physiological diseases, whereas unnatural causes such as suicide account for around 15% of the excess mortality rate in schizophrenia (Charlson et al., 2018).

Treatment

Psychiatric rehabilitation of schizophrenia spectrum disorders is interdisciplinary (Spaulding et al., 2017). The guidelines for evidence-based treatment recommend a combination of pharmacological and psychotherapeutic treatment for the management of symptoms, skills training, and support for independent living and vocation, as well as family interventions for stress reduction and relapse prevention (American Psychiatric Association, 2021b; Norwegian Health Authority, 2013). Cognitive remediation is rarely systematically provided as part of standard care, despite evidence that it improves daily life function (Bryce et al., 2021). For young people experiencing a first episode of psychosis, specialized early-intervention services that integrate pharmacological and psychosocial treatments carry the greatest benefits (Anderson et al., 2018; Correll et al., 2018; Pipkin, 2020). For psychosis risk syndromes, the recommended treatment resembles psychosis treatment, but does not include

anti-psychotic drugs (National Institute for Health and Care Excellence, 2013; Norwegian Health Authority, 2013). Presently, support is insufficient for specific treatments that prevent conversion to psychosis (Bosnjak Kuharic et al., 2019; Mei et al., 2021). However, early-discovery leads to shorter duration of untreated psychosis. Reducing the duration of untreated psychosis improves prognoses and lowers hospitalization rates (Fusar-Poli et al., 2019; Mei et al., 2021; Penttila et al., 2014; Sizer et al., 2022).

More than half of patients with schizophrenia spectrum disorders experience either symptomatic remission, personal recovery, or functional recovery after a first-episode psychosis (Catalan, Richter, et al., 2021; Peralta et al., 2022). However, simultaneous personal, clinical, and functional recovery has been more difficult to achieve. Joint clinical and functional recovery occurs in about a third of patients (Catalan, Richter, et al., 2021). Even among those who experience stable clinical and personal recovery and good general social function, the areas of study, work, and housekeeping remain challenging (Castelein et al., 2021). Presently, sufficient evidence is lacking for treatment to improve function among people with a risk of psychosis, as few studies have been conducted so far (Fusar-Poli et al., 2019; Mei et al., 2021). Note, however, that the criteria for functional recovery has also been criticized for being too strict, as nearly one in five healthy controls fail to meet the criteria (Åsbø et al., 2022). Nonetheless, the challenges to improving function have led to research interest in cognition and cognitive remediation.

Cognitive Difficulties Among People With Schizophrenia

General Cognition

Cognitive difficulties frequently occur together with schizophrenia (Green et al., 2019). On average, people with schizophrenia spectrum disorders score one standard deviation lower than healthy people on neuropsychological measures across most cognitive

domains (East-Richard et al., 2020; Fioravanti et al., 2012; Mesholam-Gately et al., 2009; Sheffield et al., 2018). There is much individual variation, however. Around 44% of participants with schizophrenia show a severe global cognitive dysfunction, scoring up to three standard deviations lower than healthy controls on most measures (Carruthers et al., 2019). Approximately 25% of the participants across studies show relatively intact cognition, characterized only by mild dysfunction compared to healthy controls (Carruthers et al., 2019). The remaining third of participants show intermediate performance on neuropsychological tests. The magnitude of cognitive impairment in schizophrenia spectrum disorders has been questioned because lack of motivation and negative symptoms may lower performance on neuropsychological tests (Grant et al., 2019). However, people with schizophrenia also consistently report significantly more subjective cognitive complaints than do healthy controls (Potvin et al., 2014).

The cognitive difficulties observed in people with schizophrenia spectrum disorders are already present before the development of psychotic symptoms and have been observed in early childhood among people who later develop the disorders (Fett et al., 2022; Mollon et al., 2018). Recent reviews of meta-analyses and longitudinal studies of cognition in psychosis show an overall increase in impairment, as compared to healthy development from childhood to the first episode of psychosis (Fett et al., 2022; Sheffield et al., 2018). The course of cognition appears to be characterized by greater stability after the first episode of psychosis (Fett et al., 2022).

The severity of cognitive difficulties in persons with psychosis risk falls between that observed in first-episode psychosis and healthy controls (Catalan, Salazar de Pablo, et al., 2021; Hauser et al., 2017; Mohn-Haugen et al., 2022; Zheng et al., 2018). Poorer cognitive performance predicts conversion to psychosis from psychosis risk syndromes (Catalan, Salazar de Pablo, et al., 2021; Seidman et al., 2016). Individuals with higher familial risk or

more attenuated psychotic symptoms have greater cognitive difficulties (Sheffield et al., 2018). Thus, the intermediate level of severity of cognitive difficulties in psychosis risk syndromes may partially reflect the group's composition of both individuals who do later experience psychosis and individuals who do not (Sheffield et al., 2018). People with psychosis risk syndromes who do not develop psychosis tend to score poorer than do healthy people on cognitive tasks, but on a level similar to that of help-seeking youth with other mental health challenges than psychosis (Millman et al., 2022).

It is not known whether the cooccurrence of cognitive dysfunction and schizophrenia spectrum disorders expresses a causal relationship (Grant et al., 2019; Melle, 2019; Reichenberg et al., 2019). Increasing developmental lags in cognition in youth who later develop schizophrenia spectrum disorders suggest that cognition is a marker of illness, reflecting a shared underlying neurodevelopmental etiology (Melle, 2019; Mohn-Haugen et al., 2022; Sheffield et al., 2018). Nevertheless, the possibility remains that a fall in function warranting contact with the health services mostly occurs among those people with both psychotic symptoms and cognitive dysfunction, but that these two phenomena are actually unrelated (Reichenberg et al., 2019).

Importantly, cognition is significantly associated with daily life function in cross-sectional and longitudinal studies of early psychosis (Cowman et al., 2021). In people with schizophrenia, moderate to severe cognitive difficulties increases the risk of hospitalization, poorer physical health, and even premature death (Helldin et al., 2015; Kadakia et al., 2022; Moradi et al., 2018). Unlike psychotic symptoms, cognition does not improve during periods of remission and improves only modestly with second generation antipsychotic medications (Ohi et al., 2020). Poorer cognition also predicts poorer quality of life in persons with schizophrenia spectrum disorders or risk of psychosis (Kadakia et al., 2022; Kim et al., 2019).

Thus, effective interventions aimed at cognition in early psychosis are necessary to ameliorate cognitive function and potentially improve prognosis (Cowman et al., 2021; Melle, 2019).

Executive Function

Conceptions of Executive Function. Executive function is an umbrella term for the higher-order mental cognitions necessary for top-down control of thought, emotion, and action to ensure goal achievement (Snyder et al., 2015). Executive functions allow humans to plan, organize, and initiate activities. During activities, executive functions are responsible for self-monitoring, resisting distraction, and keeping the relevant goal in working memory. Executive functions also ensure adaptation to changing demands in the surroundings and effective problem solving during the activities.

There is no consensus on a precise definition of executive function, because historically several theoretical models and strands of research have existed in parallel and have used varying terminology (Kluwe-Schiavon et al., 2013; Zink et al., 2021). In the field of neuroscience the term "cognitive control" is often preferred to "executive function," but the two terms conceptually overlap (Husain, 2021). Examples of influential theoretical work on executive function include Duncan's observations of apparent goal neglect after frontal lobe damage (Duncan, 1986; Duncan et al., 1996) and the concept of the central executive allocating memory resources in Baddeley's multicomponent working-memory model (Baddeley, 2012; Baddeley & Hitch, 1974). Another influential model is the supervisory attentional system proposed by Norman, Shallice, and Burgess which supposes that executive functions are required to override habits (Norman & Shallice, 1980; Shallice & Burgess, 1991). Despite variations in the operationalization of executive function, all models share a notion of cognitive control functions necessary to adapt to the demands of complex and changing environments (Friedman & Robbins, 2022; Zink et al., 2021).

The most extensively studied mental processes that fall under the umbrella term of "executive function" are inhibition, shifting, and updating of working memory (Friedman & Robbins, 2022). Inhibition is the ability to hold back an automated response when required. Shifting (sometimes referred to as set switching or mental flexibility), is the process of relinquishing attention from one task and engaging in another. Working memory is the capacity to hold on to information for a brief period while using that information to perform mental operations. While working memory capacity is not considered an executive function, it is believed that executive control is involved in the process of releasing no longer important content from working memory and replacing it with more relevant information (Miyake et al., 2000). In addition to these three most studied processes, executive function includes attentional control, self-monitoring, fluency, planning, reasoning, decision making, and problem solving (Diamond, 2013; Friedman & Robbins, 2022).

Executive Function in Schizophrenia Spectrum Disorders and Psychosis Risk Syndromes. The evidence is mounting that executive dysfunction is present in mental disorders arising in childhood and adolescence, raising the question of common transdiagnostic mechanisms in psychopathology involving the prefrontal cortex (East-Richard et al., 2020; Friedman & Robbins, 2022; Snyder et al., 2019). One reason executive difficulties are pervasive in psychopathology may be that the executive functions are higher order functions, supported by large, dispersed networks in several brain regions (Zelazo, 2020). A disruption anywhere in the supporting functions could lead to failure in executive functioning (Harvey, 2019). It has been suggested that difficulties with aspects of cognitive control such as inhibition and shifting are responsible for difficulties in goal-directed behavior among people with schizophrenia (Smucny et al., 2022). Because effective executive function is beneficial for many different cognitive tasks, it has been suggested that the executive

functions should be the focus of cognitive remediation among people with schizophrenia (Wykes & Reeder, 2005).

Executive dysfunction is considered a core feature of schizophrenia spectrum disorders, as it is among the most severely impaired cognitive domains (East-Richard et al., 2020; Freedman & Brown, 2011; Snyder et al., 2015). Even people with schizophrenia who otherwise show little to no overall cognitive dysfunction often score poorer on executive tests compared to healthy controls (Carruthers et al., 2019). In particular, people with schizophrenia score lower than healthy controls on neuropsychological tasks of inhibition, shifting, working memory, and attentional control (Fatouros-Bergman et al., 2014; Forbes et al., 2009; Laere et al., 2018; Nuechterlein et al., 2015; Westerhausen et al., 2011). They also score lower than healthy controls on complex ecological tasks measuring inhibition of pre-learned behavior, organizing and planning, novel problem solving, and forward planning (Thai et al., 2019). Furthermore, persons with schizophrenia report more subjectively experienced difficulties across domains of executive function including inhibition, shifting, working memory, the initiation and organizing of activities, self-monitoring, task-monitoring, emotion regulation, and organization of materials (Bulzacka et al., 2013; Van Aken et al., 2022).

Relative to healthy controls, individuals with psychosis risk underperform on tests and parental reports of executive functioning (Catalan, Salazar de Pablo, et al., 2021; Hwang et al., 2019; Niendam et al., 2007; Sheffield et al., 2018). In the latest, most comprehensive meta-analysis of longitudinal studies of cognition in people with psychosis risk, those who later developed psychosis scored similar to people with a first episode of psychosis in tasks of inhibition, attentional control, and shifting (Catalan, Salazar de Pablo, et al., 2021).

The executive difficulties seen in schizophrenia are considered a separate dysfunction and not an expression of psychotic symptoms (Pijnenborg et al., 2003). However, there is

some indication of a shared relationship. Poorer performance on tasks of executive function is associated with more negative and disorganized symptoms among people with schizophrenia who are in stable clinical phases (Dibben et al., 2009). The associations are in the range of small to moderate. It is possible that executive difficulties contribute to disorganized symptoms, but evidence is currently tentative (Smucny et al., 2022). The positive symptoms of psychosis are unrelated to executive performance (Dibben et al., 2009).

Importantly, executive functioning is associated with vital life outcomes such as everyday function, education, and work (Diamond, 2013). Lower scores on measures of executive function predict poorer functioning, greater need for vocational support, and lower life satisfaction in schizophrenia spectrum disorders and psychosis risk syndromes (Cowman et al., 2021; Eslami et al., 2011; Fujii et al., 2004; McGurk & Mueser, 2006; Squarcina et al., 2022). Executive functions are still developing in adolescence and early adulthood when a first episode of psychosis is typically diagnosed (Freedman & Brown, 2011; Zelazo, 2020). Increasing independence and less reliance on the guidance of parents and teachers is expected of young people at this age. Executive difficulties among adolescents or young adults at risk of psychosis may exacerbate challenges in meeting the increased expectations of self-organization at home, in school, or in social situations. A bidirectional interplay between difficulties in executive function and psychopathology has been suggested (Romer & Pizzagalli, 2021; Zelazo, 2020). Failing to meet expectations from parents, peers, or teachers could cause stress and raise the risk of psychotic symptoms (Freedman & Brown, 2011; Shakoor et al., 2016). As a consequence, interventions aimed at executive function may be particularly important for people with early schizophrenia or psychosis risk (Carruthers et al., 2019; Melle, 2019).

Challenges in Measuring Executive Function

A criticism of research on executive function in schizophrenia has been that many studies use a single task to measure what is a very complex cognitive domain (Hwang et al., 2019). Executive functioning is both one integrated process and separate component processes (e.g. inhibition, shifting and updating of working memory; Friedman & Robbins, 2022). Available evidence from studies of laboratory tasks, lesions, and neuroimaging in humans, as well as animal studies, support both the fractionation and integration of cognitive control processes within the pre-frontal cortex (Collette et al., 2005; Friedman & Miyake, 2017; Friedman & Robbins, 2022; Niendam et al., 2012). Factor analyses and network analyses of tasks targeting different executive processes indicate that executive processes such as inhibition, shifting, and updating of working memory appear to be separate and associated in people with schizophrenia and healthy controls (Berberian et al., 2019; Miyake et al., 2000; Sanchez-Torres et al., 2022). As a result of the integration and fractionation of executive components, researching executive function necessitates the analysis of several task measures, both alone and in combination (Hwang et al., 2019).

Furthermore, executive function may be assessed with both subjective (self-reported questionnaires) and objective measures (neuropsychological tests). However, discrepancies between the results of subjective and objective assessments of executive function are often found in both healthy and clinical samples (Toplak et al., 2013). One valuable contribution of objective measures is that they limit the influence of confounding factors through control over the test situation (Harvey, 2012). Consequently, the lab setting provides too much structure to assess the complexity of the interacting components of executive function required in everyday life (Sbordone, 2014). Subjective measures, on the other hand, tap into complex everyday situations, but are more easily influenced by confounding emotional states (Shwartz et al., 2020). One way of countering these challenges is to include both subjective and

objective measures in studies, as both are useful and complementary (Friedman & Banich, 2019; Isquith et al., 2013).

Moreover, the assessment of executive function may be improved by including naturalistic role playing tasks mimicking complex real-world situations (Burgess et al., 2006; Snyder et al., 2015; Tyburski et al., 2021). Role playing tasks attempt to capture performance resulting from interacting executive functions by measuring performance in situations that are less structured and more similar to real-world situations. One example of a complex role playing task is the Hotel task, a form of multiple-errands task measuring how well participants allocate time between different tasks according to an overarching goal (Manly et al., 2002).

Discrepancy between Subjective and Objective Cognition

A further challenge in assessing executive function is that in studies of cognition in schizophrenia, the difference between subjective and objective assessment has been found greater than in healthy samples (Medalia et al., 2008; Potvin et al., 2014). Even though persons with schizophrenia have more subjective cognitive complaints, on average, than healthy controls, a substantial portion report fewer subjective cognitive complaints than would be expected from their performance on lab tasks (Harvey & Pinkham, 2015; Potvin et al., 2014). Less is known about discrepancy between subjective and objective cognition in psychosis risk syndromes, but one study found a tendency towards reporting more severe subjective complaints than was expected based on the objective test performance (Glenthøj et al., 2020).

The discrepancy between subjective and objective assessment of executive function in psychosis remains largely unexplored, as most studies have focused on general cognition and used few tests and questionnaire items specifically to assess the executive domain (Freedman & Brown, 2011; Potvin et al., 2014).

The discrepancy between subjective and objective cognition in schizophrenia has been assumed to be due to biases in the self-reporting (Harvey & Pinkham, 2015; Homayoun et al., 2011). Subjective cognitive complaints that are lower than would be expected from task performance in individuals with schizophrenia, has often been interpreted as a lack of insight into cognitive difficulties (Burton et al., 2016). Higher subjective cognitive complaints than expected based on task performance has been assumed to be due to negative emotional states influencing questionnaire responses (Raffard et al., 2020). The importance of subjective measures of cognition may have been underestimated due to the emphasis on biases in self-reporting. People with schizophrenia reliably report greater executive and other cognitive difficulties than healthy controls, showing that self-reports in many cases are valid sources of information (Bulzacka et al., 2013; Potvin et al., 2014; Van Aken et al., 2022).

The associations between psychotic symptoms and the discrepancy between subjective and objective cognition in schizophrenia have varied between studies (Homayoun et al., 2011; Potvin et al., 2014). One reason for the varied results may be that studies have included mainly positive and negative symptoms. A five factor grouping of psychotic symptoms might improve the prediction of discrepancy, since disorganized symptoms share a stronger relationship with cognition than positive symptoms do (Rodriguez-Jimenez et al., 2013; Ventura et al., 2010). The five factor grouping of symptoms also allows for depression to be distinguished. Depressive symptoms have been associated with more subjective cognitive complaints in schizophrenia (Raffard et al., 2020; Sellwood et al., 2013).

Furthermore, psychological mechanisms such as self-efficacy might be relevant to the relationship between subjective and objective cognition, but have rarely been investigated (Cella et al., 2014). Self-efficacy represents the belief in one's capability to manifest the behaviors needed to produce a desired outcome (Bandura, 1977). People with higher self-efficacy are more motivated for tasks, set more difficult goals, exert more effort, and are more

persistent in the face of difficulty. In contrast, people low in self-efficacy make fewer attempts and give up more easily (Bandura, 1977; Bandura, 2011). Self-efficacy is an important mediator in the relationship between cognition, negative symptoms, and real-world functioning in schizophrenia (Allott, Steele, et al., 2020; Ventura et al., 2014). Thus, the predictive value of self-efficacy in explaining the gap between subjective and objective executive function should be assessed.

Both directions of discrepancy correspond to adverse outcomes in schizophrenia. More objective than subjective cognitive dysfunction has been associated with poorer independent living skills (Gould et al., 2015; Silberstein & Harvey, 2019). Prevalent subjective cognitive complaints, on the other hand, are associated with self-stigma and poorer quality of life (Shin et al., 2016). In consequence, the discrepancy can be problematic for patients and clinicians as they decide on the best treatment and support. Clinicians must navigate situations in which patients with impaired performance on objective tests may lose the opportunity for necessary services because they do not communicate a subjective need for them (Olsson et al., 2019). Alternatively, clinicians may be uncertain whether interventions are relevant for people with subjective cognitive complaints that are not corroborated by objective test results.

Cognitive Remediation

Cognition has emerged as an important target in research on the treatment of schizophrenia spectrum disorders, due to the association between cognition and daily life function (Harvey et al., 2019; Javitt, 2015). Neither cognition, nor daily life function is sufficiently improved by mainstay treatment for psychosis (Javitt, 2015). One way to improve cognition is through cognitive remediation. Cognitive remediation is “behavioral training-based intervention that aims to improve cognitive processes with the goal of durability and

generalization" (Bowie et al., 2020). Several forms of cognitive remediation interventions have been investigated for people with schizophrenia. Some emphasize the bottom-up training of lower-level processes such as perceptual processing, whereas others target top-down processes such as higher-level memory or executive processes (Nuechterlein et al., 2014). Cognitive remediation can take the form of repeated drill and practice training thought to restore cognitive function through brain plasticity or compensatory strategy training thought to work around challenges by relying instead on intact cognitive functions or the utilization of environmental aids (Saperstein & Kurtz, 2013).

A large body of research affirms the effectiveness of cognitive drill and practice training in improving performance on lab tasks (Lejeune et al., 2021; Seccomandi et al., 2020; Vita et al., 2021). A challenge for drill and practice training has been that functional gains in daily life were initially modest. However, the effect on daily life function has been shown to improve with the addition of bridging groups and strategy training (Bowie et al., 2020; Lejeune et al., 2021; Vita et al., 2021). Bridging groups with peers and therapists attempt to bridge training and daily life through discussions of how to apply the trained skills in practice. Strategy training often involves the use of active therapists to assist in the structured development of mental strategies to resolve training tasks. Based on the available evidence, experts in cognitive remediation for people with schizophrenia recently agreed on four core elements of cognitive remediation: Repeated practice of cognitive exercises, the presence of an active therapist, the structured development of cognitive strategies, and procedures to facilitate the transfer of skills from training to real world functioning (Bowie et al., 2020).

There is evidence for durably improved function in daily life for people with schizophrenia spectrum disorders after compensatory interventions (Allott, van-der-El, et al., 2020). Compensatory interventions include self-management strategies such as self-talk or chunking information to aid memory. In addition, compensatory interventions can involve

environmental modifications such as labeling objects, using automatic reminders, and calendars (Allott, van-der-El, et al., 2020). The existing cognitive remediation interventions for people with schizophrenia vary in their relative combination of restorative and compensatory approaches (Medalia & Saperstein, 2013).

Although cognitive remediation for schizophrenia primarily targets cognitive function, and ultimately real world function, small significant improvements have also been seen in clinical symptoms (Vita et al., 2021). The small to moderate effects on negative symptoms across studies is especially promising, as these symptoms have been difficult to treat among people with schizophrenia (Cella et al., 2017).

As an early intervention in psychosis, cognitive remediation is compelling because it might counteract the detrimental consequences of psychotic illness in late adolescence (Barlati et al., 2013; Bechdolf et al., 2012). Cognitive remediation has shown promising effects on objective cognition lasting up to a year in adolescents with early-onset schizophrenia spectrum disorders (Ueland & Rund, 2005). It is possible that remediation will be more effective in younger individuals who have not experienced as many disruptions to daily life as a consequence of illness (Bowie et al., 2014; Deste et al., 2019). So far, meta-analyses of cognitive remediation studies indicate that the larges effect sizes have been found among participants who are older and have been ill for longer (Revell et al., 2015; Vita et al., 2021). However, these results could stem from the fact that most cognitive remediation trials have had adult participants in mid-life, with fewer studies being done among adolescents or young adults (Gergov et al., 2022; Vita et al., 2021). Thus, more studies of cognitive remediation as an early intervention for psychosis are needed.

Research on cognitive remediation for individuals with psychosis risk is emergent. There is some indication that cognitive remediation may prevent the development of psychosis among at-risk participants (Bechdolf et al., 2012). However, cognitive remediation

requires rigorous investigation in large scale, high quality trials to compare the effects to treatment as usual among people with psychosis risk syndromes. So far, insufficient evidence exists for the effectiveness of drill and practice training in improving cognition and function in psychosis risk (Devoe et al., 2019; Glenthøj et al., 2017). However, many of the early trials had small sample sizes and investigated isolated computerized training without the core elements of cognitive remediation, such as active therapists, strategy coaching, or procedures for transfer to everyday life (Glenthøj et al., 2017). At present, several RCTs with sufficient sample sizes are underway that integrate drill and practice training with cognitive strategy training or social cognitive training, and the results are promising (Friedman-Yakoobian et al., 2020; Mahmood et al., 2019; Vidarsdottir et al., 2019).

Since executive function is a substantially impaired cognitive domain in early psychosis and is vital for real world function, effective intervention has significant potential for improving daily life in this patient group (Cowman et al., 2021; East-Richard et al., 2020; Eslami et al., 2011; Squarcina et al., 2022). There is also evidence that change in executive function is required to improve daily life function as a result of cognitive remediation (Penadés et al., 2009; Reeder et al., 2004). Metacognitive strategies are recommended for executive dysfunction precisely because these interventions are more likely to address the complexity of interacting higher order cognitive functions activated in novel and demanding real-world situations (Cicerone et al., 2019). Though several existing cognitive remediation programs for psychosis include mental strategies, these strategies often target specific tasks or situations. Metacognitive strategy training uses a more global approach.[1] A metacognitive strategy is a recipe for how to think, sometimes in the form of a collection of mental steps. For example, mental steps in the GMT strategy include the following: *Stop – Focus* on the

[1] Metacognitive strategy training is distinguishable from *metacognitive therapy* which focuses on thought content such as worry and rumination. It is also distinguishable from *metacognitive training* which is directed at cognitive biases. The treatment forms are related in that all encourage the metacognitive capacity to observe mental processes.

present goal – *State goal* aloud – (*Split goal* into subgoals when required) – *Check* that goal is active in working memory and that current actions support goal achievement. Metacognitive strategy training may have widespread application in that the same technique may be used across any number of everyday situations. During metacognitive strategy training, thinking processes are made explicit for participants, creating awareness of errors and increasing self-monitoring of performance.

Few cognitive remediation studies have targeted executive functioning using metacognitive strategy training as a stand-alone intervention in schizophrenia, with seemingly none in psychosis risk (Glenthøj et al., 2017; Vita et al., 2021). When studies have included metacognitive strategy training, they have usually been combined with other forms of cognitive remediation (Twamley et al., 2012). Exploring interventions alone before combining them with other interventions is important to better understand the mechanisms of cognitive remediation (Cella & Wykes, 2019).

Goal Management Training (GMT)

GMT (Levine et al., 2000; Robertson, 1996) aims to improve executive function through metacognitive strategy training that targets attentional control and problem solving. GMT was created to address the distracted behavior frequently observed after traumatic brain injury occurring naturally, but not necessarily on neuropsychological tasks. The theory behind GMT is based on the assumption that when there are disruptions in the brain, networks contributing to sustained attention, goal-directed behavior are replaced by reliance on habits or cues in the environment (Levine et al., 2011). For example, despite knowing that the goal is to clean the apartment, a person may find themselves reading the newspaper for half an hour, having been distracted from the task. Suddenly, a reminder may lead to a flurry of activity. While this behavior is normal and occurs in all healthy humans at times, it is far more

common in people with executive dysfunction (Duncan, 1986; Duncan et al., 1996; Levine et al., 2011).

Distracted behavior may have significant negative consequences for a person's daily routines, finances, or relationships. GMT seeks to replace the distracted behavior with deliberate establishment of and increased adherence to goals. GMT achieves this by teaching participants to periodically stop and remind themselves of their goals in the present situation. Participants are encouraged to repeat central steps of a mental strategy, preferably out loud. The objective is to internalize the strategy through repetition. In addition, the GMT manual seeks to raise awareness of attentional slips through group discussions of real life-examples and demonstrations. The current GMT manual also includes exercises with present minded focus (Kabat-Zinn, 1990; Levine et al., 2011). By raising awareness and building new habits through attention training and strategy rehearsal, GMT aims to increase self-monitoring and improve goal-achievement.

Evidence for the Efficacy of GMT

GMT has received empirical support in studies with several different patient populations experiencing executive dysfunction. Most GMT studies have been undertaken with individuals with acquired brain injury (Krasny-Pacini et al., 2014). However, studies have also investigated the effect of GMT in persons with other neurological conditions or ageing (Stubberud et al., 2013a; Turner et al., 2020; Vlagsma et al., 2020). In the field of mental health, studies have examined GMT for executive dysfunction accompanying substance abuse, attention deficit hyperactivity disorder (ADHD), obsessive compulsive disorder (OCD), post-traumatic stress disorder (PTSD), and depression (Alfonso et al., 2011; Boyd et al., 2019; Cameron et al., 2020; Hagen et al., 2020; In de Braek et al., 2017; Jensen et al., 2021; Valls-Serrano et al., 2016). The reason for the broad diagnostic scope of GMT studies is that underlying brain networks supporting executive functions are prevented from

functioning optimally in several medical states and mental disorders (East-Richard et al., 2020; Stamenova & Levine, 2018).

A meta-analysis of GMT studies published before 2017 found GMT effective in enhancing executive function (Stamenova & Levine, 2018). The analysis included 19 GMT group trials with adult participants from several diagnostic groups including mental disorders. A significant beneficial effect of GMT was found on subjective and objective measures of executive function immediately after intervention. This effect was sustained for objective measures in the studies including a follow-up assessment, most commonly six months after intervention (Stamenova & Levine, 2018). Increased activation in brain regions associated with cognitive control has also been observed following GMT (Adnan et al., 2017). The recent meta-analysis of GMT studies found significant improvement in daily function and clinical symptoms (questionnaires about mental health) following GMT (Stamenova & Levine, 2018).

So far, two studies have investigated GMT among people with schizophrenia. A case study of a 39-year-old man diagnosed with schizophrenia found improved performance on familiar and novel laboratory and real-life tasks after individually administered GMT (Levaux et al., 2012). Moreover, the participant in the case study reported increased self-confidence in everyday tasks following GMT. The effects persisted two years later (Levaux et al., 2012). In a recent RCT by Vizzotto et al. (2021), GMT was combined with occupational therapy among adults with treatment resistant schizophrenia. The occupational therapy involved practice in naturalistic tasks such as cooking, paying bills, buying goods, or interacting with people. The study found the combined intervention to have a beneficial effect on neuropsychological tests of executive function, informant ratings of independent living skills, and observations of everyday function (Vizzotto et al., 2021). Seemingly no RCT of stand-alone GMT nor GMT in combination with other remediation interventions has yet been undertaken in

schizophrenia. Moreover, GMT has not been investigated among persons with early schizophrenia spectrum disorders or risk of psychosis.

Potential Moderators of GMT

Increasing knowledge of who benefits from cognitive remediation interventions is important so that clinicians can make appropriate recommendations and so that patients can choose the best treatments (Bowie et al., 2020; Cella et al., 2015; Wykes & Spaulding, 2011). Targeted interventions may reduce experiences of treatment failure for patients, their families, and clinicians.

Research on drill and strategy training in people with schizophrenia indicates that remediation is more effective for individuals with more severe global cognitive impairment and whose daily life function is poorer (DeTore et al., 2019; Vita et al., 2021). Still, since GMT requires learning a metacognitive strategy, severe executive dysfunction could interfere during sessions. In the field of traumatic brain injury, where GMT has been most widely studied, it is recommended for mild to moderate executive dysfunction (Cicerone et al., 2019). Moreover, studies show that working memory, inhibition, and shifting contributes to higher-order cognitive processes such as reasoning and learning (Collins et al., 2014; Robertson & Garavan, 2000; Zhu et al., 2020). Accordingly, severe impairments in the components of executive function may pose obstacles to successful remediation with GMT (Cicerone et al., 2019; Emmanouel et al., 2018).

Whether the discrepancy between subjective and objective cognition is an obstacle to effective cognitive remediation has also been investigated only rarely (Seccomandi et al., 2020). It is often assumed that greater objective than subjective dysfunction represents at least some difficulty in making accurate self-assessments (Harvey & Pinkham, 2015). In the context of cognitive remediation, difficulty recognizing cognitive challenges could lower motivation to rehearse new skills and strategies or perhaps understand when these need to be

applied in real life situations. Greater subjective than objective dysfunction, on the other hand, may at least partially correspond to negative thought patterns. For example, people with schizophrenia who have more subjective cognitive complaints than expected from their test performance also have higher self-reported depression and lower self-esteem (Cella et al., 2014; Raffard et al., 2020). The negative thought patterns often associated with depression and poor self-esteem (e.g., the attribution of success to external factors and failure to internal factors) could frustrate the recognition of potential abilities or improvements during cognitive remediation (Allott, Steele, et al., 2020; Beck et al., 2018). Thus, the discrepancy between subjective and objective executive function could represent an obstacle for effective cognitive remediation.

Unanswered Questions

The present study may help to fill certain important knowledge gaps in the research on remediation of executive functioning in people with early schizophrenia and risk of psychosis. First, to the best of the project group's knowledge, this study is the first RCT of stand-alone GMT in early intervention for psychosis. Despite some promising results, insufficient evidence exists for the efficacy of cognitive remediation in young individuals recently diagnosed with schizophrenia spectrum disorders or psychosis risk syndromes (Bowie et al., 2014; Datta et al., 2020; Deste et al., 2019; Gergov et al., 2022; Glenthøj et al., 2017; Vita et al., 2021). Investigations of metacognitive strategy training are rare in cognitive remediation studies in schizophrenia, although this form of remediation is recommended for executive dysfunction (Cicerone et al., 2019). Evaluating GMT as a standalone intervention allows for a better evaluation of mechanisms of change in cognitive remediation (Lejeune et al., 2021; Wykes & Spaulding, 2011).

Second, more knowledge of who benefits from cognitive remediation interventions is important to improve targeted treatment and to avoid repeated experiences of treatment failure (Bowie et al., 2020; Seccomandi et al., 2020; Wykes & Spaulding, 2011). The present study investigates the potential moderators of GMT efficacy, such as the severity of impairment in objective executive functions and discrepancies between self-reported executive function and task performance. Such a discrepancy has rarely been investigated specifically in executive functioning and seldom as a moderator of cognitive remediation (Raffard et al., 2020; Seccomandi et al., 2020).

Finally, despite the knowledge that the discrepancy between subjective and objective cognition is greater among those with schizophrenia than in the general population, little is known about psychological variables associated with this gap (Cella et al., 2014; Harvey & Pinkham, 2015; Potvin et al., 2014). The present study explores self-efficacy as a predictor of discrepancy between subjective and objective executive function. Furthermore, a five factor model of psychotic symptoms distinguishing positive, negative, disorganized, depressive, and excited symptoms is explored in the prediction of discrepancy.

Aims

The main aim of the research project of which this thesis is a part, is to investigate the potential of GMT to improve executive functioning among people with recently diagnosed broad schizophrenia spectrum disorder or risk of developing such a disorder. The potential to improve daily life function and clinical symptoms is also explored. Furthermore, the characteristics of those who benefit most from the intervention is investigated, allowing for future clinical recommendations. To increase the understanding of executive function in early schizophrenia, the significance of any discrepancy between subjective and objective measures is investigated among individuals with a schizophrenia spectrum disorder in the sample.

Aims of Paper I: Executive Dysfunction in Schizophrenia – Predictors of the Discrepancy between Subjective and Objective Measures

The first paper investigates what predicts the discrepancy between subjective and objective measures of executive function among persons with schizophrenia spectrum disorders. The relationship between discrepancy in cognitive assessment and psychological variables such as perceived self-efficacy has rarely been explored. Furthermore, the present study expands the research on the relationship between discrepancy in cognitive assessment and psychotic symptoms, by including disorganized and depressive symptoms. The results may aid clinicians in interpreting assessments of executive function in schizophrenia.

Aims of Paper II: A Randomized Controlled Trial of Goal Management Training for Executive Functioning in Schizophrenia Spectrum Disorders or Psychosis Risk Syndromes

The second paper aims to measure the effect of GMT in a sample of participants with schizophrenia spectrum disorders or psychosis risk syndromes using a randomized, controlled, parallel group trial design with a wait-list control group, masked assessors, and assessments immediately after intervention (5 weeks) and six-months after intervention (30 weeks). The primary outcome measures were self-reported executive function in everyday situations and a computerized attention task. Secondary outcome measures comprised a broad battery of neuropsychological tests of executive functions, a functional capacity task, and self-reported and clinician rated clinical symptoms and daily life function.

Aims of Paper III: Moderators of Metacognitive Strategy Training for Executive Functioning in Early Schizophrenia and Psychosis Risk

The third paper examines what characterized those participants who benefited most from GMT. Variation in objective executive function and discrepancy between subjective and objective measures of executive function were analyzed as moderators of efficacy of GMT. The results may aid clinicians and patients in treatment recommendation and selection.

Methods

Participants

Participants were recruited among patients who had been referred to Innlandet Hospital, Norway, for treatment of psychosis in the period 2012–2019. The study was conducted in the setting of early discovery and intervention for psychosis, where young people with signs of psychosis are referred for diagnostic assessment. Many of the referred patients had cognitive complaints. Those in the study sample were young, ranging 16–44 years with a mean age of 25 years. The median and mode age was 24 years. The gender distribution was 49 males (60%) and 32 females (40%). Approximately 80% of the participants had a schizophrenia spectrum disorder. Table 1 describes the baseline characteristics of the participants in the sample. Approximately half the participants (53.2%) were engaged in some form of work or study, and 18.5% received a disability pension.

The scores from the 16 participants with a psychosis risk syndrome are included in the analyses in the papers from the pre-registered trial on the efficacy of GMT and moderators of treatment effect of GMT (Paper II and III). The participants with a psychosis risk syndrome, six females and 10 males, did not differ significantly from participants with a schizophrenia spectrum disorder in the distribution of age in a Mann–Whitney test, M_{risk} = 23 years, *SD* 5.24 versus $M_{diagnosis}$ = 25 years, *SD* 6.53, *p*. 076. The mean years of education were 13 in both groups. The groups did not differ in estimated IQ scores, M_{risk} = 101.75, *SD* 14.44 versus $M_{diagnosis}$ 98.03, *SD* 13.97, *p* .475. Participants with psychosis risk syndromes had experienced fewer hospitalizations due to mental health, M_{risk} = 0.81, *SD* 1.33 versus $M_{diagnosis}$ = 3.23, *SD* 5.07, $p. < .001$. They had also spent fewer months in hospital than had participants with a diagnosis in the schizophrenia spectrum, M_{risk} = 1.47, *SD* 3.16 versus $M_{diagnosis}$ = 5.69, *SD* 8.15, $p. < .001$.

Table 1

Demographical and Clinical Characteristics (N = 81)

Sample characteristics	Frequency	*Mean*	*SD*	*SE*
Age		24.90	6.35	0.71
Gender				
Female	32 (39.50%)			
Male	49 (60.50%)			
Education (in years)		12.90	1.83	0.20
Estimated IQ		98.82	14.05	1.61
Employment				
Full-time work/study	16 (19.80%)			
Part-time work/study	11 (13.60%)			
Supported employment	16 (19.80%)			
Not working/studying	38 (46.80%)			
Living arrangements				
Alone	25 (30.90%)			
With partner and/or children	16 (19.80%)			
With parent	24 (29.60%)			
With friends/ in shared house	3 (3.70%)			
In supported housing	13 (16%)			
In a relationship	18 (22.20%)			
Schizophrenia spectrum disorder	65 (80.20%)			
Schizophrenia	29 (35.80%)			
Schizoaffective disorder	14 (17.30%)			
Schizophreniform disorder	6 (7.40%)			
Psychotic disorder NOS	15 (18.50%)			
Delusional disorder	1 (1.20%)			
Psychosis risk syndrome	16 (19.80%)			
Positive attenuated symptoms	9 (11.10%)			
Brief limited intermittent symptoms	5 (6.20%)			
Genetic risk w/ fall in function	2 (2.50%)			
Duration of untreated psychosis (weeks)		195.32	237.75	26.42
Symptoms of psychosis (mean scores)				
PANSS Positive		2.93	0.85	0.09
PANSS Negative		2.55	0.82	0.09
PANSS Disorganized		2.34	0.66	0.07
PANSS Depressive		3.46	0.92	0.10
PANSS Excited		2.16	0.70	0.08
Treatment				
Previous hospitalizations		2.75	4.68	0.52
Months in hospital		4.86	7.61	0.85
Current TAU				
Psychotherapy	49 (60.50%)			
Drug therapy	60 (74.10%)			
Antipsychotics	50 (61.70%)			
Defined daily dose				
Antipsychotics		0.560	0.72	0.08
Antidepressants		0.493	0.87	0.97
Mood stabilizers		0.116	0.43	0.05
Central nervous system stimulants		0.041	0.19	0.02
Anxiolytics (antihistamines)		0.012	0.08	0.01
Anxiolytics (benzodiazepines)		0.059	0.25	0.03
Sedatives (antihistamines)		0.041	0.22	0.02
Sedatives (benzodiazepines)		0.107	0.35	0.04

The scores from the participants with a psychosis risk syndrome are not included in the analysis in Paper I, which investigates discrepancy between subjective and objective executive function. Since the paper is a novel investigation of discrepancy in the executive domain, limiting heterogeneity in the sample was a priority. It is presently unknown whether average patterns of discrepancy between subjective and objective cognition are similar among at-risk participants and people with schizophrenia (Glenthøj et al., 2020).

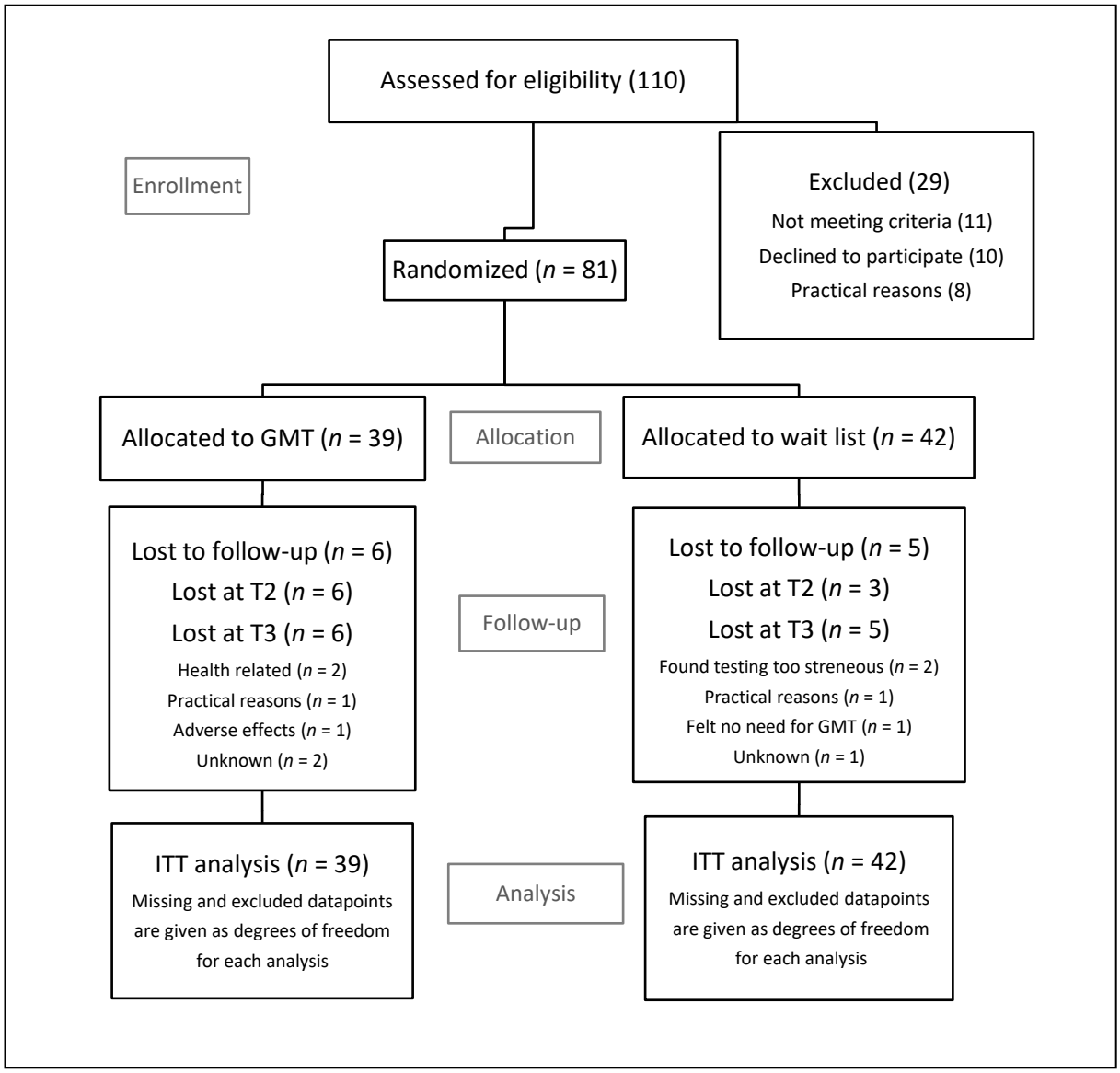
Study Design and Procedures

A randomized, controlled, and masked parallel group trial was conducted. Half the participants received GMT immediately after baseline assessment and the other half was assigned to a wait-list control condition receiving treatment as usual (TAU). Measurements were gathered at baseline (T1: 0 weeks), post-intervention (T2: 5 weeks), and in a six-month follow-up assessment (T3: 30 weeks). Figure 1 presents a flow chart of the trial according to CONSORT guidelines for parallel group trials (Schulz et al., 2010).

The inclusion criteria were people of ages 16–69 with a diagnosis of schizophrenia spectrum disorder according to the DSM-IV or a psychosis risk syndrome (American Psychiatric Association, 2000; Miller et al., 1999; Yung et al., 1998). Risk was defined according to the criteria of three psychosis risk syndromes characterized by attenuated positive symptoms, brief intermittent psychotic symptoms, or genetic risk and deterioration in function (Miller et al., 1999; Yung et al., 1998). In addition, eligible participants had to have subjective complaints of executive dysfunction according to the Behavior Rating Inventory of Executive Function – Adult version (BRIEF-A) (Roth & Gioia, 2005). T-scores above 55 were defined as the cut off for inclusion. According to American norms, scores above T65 are considered clinically relevant, but in the Norwegian cultural context, scores greater than T55 has proven to be more appropriate (Løvstad et al., 2016; Roth & Gioia, 2005).

Figure 1

Flowchart of Allocation and Attrition



Exclusion criteria for participants were ongoing substance or alcohol abuse or dependency, an IQ < 70, an acquired brain injury or degenerative neurological disease, or treatment for psychosis for more than five years.

Diagnostic assessment was done by a clinical psychologist (I.H., the PhD-candidate) under supervision from a specialist in psychiatry (E.H., co-supervisor) using the Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV) Axis I disorders, SCID-I, and the Structured Interview for Prodromal Symptoms (First et

al., 2005; Miller et al., 1999). Estimated IQ was measured with the Matrix Reasoning and Vocabulary subtests from Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) or the General Ability Index from Wechsler's Adult Intelligence Scale, 4th edition (WAIS-IV; Wechsler, 2008). Neuropsychological assessment was done by the same psychologist under supervision from a specialist in neuropsychology (M.G.Ø., principal investigator and main supervisor).

After assessment for eligibility, 81 participants were randomly assigned to GMT (n = 39) or a wait list condition receiving TAU (n = 42) using computerized randomization from https://www.randomizer.org. A person independent from the study team performed and kept a record of the randomization. Baseline assessments were collected by the PhD-candidate and two trained psychiatric nurses. Post-intervention and follow-up assessments were collected by the nurses, and group allocation was masked.

All participants gave informed consent, and the study was conducted in accordance with the World Medical Association's Declaration of Helsinki on ethical principles for medical research involving humans subjects (World Medical Association, 2013). The research was approved by the Regional Committee for Medical and Health Research Ethics in Norway (2015/2118) prior to commencement. Participants in the TAU condition were offered GMT after study completion. Advisors with service-user experience were involved in the planning and evaluation of the study. Funding for the study was provided by the South-Eastern Norway Health Authority (grant number 2017012), Innlandet Hospital Trust (grant number 150602), and University of Oslo (grant number 353139). Funders had no involvement in the execution of the study.

The study was preregistered as a clinical trial at clinicaltrials.gov (NCT03048695 09/02/2017). The preregistration specified three primary outcome measures: the questionnaire Behaviour Rating Inventory of Executive Function (BRIEF-A; Roth & Gioia, 2005), the

computerized attention task Conners Performance Test, 3rd edition (CPT 3; Conners, 2014), and symptoms of psychosis assessed with the Positive and Negative Symptom Scale (PANSS; Kay et al., 1987). The present study evaluates the effect of GMT on executive function, daily life function and clinical symptoms. A fourth paper based on a recent master thesis, not included in the present doctoral thesis, will explore the effect of GMT on wellbeing (Øie, 2021).

Certain minor changes were made to the protocol after pre-registration, due to assessment days being too costly and strenuous. As a result, data from the Digit Letter Sequence task and the Iowa Gambling Task were collected only at baseline. Goal attainment scaling was originally intended as an outcome measure, but was integrated into the GMT manual instead. Due to an administration error, the Cognitive Failures Questionnaire was excluded from the protocol.

Assessment

Table 2 presents the instruments, assessment times, and variables analyzed in the present study.

Subjective Executive Function

Behavior Rating Inventory of Executive Function – Adult version, BRIEF-A, is a 75-item self-report questionnaire of executive difficulties in everyday situations (Roth & Gioia, 2005). The items are arranged in the nine subscales covering central domains of executive function: Inhibit, Shift, Emotional Control, Self-Monitor, Initiate, Working Memory, Plan/Organize, Task Monitor, and Organization of Materials. The instrument has shown good test-retest reliability ranging from *r* .82 to *r* .93 across the nine subscales (Roth & Gioia, 2005). The total scale showed good internal consistency in the present study at baseline with a Cronbach's alpha score of $\alpha = .95$.

Objective Executive Function

Inhibition. Detectability and commission errors from Conners Performance Test, 3rd edition, CPT 3, were used as measures of inhibition. The CPT 3 is a computerized reaction task assessing several aspects of inattention (Conners, 2014). Participants respond as quickly as they can by button push to letters appearing on a screen and try to avoid pressing the button when the letter X is displayed. Detectability, used as a primary outcome measure of the GMT trial in Paper II, is the ratio of incorrectly acknowledged non-targets to correctly identified targets. The age normed T-score for commission errors, or portion of endorsed non-targets was used as a measure of inhibition in Paper I and III. Both measures have shown adequate split-half reliability (r = .91-.92) and test-retest reliability (r = .74 - .85) in a normative sample (Conners, 2014).

The Color-Word Interference Test (CWIT, condition three, from the Delis-Kaplan Executive Function System, D-KEFS) was also used to measure inhibition (Delis et al., 2001). The CWIT is a timed Stroop task assessing inhibition and shifting. The task consists of four conditions: naming colors, reading, inhibition, and inhibition/switching. In the inhibition condition, the participants must override the automatic response to read a word and instead name the color of the ink of the printed word. The ink color is often incongruent to the meaning of the word, for example the word “red” printed in blue ink. The test-retest reliability correlation for the inhibition condition of CWIT in normative samples is r = .71 in adults and r = .90 in adolescents (Delis et al., 2001).

Table 2

Assessment tools

		Variables in the analyses		
Instrument	**Time points**	**Paper I**	**Paper II: RCT**	**Paper III**
Diagnostic and Statistical Manual of Mental Disorders-IV Axis I (SCID-I) (First et al., 2005)	Inclusion			
Structured Interview for Prodromal Symptoms (SIPS) (Miller et al., 1999)	Inclusion			
Structured Clinical Interview for the Positive and Negative Syndrome Scale for Schizophrenia (SCI-PANSS) (Kay et al., 1987)	T1, T2, T3	Predictor: Total and mean scores for five symptom categories (Wallwork et al., 2012)	Secondary outcome and controlling for: Total scores in five symptom categories (Wallwork et al., 2012)	
Symptom checklist, brief ten-item version (SCL-10) (Derogatis et al., 1974)	T1, T2, T3		Secondary outcome: Total score	
Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999)	Inclusion T1	Controlling for: Estimated IQ from Matrix Reasoning and Vocabulary	Controlling for: Estimated IQ from Matrix Reasoning and Vocabulary	
Wechsler's Adult Intelligence Scale, 4th edition (WAIS-IV) (Wechsler, 2008)	Inclusion T1	Controlling for: Estimated IQ from General Ability Index (GAI)	Controlling for: Estimated IQ from General Ability Index (GAI)	
Behavior Rating Inventory of Executive Function - Adult version (BRIEF-A) (Roth & Gioia, 2005)	Inclusion T1, T2, T3	Dependent variable (discrepancy) based on *T*-scores for Inhibit, Shift, and Working Memory subscales	Primary outcome: Total raw score Post-hoc analysis: Nine subscale scores	Outcome variable: Total raw score Moderator variable (discrepancy) was created from *T*-scores for Inhibit, Shift, and Working Memory subscales
Conners Continuous Performance Test 3rd edition (CPT 3) (Conners, 2014)	T1, T2, T3	Dependent variable (discrepancy) based on *T*-score for commission errors	Primary outcome: Detectability (d') raw score Post-hoc analysis: Change in GMT vs change in TAU	Moderator variables based on *T*-score for commission errors

Letter Number Sequencing from WAIS-IV (Wechsler, 2008)	T1	Dependent variable (discrepancy) based on total scaled score		Moderator variables based on total scaled score
Digit Span from WAIS-IV (Wechsler, 2008)	T1, T2, T3	Dependent variable (discrepancy) based on total scaled score	Secondary outcome: Total number of correct trials from the forward, backwards, and sequential conditions	Moderator variables based on total scaled score
Trail Making Test (TMT) from the Delis-Kaplan Executive Function System (D-KEFS) (Delis et al., 2001)	T1	Dependent variable (discrepancy) based on scaled score for time spent on condition 4, Letter-Number Switching.		Moderator variables based on scaled score for time spent on condition 4, Letter-Number Switching.
Color-Word Interference Test (CWIT) from D-KEFS (Delis et al., 2001)	T1, T2, T3	Dependent variable (discrepancy) based on scaled score for time spent on Inhibition and Switching conditions	Secondary outcome: Time – raw scores in seconds were used to create raw contrasts between conditions 4 versus 3 (switching) and between condition 3 versus 1 and 2 (inhibition)	Moderator variables based on scaled score for time spent on Inhibition and Switching conditions
Tower Test from D-KEFS (Delis et al., 2001)	T1, T2, T3		Secondary outcome: Total achievement raw score	
University of California San Diego Performance-based Skills Assessment, brief version (UPSA-B) (Patterson et al., 2001; Patterson & Mausbach, 2006)	T1, T2, T3		Secondary outcome: Total score	
Hotel Task (Manly et al., 2002)	T1, T2, T3		Secondary outcome: Seconds deviating from optimal time distribution	
Social Functioning Scale (SFS) (Birchwood et al., 1990)	T1, T2, T3		Secondary outcome: Independence Competence and Independence Performance	
Global Assessment of Functioning-Split Version (GAF) (American Psychiatric Association, 2000)	T1, T2, T3		Secondary outcome: Total score	
General Self-efficacy Scale (GSES) (Schwarzer & Jerusalem, 1995).	T1, T2, T3	Predictor: Total score		

Note. T1 = Time one, baseline assessment; T2 = Time two, post-intervention assessment; T3 = Time three, follow-up assessment six months after intervention.

Shifting. To measure shifting, condition four of CWIT, inhibition/switching, from D-KEFS was used (Delis et al., 2001). In this condition of the test, the participants must continually swap between reading words and naming ink colors. The test-retest reliability correlations for the inhibition/switching condition in normative samples is $r = .52$ in adults, and $r = .80$ in adolescents (Delis et al., 2001). In addition to the time spent on conditions three and four, raw contrast scores may be calculated and used to separate the confounding effects of processing speed (Neill & Rossell, 2013; Savla et al., 2010). This procedure was used in Paper II in the analysis of the outcome of the GMT trial.

At baseline, condition four of the Trail Making Test from D-KEFS was used as an additional measure of shifting. Condition four of TMT, Letter-Number Switching, is a timed task where participants are asked to draw lines while continually shifting between numbers in increasing order and letters in alphabetical order (e.g., 1-A-2-B). In normative samples, the test-retest correlation for the measure is $r = .38$ (Delis et al., 2001).

Working Memory. The two subtests Digit Span and Letter-Number Sequencing from WAIS-IV were used to assess working memory (Wechsler, 2008). The Letter-Number Sequencing test has a test-retest reliability of $r = .80$ (Wechsler, 2008). The three conditions of the Digit Span test has adequate internal consistency ($\alpha = .78$ - $.89$) and test-restest reliability ($r = .71$ - $.77$) in normative samples (Wechsler, 2008).

Planning. The Tower Test is a strategic planning task in which participants solve wooden puzzles with as few moves as possible. Higher scores indicate better performance. The test has yielded test-retest correlations of r .41–51, in normative samples with adolescents and young adults (Delis et al., 2001).

Interacting Objective Executive Functions. The Hotel Task is a naturalistic role playing task mimicking a real world multitasking work environment (Manly et al., 2002). Participants are asked to work on five tasks for 15 min, dividing their time equally between

sorting coins, proofreading, filling out bills, sorting name tags alphabetically, and finding phone numbers in a registry. In addition, they are to press a button at two specific times to open and close a door for deliveries. Optimal time distribution is 180 s per task. The number of seconds deviating from optimal time distribution was used as an outcome measure of the GMT trial in the present study.

Functional Capacity

The University of California San-Diego Performance-based Skills Assessment – Brief Version, UPSA-B is a functional capacity task developed especially for the assessment of potential real-world function in persons with serious mental illness (Patterson et al., 2001; Patterson & Mausbach, 2006). During the task, participants are asked to count money, pay bills, and reschedule a doctor's appointment using a telephone. The test provides a total score out of 100. The test showed good psychometric reliability and validity in a recent, large systematic review (Becattini-Oliveira et al., 2018). It has small-to-moderate significant correlations with measures of function, including independent residential status (Szabo et al., 2018).

Daily Life Functioning

Social Functioning Scale, SFS, is a self-reported questionnaire initially designed for people with schizophrenia (Birchwood et al., 1990). The Norwegian translation of the scale has been shown reliable and valid among people with schizophrenia (Hellvin et al., 2010). The scale consists of the seven subscales: Withdrawal, Interpersonal Behavior, Pro-Social Activities, Recreation, Independence Competence, Independence Performance, and Employment. Independence Ability and Independence Performance were used as outcome measures of the RCT in Paper II, as these subscales reflect activities of daily living. The remaining subscales cover aspects of social functioning more likely associated with social cognition than executive function (Horan et al., 2011). It was also considered unlikely that

GMT could change a participant's occupational status in six months, since employment also depends on external factors. The internal consistency of the Independence Performance subscale, α = .81, and of the Independence Competence subscale, α = .65, were adequate in the present study.

Global Assessment of Functioning - Split version, GAF-F, was used as a clinician rating of global daily life function (American Psychiatric Association, 2000). The scale renders a score 0–100, where higher scores indicate better functioning in important context, for example in school or work, socially, and in daily activities (e.g., hygiene practices). Scores are highly consistent when raters are experienced in using the scale (Pedersen et al., 2007).

Self-Efficacy

The General Self-Efficacy Scale, GSES, is a 10-item self-reported questionnaire about beliefs in having the required abilities to reach goals and handle problems if they arise (Schwarzer & Jerusalem, 1995). The scale has shown good test-retest reliability and internal consistency in studies with participants with schizophrenia (Chiu & Tsang, 2004). In the current study, the Cronbach alpha coefficient for the scale was α = .85.

Symptoms of Psychosis

The Structured Clinical Interview for the Positive and Negative Syndrome Scale for Schizophrenia, SCI-PANSS, was used to assess the severity of psychotic symptoms at the time of testing (Kay et al., 1987). The SCI-PANSS provides clinician ratings of 30 symptoms based on a structured interview with participants, supplemental information from caregivers, and observations. Symptom severity is measured on a scale ranging from 1 (absent) to 7 (extreme). A score of 4 is considered above psychotic threshold for the items covering hallucinations and delusions. The inter-rater reliability of the Norwegian version of the instrument is adequate when it is performed by trained clinicians (Friis et al., 2003). Symptoms were grouped according to a five-factor consensus model with positive, negative,

disorganized, depressive, and excited symptoms (Wallwork et al., 2012). The internal consistency of the five factors was adequate at baseline, ranging from α = .55 for three depressive symptoms, α = .62 for three disorganized symptoms, α = .64 for four positive symptoms, and α = .73 for four excited symptoms to α = .85 for six negative symptoms.

In addition participants self-reported symptoms of psychological distress during the week of testing using the ten item version of the Symptom Check List, SCL-10, (Derogatis et al., 1974). The questionnaire reflects subjectively experienced anxiety and depressed mood. Items are scored on a scale ranging from 1 (a little bothered) and 4 (very bothered). The SCL-10 has shown adequate psychometric qualities equivalent to longer versions of the instrument and it has been validated in the Norwegian population (Strand et al., 2003). The internal consistency of the questionnaire at baseline in the present sample was, α = .83.

Executive Function in the Sample at Baseline

At baseline, the sample showed elevated subjective complaints of executive function in real-world situations. The mean total BRIEF-A *T*-score in the sample was *T*68. Higher scores mean more self-reported executive difficulties. The mean score in the sample is higher than the normative mean of *T*50 and the clinical cut-off of *T*65 according to US norms (Roth & Gioia, 2005). The score is also more than one standard deviation above *T*55, which is considered clinically relevant in the Norwegian cultural context (Løvstad et al., 2016). Table 3 shows scores on the subscales of BRIEF-A in the sample. In addition, the table shows separate mean scores for participants with schizophrenia spectrum disorder and psychosis risk syndrome. Both groups reported executive difficulties above the normative mean on all subscales.

Despite subjective working memory complaints, the sample showed comparable performance to normative samples on the working memory tasks Digit Span and Letter

Number Sequencing. All conditions of the CWIT were completed more slowly than the normative average. When contrasting the conditions requiring shifting and inhibition with less demanding conditions, however, no additional slowing was apparent. Similar results have been found in previous studies (Savla et al., 2010). On average, the sample showed greater difficulties differentiating between targets and non-targets on the CPT 3. This finding is aligned with those of other studies using versions of the CPT with varying complexity in large samples with patients having schizophrenia (Nuechterlein et al., 2015). Table 4 shows objective executive functioning in the sample compared to the standardized means derived from large norming samples with healthy participants listed in the test manuals of the instruments (Conners, 2014; Delis et al., 2001; Roth & Gioia, 2005; Wechsler, 2008). Scores were similar among participants with schizophrenia spectrum disorders and psychosis risk syndromes, but at-risk participants did not show slowing on the CWIT. They did, however, show slowing similar to the group with a diagnosis on the switching condition of the Trail Making Test.

Comparisons of Treatment Groups at Baseline

Any baseline differences between the treatment groups after randomization are considered incidental (Moher et al., 2010). The GMT group reported more subjective EF complaints at baseline, $F(1,72) = 6.66$, $p = .012$. They showed a significantly lower level of negative symptoms than the TAU group, $F(1, 79) = 17.34$, $p = .008$. More participants in the GMT group received psychotherapy, χ^2 (1, 80) = 6.05, $p = .016$, $\varphi c = .27$. The groups were otherwise comparable in demographical, clinical, and cognitive variables. Table 5 shows the baseline comparisons of the two treatment groups.

Table 3

Subjective Executive Function at Baseline

	Norms	Sample (N = 81)			Schizophrenia spectrum (n = 65)			Psychosis risk (n = 16)		
	M (*SD*)	*M* (*SD*)	*T*	Sig.	*M* (*SD*)	*t*	Sig.	*M* (*SD*)	*t*	Sig.
BRIEF-A Total	*T*50 (10)	68.08 (10.59)	14.68	< .001	67.00 (10.86)	12.12	< .001	72.71 (8.13)	10.46	< .001
Inhibit	*T*50 (10)	58.43 (11.72)	6.19	< .001	57.07 (11.80)	4.64	< .001	64.29 (9.73)	5.49	< .001
Shift	*T*50 (10)	62.82 (11.30)	9.76	< .001	62.88 (11.76)	8.49	< .001	62.57 (9.46)	4.97	< .001
Emotional Control	*T*50 (10)	58.01 (11.73)	5.88	< .001	57.23 (12.05)	4.65	< .001	61.36 (9.92)	4.28	< .001
Self-Monitor	*T*50 (10)	53.95 (10.97)	3.10	.001	53.05 (11.22)	2.11	.040	57.79 (9.19)	3.17	.007
Initiate	*T*50 (10)	68.92 (12.01)	13.55	< .001	68.10 (12.73)	11.02	< .001	72.43 (7.66)	10.95	< .001
Working Memory	*T*50 (10)	67.73 (10.38)	14.70	< .001	67.68 (10.50)	13.04	< .001	67.93 (10.20)	6.58	< .001
Plan/ Organize	*T*50 (10)	62.53 (9.83)	10.96	< .001	61.62 (9.59)	9.39	< .001	66.43 (10.27)	5.99	< .001
Task Monitor	*T*50 (10)	61.01 (11.01)	8.61	< .001	60.23 (11.02)	7.19	< .001	64.36 (10.67)	5.03	< .001
Organizing Materials	*T*50 (10)	54.78 (10.59)	3.27	< .001	53.33 (12.73)	2.16	.035	60.07 (10.78)	3.50	.004

Note. One sample *t*-test comparison of mean scores to normative mean values in healthy populations (Roth & Gioia, 2005). Higher scores indicate greater difficulties.

Table 4

Objective Executive Function at Baseline

	Norms	Sample (*N* = 81)			Schizophrenia spectrum (*n* = 65)			Psychosis risk (*n* = 16)		
	M (*SD*)	*M* (*SD*)	*t*	Sig.	*M* (*SD*)	*t*	Sig.	*M* (*SD*)	*t*	Sig.
Inhibition										
CPT d'	*T*50 (10)	54.88 (10.38)	4.23	< .001	55.65 (10.21)	4.46	< .001	51.75 (10.83)	0.65	.528
CPT commissions	*T*50 (10)	55.98 (10.63)	5.06	< .001	57.15 (10.91)	5.29	< .001	51.19 (7.99)	0.60	.561
CWIT3 time	*SS*10 (3)	8.27 (3.46)	-4.46	< .001	7.76 (3.35)	-5.30	< .001	10.25 (3.24)	0.31	.761
CWIT3 contrast	SS10 (3)	11.41 (2.66)	4.69	< .001	11.40 (2.58)	4.30	< .001	11.44 (3.05)	1.88	.079
Shifting										
TMT4 time	*SS*10 (3)	6.76 (3.91)	-7.18	< .001	6.53 (3.98)	-6.70	< .001	7.63 (3.59)	-2.64	.018
TMT4 contrast	*SS*10 (3)	8.65 (3.50)	-3.33	.001	8.78 (3.38)	-2.78	.007	8.19 (4.00)	-1.81	.090
CWIT4 time	*SS*10 (3)	7.95 (3.85)	-4.74	< .001	7.60 (3.74)	-5.08	< .001	9.31 (4.06)	-0.68	.509
CWIT4 contrast	*SS*10 (3)	9.73 (2.97)	-0.80	.429	9.87 (3.02)	-0.33	.740	9.19 (2.79)	-1.17	.262
Working memory										
Digit Span	*SS*10 (3)	9.88 (2.60)	-0.39	.697	9.79 (2.58)	-0.64	.525	10.25 (2.74)	0.36	.721
Letter Number Seq.	*SS*10 (3)	9.68 (2.77)	-1.03	.307	9.69 (2.75)	-0.88	.381	9.63 (2.92)	-0.51	.615
Planning										
Tower	*SS*10 (3)	10.60 (2.53)	2.15	.034	10.49 (2.60)	1.52	.132	11.06 (2.21)	1.93	.073

Note. One sample t-test comparisons of mean scores to normative mean values in healthy populations based on the norming samples in the test manuals of the instruments (Conners, 2014; Delis et al., 2001; Roth & Gioia, 2005; Wechsler, 2008). For CPT, higher scores indicate greater difficulties distinguishing between targets and non-targets. For the other tests, higher scores indicate better or faster performance.

Table 5

Baseline Comparisons of Treatment Groups

	GMT (*n* = 39)				TAU (*n* = 42)				
	Frequency	*M*	*SD*	*SE*	Frequency	*M*	*SD*	*SE*	*p*
Sex									.102
Female	19 (49%)				13 (31%)				
Male	20 (51%)				29 (69%)				
Age		25.46	6.68	1.07		24.38	6.07	0.94	.504
Years of education		13.00	2.00	0.32		12.81	1.67	0.26	.814
Diagnosis									.869
Schizophrenia	31 (80%)				34 (81%)				
Psychosis risk	8 (20%)				8 (19%)				
Symptoms (mean)									
Positive		3.05	0.87	0.14		2.82	0.82	0.13	.265
Negative		2.31	0.73	0.12		2.78	0.84	0.13	**.012**
Depressive		3.46	0.96	0.15		3.45	0.89	0.14	.830
Disorganized		2.29	0.57	0.09		2.39	0.73	0.11	.701
Excited		2.24	0.65	0.10		2.10	0.73	0.11	.279
DUP (weeks)		205.44	266.77	42.72		185.93	210.11	32.42	.924
Drug therapy	30 (77%)				30 (71%)				.573
Antipsychotics	23 (59%)				27 (64%)				.623
Psychotherapy	29 (59%)				20 (41%)				**.016**
Estimated IQ		98.65	15.11	2.48		98.97	13.17	2.11	.670
Objective EF (total)		8.60	2.28	0.37		8.87	1.86	0.29	.511
Subjective EF (total)		71.31	8.96	1.51		65.18	11.21	1.79	**.012**

Note. Comparisons using the Mann–Whitney test for continuous variables and Pearson Chi Square test for categorical variables.

The Intervention: Goal Management Training

GMT was administered in 9 (twice weekly) sessions of 2 h each, using the Norwegian translation of the current GMT research protocol (Stubberud et al., 2013b). A recent meta-analysis of all GMT studies found that the training is most effective when sessions are held more frequently than once a week (Stamenova & Levine, 2018). Table 6 summarizes the content of the GMT sessions. GMT was administered to groups of three to eight participants by a trained therapist (I.H.) and a local co-therapist recruited among clinicians who work with the patient group. Training in the GMT manual was provided by an experienced GMT therapist and neuropsychologist (J.S., co-supervisor). Co-therapists were doctors, psychologists, occupational therapists, or psychiatric nurses.

The manual takes the form of PowerPoint-slides with an accompanying script for the therapist and participant workbooks. The training consists of psychoeducation and the normalization of executive dysfunction, discussions of lived examples, and in-session and between-session exercises demonstrating inattentiveness or mindful goal-achievement. The current GMT manual includes mindful breathing exercises to encourage adequate arousal and further to improve the focus on goals in the present situation (Kabat-Zinn, 1990; Levine et al., 2011). However, for the present study, the GMT manual was revised by removing a mindfulness exercise involving sensory scanning of the body to reduce discomfort in case of tactile hallucinations or self-anomalies among people with psychosis. An exercise was added where participants developed one individual long-term goal according to the procedures in goal attainment scaling (Ashford & Turner-Stokes, 2006). A review of GMT studies showed that personal goals increased the effect of the intervention (Krasny-Pacini et al., 2014). Text messages reading “STOP” were sent to participants once a day between sessions four and nine as a reminder to rehearse the GMT strategies. Cueing also interrupts ongoing thought

processes and sparks goal directed behavior in the moment (Fish et al., 2007; Manly et al., 2002). Text messages have shown potential in prompting activities of daily living among people with schizophrenia (Pijnenborg et al., 2007). Individual makeup sessions were offered to ensure that participants received all nine sessions even if they had to cancel a regular session. Five participants completed the last three sessions via videoconference due to the outbreak of the Covid-19 pandemic. After follow-up assessment, wait-listed control participants were offered GMT.

The treatment group received GMT in addition to treatment as usual, in accordance with national guidelines on treatment for psychosis (Norwegian Health Authority, 2013). The control group received treatment as usual. Treatment often involves a combination of pharmacological and psychosocial interventions. In the present study, 62% of participants received anti-psychotic drugs as part of their treatment, and an additional 12% received other pharmacological treatment. The average daily dosage of anti-psychotic drugs was 0.560, which is similar to other cognitive remediation studies (Lejeune et al., 2021; Vita et al., 2021). Around 61% received psychotherapy, and an additional 24% received some form of supportive conversation on a regular basis. The treatment variation is partly explained by diagnosis, as antipsychotic drugs are not routinely recommended for at-risk states. In addition, although participants were recruited through the early detection and intervention for psychosis clinics, follow-up care was provided in different settings. At the time of inclusion, eight participants were in-patients, five were living in other institutions, and 56 were outpatients. Some of the outpatients received continued care in the specialized early intervention clinics, whereas others received care in general mental health clinics closer to their home. Twelve participants received care from their general practitioner rather than at the hospital.

Table 6

Content of Goal Management Training

Module	Content	In session exercises	Between sessions exercises
1. Present- and absentmindedness	Absentmindedness is normal. Present mindedness can be practiced.	Clapping task Mindful eating of a raisin	Record absentmindedness, practice present mindedness
2. Slip-ups	Absentmindedness can lead to slip-ups	Clapping task Set personal goal	Record slip-ups, practice present mindedness
3. The autopilot	Acting on autopilot (absentmindedly) can lead to slip-ups	Sorting cards Breathing exercise	Record slip-ups, practice breathing exercise
4. STOP the autopilot	Saying STOP interrupts the autopilot and allows us to refocus	Sorting cards with STOP Short breathing exercise	Practice STOP 30 minutes each day, practice breathing exercise
5. The mental blackboard	Update working memory using the STOP-FOCUS-CHECK sequence	Sorting cards with distraction Short breathing exercise	Practice STOP-FOCUS-CHECK MENTAL BLACK BOARD 30 minutes each day, practice breathing exercise
6. State your goal	Stating goals aloud before and during tasks helps goal-attainment	Complex exercise that requires switching between 5 tasks	Practice STOP-FOCUS-STATE YOUR GOAL-CHECK 30 minutes each day
7. Decision making	Recognize stress as a signal to use strategy to overcome indecision	Complex decision making task	Practice STOP-FOCUS-STATE YOUR GOAL- CHECK when naturally occurring Internet shopping task
8. Dividing goal into smaller goals	Large tasks are often made up of smaller tasks. Add “split goal” to strategy when overwhelmed.	Define the subgoals in moving house Organize wedding	Practice STOP-FOCUS-STATE YOUR GOAL-SPLIT GOAL INTO SMALLER GOALS-CHECK
9. Check that you are meeting your goal	Checking if actions help reach the goal can improve efficiency	Revisit clapping task Summary of the training	

Statistical Analysis

All analyses were performed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). Scores were inspected for normal distribution and extreme values. Outlying scores or extreme residuals more than three standard deviations from the mean were removed. Scores from CWIT Inhibition and SFS Independence, Competence, and Duration of Untreated Psychosis (DUP) were transformed because of skewed distributions. Age normed scores were used in Papers I and III to allow for comparison with normative values of subjective and objective executive function, since the study does not include a healthy control group. In Paper II, raw scores were entered into the analysis to retain variance, as the comparison centers on differences between the GMT group and the TAU group.

Paper I. The predictive value of self-efficacy (GSES) and symptoms (PANSS) on the discrepancy between subjective (BRIEF-A) and objective executive function (neuropsychological tests) was analyzed using a multiple linear regression analysis with bias-corrected bootstrapping. Psychotic symptoms were grouped according to a five factor consensus model with positive, negative, disorganized, depressed, and excited symptoms (Wallwork et al., 2012). Discrepancy scores were calculated along a dimension ranging from sensitivity (greater subjective than objective executive dysfunction) to stoicism (greater objective than subjective executive function), according to a framework from research on affective disorders (Miskowiak et al., 2016).[2] Four analyses were run, one for each central component of executive function: inhibition, shifting, and working memory, plus one for total executive function. The scores from participants with a diagnosis in the schizophrenia

[2] A note on language: The terminology used for discrepancy varies somewhat between Paper I and Paper III. The Stoicism-Sensitivity framework (Miskowiak et al., 2016) has methodological advantages outlined in Paper I, but the words stoicism and sensitivity unintentionally imply psychological mechanisms that the present study does not measure. Thus, in Paper III a more neutral language is used. *Lack of neurocognitive insight*, used elsewhere, was also avoided as this implies assumptions about the reasons for discrepancy not measured and may underestimate the validity of subjective measures (van Aken et al, 2022; Bulzacka et al., 2013)

spectrum were included in this analysis, excluding the scores from participants with a psychosis risk syndrome.

Paper II. The effect of GMT on subjective executive function (BRIEF-A), objective executive function (CPT detectability, CWIT inhibition, and switching, Digit Span, the Tower Test, and Hotel Task), functional capacity (UPSA), and daily life function (Independence Competence and Independence Performance from SFS and GAF-F) was analyzed using linear mixed models analysis. The model specified fixed effects of time, group, and group × time were specified, and a random intercept. A first-order autoregressive covariance matrix was specified for the repeated measurements. Restricted maximum likelihood was used as method of estimation. Any significant differences after randomization between the GMT and TAU groups are considered coincidental (Moher et al., 2010). The TAU group had more baseline negative symptoms and fewer subjective executive complaints than did the GMT group. More participants in the GMT group received psychotherapy as part of their treatment than did those in the TAU group. When controlled for, neither of these variables changed the outcome of the analysis. Demography (gender, age, education) and clinical variables (symptoms of psychosis, concomitant treatment, duration of untreated psychosis, hospitalizations) were also controlled for.

Statistical Power. An a priori power analysis for the RCT estimated that a sample size of 60 participants would render sufficient statistical power to detect a moderate effect size on BRIEF-A in a repeated measures ANOVA. Instead of the planned ANOVA, linear mixed models analysis was adopted to include data from all participants intended to receive treatmeant (Gupta, 2011).

Nine participants dropped out of the study before post-intervention assessment. This number increased to 11 at follow-up assessment. No significant differences were found between completers and non-completers of the study.

A complete data set was difficult to achieve for logistical reasons. Long assessment days and a challenging geography with significant travel time led us to allow questionnaires to be completed at home. Missing data was assumed to be missing at random, as no differences were detected between those who filled out questionnaires once, twice, or three times. The variables tested were treatment condition (GMT or TAU), discrepancy between subjective and objective cognition, demography (gender, age, and education), clinical characteristics (diagnosis, symptoms, global function, and treatment), and cognitive characteristics (estimated IQ, subjective, and objective executive function). Imputation of missing scores was not performed, as mixed models provide unbiased estimates under the assumption of missing at random (Krueger & Tian, 2004; Muth et al., 2016; Schielzeth et al., 2020).

Clinically Reliable Change. To check whether statistically significant effects were clinically relevant, the procedures for calculating a Reliable Change Index (RCI) were used (Jacobson & Truax, 1991). The index identified individuals with clinically reliable improvement from baseline (T1) to follow-up (T3) measured with BRIEF-A.

Paper III. A mixed models analysis similar to Paper II was used to test whether the fixed effect of GMT × time on subjective executive function (BRIEF-A) remained significant when adding objective executive function and discrepancy between subjective and objective executive function as moderators. A mean total score of objective executive neuropsychological tests was entered as a continuous variable. Discrepancy was entered as a categorical variable with four clusters of participants: both subjective and objective executive dysfunction, mostly subjective executive dysfunction, mostly objective executive dysfunction, or neither subjective nor objective executive dysfunction. Clusters were created from scores on subjective and objective measures of executive function using a two-step cluster analysis based on Schwartz's Bayesian criterion. The cluster solution was judged to be fair, with

adequate cohesion within clusters and separation between clusters. Eight participants were not assigned clusters due to missing scores on one or more measures.

In Paper III, the same linear mixed model was used as in Paper II, but with maximum likelihood (ML) as method of estimation rather than restricted maximum likelihood (REML). ML is preferable when the objective is to compare nested models. Additionally, in Paper III the effect of baseline differences in the outcome measure were controlled for by removing the main effect of treatment condition from the initial model (Twisk et al., 2018).

Summaries of Papers with Results

Paper I: Executive Dysfunction in Schizophrenia – Predictors of the Discrepancy Between Subjective and Objective Measures

Background

Subjective (self-reports) and objective (neuropsychological tasks) measures of cognition have lower correlations among people with schizophrenia than among healthy controls. This discrepancy has not been thoroughly investigated in the cognitive domain of executive function. The causes of the discrepancy are also unclear, as associations with symptoms of psychosis vary between studies. A five-factor model of psychotic symptoms may predict discrepancy better than positive and negative symptoms. Moreover, the predictive value of psychological variables such as self-efficacy has rarely been tested.

Aims

The aims were to explore self-efficacy and a five-factor model of psychotic symptoms (positive, negative, depressive, disorganized, and excited symptoms) as predictors of discrepancy between subjective and objective measures of executive function in a sample of people with schizophrenia spectrum disorders.

Methods

Sixty-six participants with broad schizophrenia spectrum disorders completed a comprehensive assessment of executive function. Discrepancies were calculated between performance on neuropsychological tests (objective) and an extensive self-report questionnaire (subjective) of executive functions (inhibition, shifting, and working memory). The potential predictors investigated were self-efficacy, positive, negative, excited, depressive, and disorganized psychotic symptoms. The hypothesis was that higher levels of self-efficacy would predict lower subjective than objective executive dysfunction. More disorganized symptoms were expected to predict lower subjective than objective dysfunction.

Greater depressive symptoms were expected to predict higher subjective than objective dysfunction.

Results

Self-efficacy was the strongest predictor, explaining 27% of the variation in discrepancy between mean total subjective and mean total objective executive function, $F(1, 51) = 19.21$, $p = .000$, $r^2 = .27$. Higher self-efficacy was associated with having fewer subjective complaints than expected from objective performance.

More severe disorganized symptoms significantly improved prediction of discrepancy in assessment of total executive function, $\Delta F(1, 51) = 5{,}54$, $p = .023$, $\Delta r^2 = .07$. Disorganized symptoms were especially apt for predicting discrepancy in the inhibition domain.

Clinician rated depression did not predict the discrepancy between total subjective and objective executive function, $\Delta F(1, 51) = 0.21$, $p = .646$, $\Delta r^2 = .00$. Nor did depressive symptoms predict discrepancy in any executive subdomains. Positive, negative, and excited symptoms did not predict discrepancy between subjective and objective executive function in any domain.

Conclusions

Low self-efficacy may signal individuals who cannot utilize their potential executive functions in daily life. Cognitive remediation for these individuals should be mindful to foster self-efficacy. Disorganized symptoms may identify individuals who need cognitive remediation for executive dysfunction and who do not experience subjective executive difficulties. These individuals may benefit from demonstrations and discussions of executive difficulties in real-world situations.

Paper II: A Randomized Controlled Trial of Goal Management Training for Executive Functioning in Schizophrenia Spectrum Disorders or Psychosis Risk Syndromes

Background

Executive functioning is essential to daily life and severely impaired in schizophrenia and psychosis risk syndromes. GMT is a theoretically founded, empirically supported, metacognitive strategy training program designed to improve executive functioning, not previously investigated as a method of early intervention for psychosis.

Aims

The primary aim was to assess the impact of GMT on measures of executive functioning. The secondary aims were to explore the effects of GMT on functional capacity and functioning in daily life, as well as clinical symptoms.

Methods

A randomized, controlled parallel group trial compared GMT with treatment as usual among 81 participants (GMT, $n = 39$ versus TAU, $n = 42$) recruited from a setting of early intervention for psychosis. Computer generated random allocation was performed by someone independent from the study team, and raters post-intervention were unaware of the allocation. A linear mixed model for repeated measures, including all partial data according to the principle of intention to treat, tested for significant group × time interaction effects assessed immediately after intervention (post-test) and six months after intervention (follow-up). A priori hypotheses were that GMT would improve subjective (self-reports) and objective (neuropsychological tasks) measures of executive function. In addition, GMT was expected to improve performance of a functional capacity task, self-reported activities of independent living, self-reported symptoms and clinician ratings of symptoms and function more than

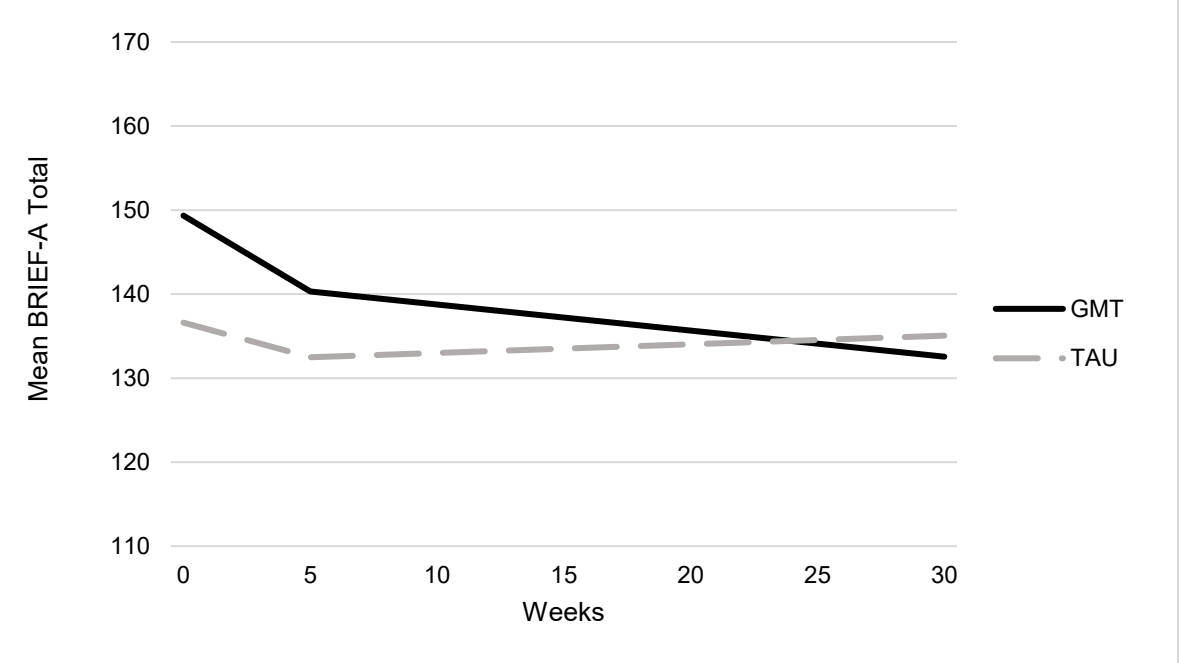
TAU. However, there were no a priori hypotheses about the size of the effects on secondary, explorative measures as the combination of intervention and measures in the study is novel.

Results

GMT improved self-reported executive functioning, measured with the Behavior Rating Inventory of Executive Function – Adult version (BRIEF-A), significantly more than treatment as usual, $F = 8.40$, $p = .005$, $r = .37$. Figure 2 shows mean BRIEF-A total raw scores over time in the GMT group versus the TAU group. The effect of GMT remained significant when controlling for demography and clinical variables. The reduction of subjective complaints was clinically relevant for significantly more participants in the GMT group (10 of 19, 52.60%) than the TAU group (2 of 18, 11.10%), $\chi 2(1) = 7.27$, $p = .007$, $\varphi c = .44$.

Figure 2

Change in Subjective Executive Function



Note. A significant group × time interaction was found for the primary outcome measure, BRIEF-A – self-reported executive dysfunction. Higher scores signify greater difficulties in everyday situations.

Improvement occurred in both groups in objective executive functioning, as measured by neuropsychological tests. However, in a post-hoc comparison, improvement in the GMT group was greater ($F = 4.33$, $p = .045$, $r = .33$) than in the TAU group ($F = 1.58$, $p = .216$, $r = .20$) on the attentional inhibition task CPT 3.

Improved mean performance on a functional capacity measure (UPSA) was found in both groups, $F = 19.57$, $p = .000$, but the treatment effect of GMT was not superior to TAU, $F = 1.79$, $p = .184$. Interaction effects between treatment group and time did not reach statistical significance in the main analysis for self-reported activities of independent living (Social Functioning Scale). However, in a post-hoc exploration of change within each group, the GMT group showed significant improvement in SFS Independence Performance – GMT $F = 5.17$, $p = .034$, $r = .44$ versus TAU $F = 0.19$, $p = .666$, $r = .08$ – and SFS Independence Competence – GMT $F = 4.79$, $p = .036$, $r = .36$ versus TAU, $F = 1.39$, $p = .251$, $r = .24$. Clinician rated global function (GAF-F) improved equally in both groups.

Both treatment groups showed a reduction in positive, disorganized and excited symptoms over time, but no significant treatment effect of GMT were registered in psychotic symptoms assessed using SCI-PANSS. The GMT-group experienced a significantly greater reduction in self-reported symptoms of anxiety and depressed mood measured by the SCL-10, $F(1, 64.05) = 5.78$, $p = .019$, $r = .29$.

Conclusions

GMT had clinically reliable and lasting effects on subjective executive function six months after a brief five-week intervention. Significant improvement in self-reported clinical symptoms were also detected after GMT. Though the effects were too small to statistically outperform TAU, there were indications that GMT improved performance on an objective attentional task of inhibition and self-reported activities of daily living.

Paper III: Moderators of Metacognitive Strategy Training for Executive Functioning in Early Schizophrenia and Psychosis Risk

Background

Knowledge of who benefits from cognitive remediation is important for clinical recommendations. This study investigates objectively measured executive function and the difference between subjective and objective executive function as potential moderators of efficacy of Goal Management Training (GMT).

Methods

Baseline scores from a randomized controlled trial with 81 participants (GMT $n = 39$ vs TAU $n = 42$) were analyzed in a linear mixed model analysis for repeated measures. The outcome variable was improvement on the self-reported Behavior Rating Inventory of Executive Function – Adult version (BRIEF-A), both immediately after and six months after GMT. Potential moderators were scores from objective measures of executive functioning and discrepancy between subjective and objective measures. Discrepancy was assessed through a comparison of four clusters of participants with differing patterns of scores: Both objective and subjective executive dysfunction, mostly subjective executive dysfunction, mostly objective executive dysfunction, or neither subjective nor objective executive dysfunction. The hypotheses were that severe objective executive function would be associated with less improvement after GMT, and that a larger discrepancy in either direction would be associated with less improvement after GMT.

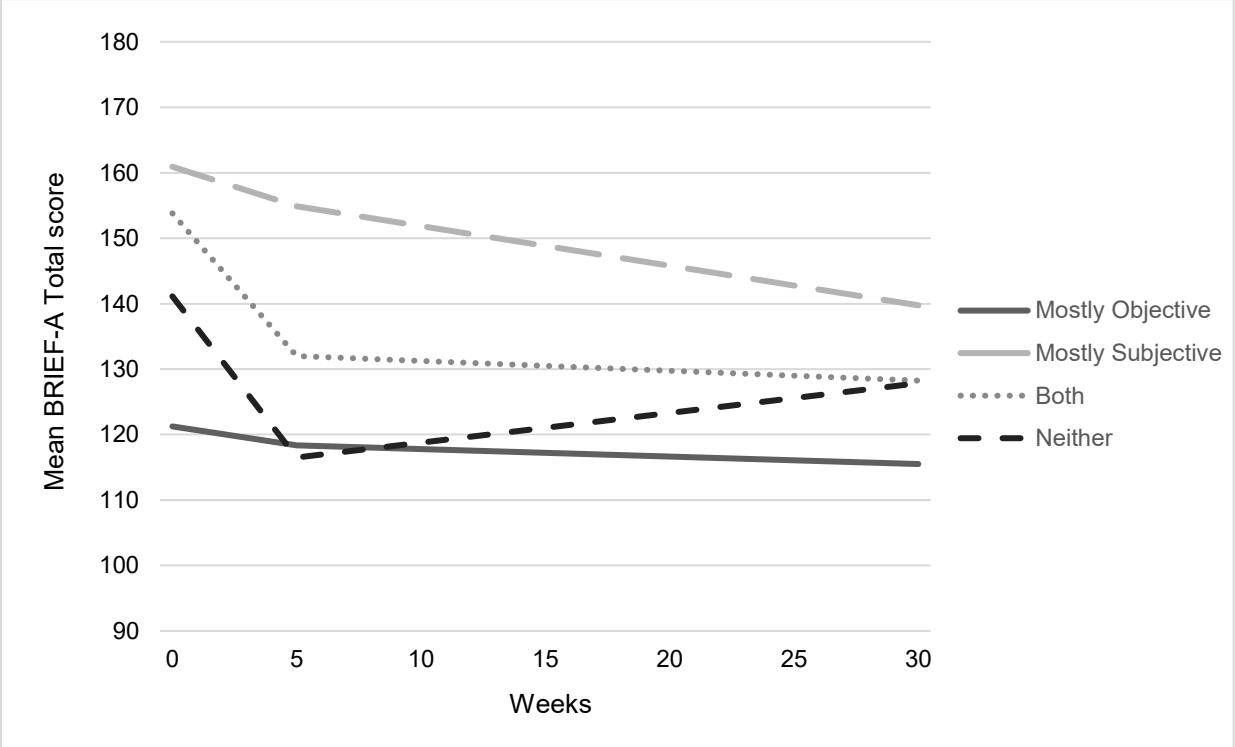
Results

The effect of GMT remained significant regardless of initial objective executive functioning at baseline, $F = 4.60$, $p = .036$, $r = .25$. It was not moderated by individual variation in objective test scores, $F = 0.86$, $p = .357$, $r = .11$.

The treatment effect of GMT remained significant regardless of discrepancy between subjective and objective executive function, $F = 6.41$, $p = .031$. There was a significant main effect of discrepancy, $F = 25.64$, $p < .001$, but the interaction effect between discrepancy and treatment effect was not significant, $F = 1.37$, $p = .241$. A contrast of the clusters within the GMT group showed that participants with mostly objective executive dysfunction, unaccompanied by subjective executive complaints, experienced significantly less improvement after GMT than did those with both objective and subjective executive dysfunction, $p = .036$. Participants with mostly subjective executive dysfunction improved as much as those with both objective and subjective executive dysfunction. Figure 3 illustrates the mean BRIEF-A total scores for each of the four clusters in the GMT group.

Figure 3

Clusters of GMT Participants



Note. Change in BRIEF-A Total scores in clusters within the treatment group with different discrepancy patterns between subjective and objective executive function at baseline. Higher scores indicate more subjective executive complaints.

Conclusions

Poor performance on neuropsychological tasks is not an obstacle to making use of GMT, but further knowledge is needed concerning the benefits of metacognitive strategy training for individuals with a combination of poor performance and few subjective complaints.

Discussion of Main Findings

This doctoral thesis approaches executive function in early schizophrenia in three papers. It investigates the treatment effect of the metacognitive strategy training Goal Management Training (GMT) for subjective and objective executive function in persons with recently diagnosed schizophrenia spectrum disorders or psychosis risk syndromes (Paper II). Initial patterns of subjective and objective executive dysfunction are explored as potential obstacles to successful remediation with GMT (Paper III). The predictors of the discrepancy between subjective and objective executive function in schizophrenia are also explored (Paper I). In the following section, the main findings from the three papers are discussed in the context of existing knowledge.

Evaluation of GMT

Executive Function

The present study is the first RCT of GMT for individuals with a recently diagnosed schizophrenia spectrum disorder or a psychosis risk syndrome. GMT improved self-reported executive function in real-world situations (Paper II). This finding remained significant regardless of control for clinical variables such as psychotic symptoms and concomitant treatment. For more than half the participants in the GMT group, the improvement in subjective executive function exceeded the cut off for a clinically reliable change (Jacobson & Truax, 1991). Improvement was greatest in initiation of activity, which is particularly compelling as this domain has been difficult to treat in schizophrenia (Aleman et al., 2017). It is also the most impaired domain in self-reports of executive functioning in the present sample and with other studies using the same questionnaire among people with schizophrenia (Bulzacka et al., 2013; Van Aken et al., 2022). Participants reported significant improvement with moderate effect sizes in self-monitoring, planning and organizing, and shifting focus

between activities. The findings have clinical importance, because better subjective executive function is associated with greater personal recovery after a first episode of psychosis (Van Aken et al., 2022).

Most cognitive remediation studies in schizophrenia specify objective measures of cognition as a primary outcome. The effects of cognitive remediation on subjective cognition are less commonly explored. A recent study of drill and strategy training in schizophrenia that included subjective cognition as outcome found no improvement (Treichler et al., 2019). Even when objective cognition improved, subjective cognition remained unchanged. Thus, GMT achieves something existing cognitive remediation programs for this patient population have not previously been shown to do consistently (Saperstein et al., 2020).

Based on previous GMT studies in neurological and mental disorders, it was expected that GMT would improve performance on objective executive tasks (Stamenova & Levine, 2018). However, the group receiving GMT did not outperform the treatment-as-usual group across measures of objective executive function. Results were mixed. GMT participants did improve more than controls receiving only treatment as usual on a computerized attention task measuring the trade-off between vigilance and inhibition (detectability from CPT 3). This finding aligns with a recent study in people with ADHD that found GMT to be primarily effective in improving inhibition (Jensen et al., 2021). Due to the lack of treatment effects across other measures of objective executive function, caution should be exercised in the interpretation of the finding. Neither group improved their performance on another measure of inhibition and shifting (CWIT). Both groups improved their performance of a visual planning task (Tower task) over the course of the study. This task has shown evidence of practice effects, a likely explanation of the improvement across treatment groups (Delis et al., 2001; Keefe et al., 2017; McCaffrey & Westervelt, 1995). Somewhat surprisingly, controls

improved their scores more than GMT participants on a working memory task (Digit Span) and a role-playing task assessing interacting executive functions (Hotel Task).

Notably, lower scores on the Hotel Task after the GMT have been seen previously and are thought to be due to the task's similarities with an exercise during the GMT intervention (Levine et al., 2011). In the Hotel Task, participants are asked to divide their time equally between five different tasks. In the GMT exercise, participants are asked to rapidly switch between tasks. The take-home message in that GMT session is to practice the ability to disengage from an activity to attend to the overarching goal. The crucial difference from the Hotel Task is that during the GMT exercise, participants are not asked to divide their time equally between tasks. Instead, the main goal is to attempt as many tasks as possible. Thus, the likeness of two tasks perhaps interferes with post-intervention performance. A few participants were observed to quickly attempt all five tasks before waiting out the remainder of the time during the Hotel Task at post-intervention assessments.

In a meta-analysis of GMT studies, the largest effect sizes were seen in working memory (Stamenova & Levine, 2018). Thus, the lack of change in scores on the Digit Span task after GMT in the present study is surprising. However, in the participants in the present study performed similar to healthy norms on average, indicating limited room for improvement.

The lack of robust effects across objective measures of executive function may have several explanations. First, GMT is metacognitive strategy training addressing situations of daily life and not drill and practice training with repeated rehearsal of specific cognitive tasks. As such, the effects of GMT might be expected to be more easily observed in real-life behavior than in neuropsychological tests. GMT may be considered both a compensatory and restorative intervention (Chung et al., 2013). The strategy training in GMT is primarily a top-down training of higher order cognitions. Therefore, the consequences of the self-talk strategy

might first be evident in compensatory behavior. Nonetheless, since the GMT strategy theoretically becomes internalized over time, it should lead to a restorative increase in cognitive control (Adnan et al., 2017). Such a restoration may be expected to improve performance on neuropsychological tasks. Though for GMT to have a restorative effect on cognitive functions that can be detected on lab tasks, a great deal of frequent strategy repetition would be required. GMT participants commonly face difficulty committing fully to practicing the strategy at home between sessions (Cameron et al., 2020). Unfortunately, the present study did not measure the amount of rehearsal each participant engaged in at home during the follow-up period. Consequently, it is not possible to conclude whether variations in amount of rehearsal explain the absence of robust treatment effects across measures of objective executive function.

Moreover, changes in objective executive function might take longer to emerge than the six months allowed before follow-up assessment in the present study. Previous GMT studies have collected data from objective executive tasks at follow-up assessment four to seven months after intervention (Stamenova & Levine, 2018; Vizzotto et al., 2021). There is variation between the studies, but overall the effect size for improved performance after GMT is larger than immediately after intervention. It is therefore possible that effects will continue to increase over time. It is not known when the largest effects of GMT on objective executive function may be detected. So far, few GMT studies have had a longer interval than the present study between post-intervention and follow-up assessments. In a case study of a person with schizophrenia who received GMT, behavioral change in everyday situations was sustained after two years, but objective executive tasks were not measured (Levaux et al., 2012).

Another possible explanation that GMT did not improve objective executive function more than treatment as usual may be that there was insufficient room for change in these measures (Carruthers et al., 2019). Some participants in the sample scored below average on

several tasks, but the overall sample showed normative performance on the objective outcome measures – except the one where a treatment effect was detected, the CPT 3 vigilance and inhibition task. Studies of cognition and cognitive remediation in both people with schizophrenia spectrum disorders and people with psychosis risk may have suffered similar concealment of treatment effects due to the inclusion of participants with heterogeneous cognitive function (Allott et al., 2022; Carruthers et al., 2019; Glenthøj et al., 2017). A recent comprehensive meta-analysis and review of cognitive remediation studies in schizophrenia found the largest effect sizes among participants with the most severe global cognitive impairments (Vita et al., 2021). The trial was powered to detect a moderate effect in self-reported executive functioning (BRIEF-A), and may therefore have lacked the sample size to detect treatment effects on other measures. It is possible that behavioral symptoms measured by the BRIEF are more sensitive to mild impairment and perhaps, therefore, also more sensitive to change than objective measures (Niendam et al., 2007).

Functional Capacity and Daily Life Function

Both groups improved on the functional capacity task (UPSA-B). The lack of a treatment effect of GMT on this measure may have been due to a lack of room for improvement. The UPSA has shown ceiling effects in previous studies for younger individuals with a first episode of psychosis (Vesterager et al., 2012).

There was some support for a treatment effect of GMT on daily life function. Even though the main analysis did not show a significant group × time interaction effect, participants in the GMT group reported greater improvement in performance of independent daily life activities and greater improvement in their competency in the same activities (Social Functioning Scale, SFS) compared to controls in a post-hoc comparison. Both groups improved equally on a clinician rated global measure of function (GAF-F), a clinical evaluation of overall function including areas of life such as school, work, and interpersonal

relationships. These areas are influenced by many factors outside of GMT, such as motivation and access to opportunities, perhaps making GAF too distal a measure of function in the context of cognitive remediation (Allott et al., 2011; Medalia & Saperstein, 2013).

The most likely explanation for the lack of greater impact of GMT on measures of daily life function is probably that cognitive remediation should be integrated into psychiatric rehabilitation to meaningfully influence function (Bowie et al., 2020). Meta-analytic reviews of cognitive remediation in schizophrenia show the greatest impact on measures of daily life function in studies where cognitive remediation is offered embedded in psychosocial interventions (McGurk et al., 2007; Vita et al., 2021). Even though the present study did take place in a clinical setting, it was administered more as an add-on than as a well-integrated part of treatment. Most study participants were recruited from specialized early intervention clinics, but there were differences in where they chose to receive their follow-up care during the study. Some participants were receiving care from specialized early intervention clinics. Others received care from standard mental health care clinics located closer to where they lived. Others still opted for follow-up care from a general practitioner, perhaps combined with community care in the municipality. Treatment content or treatment setting did not change the efficacy of GMT. However, setting common goals for psychiatric and cognitive rehabilitation appears to be more important than the content of concomitant treatment for impacting daily life function (van Duin et al., 2019). In the present study, the participants' goals in GMT were not systematically implemented as goals for their overall treatment of psychosis.

In addition, it is important that individuals who receive cognitive remediation also partake in activities where they are given the opportunity to practice what they learn, for example through work placements (Bowie et al., 2020; Holshausen et al., 2014). In the present study, approximately half of participants were involved in some form of work or study activity. Indeed, some GMT participants in the present study said they found it challenging to

rehearse the strategy at home because they were rarely doing activities that were particularly demanding of their executive functioning. Developing new skills takes time and requires opportunity for practice (Medalia & Saperstein, 2013). A recent study combining GMT with occupational therapy in individuals with treatment resistant schizophrenia found beneficial effects on activities of independent living (Vizzotto et al., 2021). In that study, participants practiced naturalistic tasks such as meal preparation with a therapist present for a total of 45 h, ensuring the transfer of GMT strategies to the activity. In the present study, 18 h of GMT was administered in group sessions. Group discussions and assignments encouraged the real-world application of the GMT strategies. Still, participants did not receive any therapist support in the application of GMT strategies to real-world situations outside sessions.

The present study was intended as an initial assessment of the feasibility and efficacy of GMT as a stand-alone intervention in early psychosis. It is important to study interventions in isolation and combination to increase knowledge of the mechanisms of cognitive remediation (Cella & Wykes, 2019; Wykes & Spaulding, 2011). However, the end goal of research on cognitive remediation in schizophrenia is to develop rehabilitation that maximizes the improvement in function, including participation in education and work (Kharawala et al., 2022; McGurk et al., 2022; Medalia & Saperstein, 2013). Thus, GMT may have synergistic effects on function if, for example, integrated with occupational therapy, vocational training, or other psychosocial interventions providing relevant opportunities to practice skills (Bowie et al., 2020; Bowie et al., 2017; Medalia & Saperstein, 2013).

In sum, the GMT in the present intervention supports the importance of the four core components identified by the Cognitive Remediation Expert Working group (Bowie et al., 2020): repeated practice, active therapists assisting with development of mental strategies and procedures for transferring skills to everyday life, and the integration of cognitive remediation in adjunct treatment for psychosis. GMT did have active therapists and group discussions

about transfer of strategy use to real life situations. However, there might have been variations in the present study in terms of amount of strategy rehearsal, opportunities for practicing new skills in real life situations, and how well GMT was integrated into treatment. This variance might have lowered the treatment effects of the intervention more than expected across measures of objective cognition and daily life function.

Clinical Symptoms

Psychotic symptoms are not the primary targets of cognitive remediation, but small to moderate improvements in symptoms have been seen across remediation studies for people with schizophrenia (Cella et al., 2017; Vita et al., 2021). In the present study, self-reported symptoms of anxiety and depressed mood (SCL-10) showed a significant improvement after GMT. This might be in an indication of better self-regulation in stressful situations. However, GMT was not superior in improving clinician rated symptoms of psychosis (SCI-PANSS) compared to treatment as usual.

There could be several reasons that the effect of GMT on symptoms was smaller than expected. This study took place in an early detection and intervention for psychosis setting. On average, the severity of symptoms measured with SCI-PANSS in the sample was low. Only depressive symptoms were moderate, leaving more room for improvement. Additionally, several of the participants were receiving treatment for psychotic symptoms for the first time in the same period as they took part in the study. Thus, the effects of TAU on symptomatology would be expected to be greater than in the majority of remediation studies were participants are older and clinical symptoms are perhaps stabilized to a greater degree (Vita et al., 2021).

Clinical Significance of GMT

Based on the present study, the clinical relevance of GMT for people with early schizophrenia may be questioned, since the largest treatment effects were limited to subjective

executive function and self-reported clinical symptoms. Still, the findings are considered robust. Despite challenges to subjective assessments, such as mood states or desirability bias, self-reports remain both valid and reliable measures of executive functioning in clinical and healthy samples (Roth & Gioia, 2005). Persons with schizophrenia consistently report more executive complaints than do healthy adults (Bulzacka et al., 2013; Potvin et al., 2014; Van Aken et al., 2022). The levels of subjective executive complaints in the sample in the present study was similar to those in previous studies. The test-retest reliability is also evident in the present study, showing large and significant correlations between repeated measurements in the control group. Thus, changes in the BRIEF-A scores most likely reflect meaningful change in subjective executive function in real-world situations.

Moreover, the importance of subjective cognition may have been underestimated in schizophrenia (Bulzacka et al., 2013; Van Aken et al., 2022). Subjective cognition has been shown to be important to quality of life among persons with schizophrenia (Paudel et al., 2020). Moreover, better subjective executive function is associated with greater personal recovery after the first episode of psychosis (Van Aken et al., 2022). The emphasis on wellbeing and personal recovery for people with lived experience of psychosis have made these psychological aspects important treatment targets in schizophrenia and psychosis risk (Grunder et al., 2021; Skar-Fröding et al., 2021). Setting personal recovery goals increases the motivation for functional recovery among people experiencing a first episode of psychosis (Fulford et al., 2020). So far, drill and strategy training does not seem to improve subjective cognition in schizophrenia, making GMT a valuable contribution to existing cognitive remediation programs (Saperstein et al., 2020; Treichler et al., 2019). One of the advantages of GMT may be that it has high face validity, as participants easily grasp its relevance to real-life situations (Cameron et al., 2020). Compensatory interventions such as GMT may be more attractive to certain service users, who do not wish to partake in repeated drill and practice

exercises (Bryce et al., 2021). Another advantage is that GMT promotes agency by encouraging participants to take control over their everyday challenges themselves, and the group setting might encourage peer support (Bowie et al., 2020; Bryce et al., 2018). The effect of GMT on wellbeing (self-efficacy, self-esteem, and quality of life), as well as clinical symptoms, will be further explored in a fourth paper not included in this doctoral thesis. A master's thesis analyzing the data from the participants with a diagnosis in the schizophrenia spectrum, found that GMT improved self-efficacy (Øie, 2021).

The findings from the present study show that GMT is an effective treatment for real-life executive dysfunction in people with early schizophrenia spectrum disorders. The long term consequences of cognitive remediation as an early intervention are yet to be determined because studies of cognitive remediation in early schizophrenia and especially psychosis risk continue to emerge (Frawley et al., 2021; Glenthøj et al., 2017). However, other forms of early interventions have proven important for long-term functional outcomes – in particular for persons who experience their first episode of psychosis in adolescence or in early adulthood (Chen et al., 2019).

There is some indication that "the earlier, the better" is a valid assumption about cognitive remediation for schizophrenia spectrum disorders (Barlati et al., 2013; Bowie et al., 2014; Corbera et al., 2017; Deste et al., 2019). However, evidence is presently insufficient to draw related conclusions. For example, in a recent review of participant characteristics as moderators of cognitive remediation in schizophrenia, the results for age were inconsistent (Seccomandi et al., 2020). Five studies reported that age was not a moderator of outcome, three reported that younger participants benefited more, and four reported that older participants experienced greater benefit from cognitive remediation (Seccomandi et al., 2020). It is also difficult to separate the significance of age from that of education and duration of illness. A recent comprehensive meta-analysis of cognitive remediation studies in

schizophrenia found that participants who were older, suffered the most severe overall cognitive impairments, and had lower daily life function, experienced the most benefit following cognitive remediation (Vita et al., 2021). This finding implies that gains from cognitive training in young people would be smaller. A meta-analysis of cognitive remediation in first episode psychosis seems to support this supposition (Revell et al., 2015). Nonetheless, it is important to contemplate that the majority of the studies to date have been conducted among adults who have been ill for several years. The average age in the studies included in the meta-analysis by Vita and colleagues (2021) was almost 37 years, and the average duration on illness was close to 14 years. Few studies have directly compared the effects of the same cognitive remediation across different age groups. One study among adults found that younger participants experienced greater improvements in working memory following cognitive remediation (Corbera et al., 2017). Another found support for greater improvement in executive functions and real-world skills among participants early in the course of illness after drill and strategy training (Bowie et al., 2014). A third found that participants early in the course of illness showed greater improvement in clinical and functional measures, but not in cognitive measures (Deste et al., 2019).

The present study adds to the evidence base for cognitive remediation as an early intervention. The results for objective cognition and daily life function align with the smaller effect sizes found in studies of cognitive remediation among people with a first episode of schizophrenia (Revell et al., 2015). In the present study, age and education did not significantly moderate the outcome of GMT.

As only 16 participants in the present sample had psychosis risk syndromes, a subgroup analysis for the at-risk group was not performed. However, diagnosis did not moderate the outcome of the trial, and results with and without at-risk participants remained similar. Thus, GMT appears promising for psychosis risk syndromes, but it is presently

impossible to draw conclusions. Evidence for improvements in cognition and daily life function after cognitive remediation among people considered at risk of developing psychosis remains scarce (Glenthøj et al., 2017). Not all trials have found significant improvements in cognition, and few have investigated daily life function. However, early trials may have been hampered by the inclusion of participants with heterogeneity in cognitive function (Allott et al., 2022; Carruthers et al., 2019; Catalan, Salazar de Pablo, et al., 2021; Millman et al., 2022). In addition, the earliest trials did not consistently include recommended core elements of cognitive remediation such as active therapists, structured development of mental strategies, and integration with psychosocial treatment (Bowie et al., 2020; Glenthøj et al., 2017).

Importantly, even if the effects of cognitive remediation turn out to be relatively small in young adults earlier in the course of illness, any preventative effect on loss of function could have great impact over time. Although not always sustained, improvements in cognition and function after cognitive remediation in schizophrenia can remain for up to a decade after intervention (Buonocore et al., 2022). Moreover, evidence is mounting that cognitive difficulties in schizophrenia increase from early childhood to first episode psychosis (Sheffield et al., 2018). Interventions during early psychosis may preserve some executive functioning, as this cognitive domain continues to develop throughout adolescence and early adulthood (Carruthers et al., 2019; Freedman & Brown, 2011). GMT explicitly addresses stressful real-life situations and, therefore, may protect against increasing stress during adolescence and early adulthood due to increasing demands on executive functioning from the surrounding environment (Zelazo, 2020). Further evidence from large-scale studies is required, but there is some indication that cognitive remediation may help prevent the development of psychosis among at-risk youth (Bechdolf et al., 2012). Although modest, the results of the present study are encouraging because if future remediation of executive

function in early psychosis could contribute to improving function in this patient group, the benefits to individuals, families, and society would be substantial.

Moderators of GMT

It is important to discover who benefits from cognitive remediation to improve personalized rehabilitation and to avoid repeated experiences of treatment failure for both patients and staff (Bowie et al., 2020; Cella et al., 2015; Wykes & Spaulding, 2011). Knowledge of reliably replicated moderators of cognitive remediation from high quality studies in schizophrenia is lacking (Seccomandi et al., 2020). Two potential moderators of GMT were investigated in the present study to help guide clinicians in their treatment recommendations: initial objective executive function and initial discrepancy between subjective and objective executive function (Paper III).

Objective Executive Function

GMT was designed for individuals with executive dysfunction, and the manual uses several pedagogical approaches (e.g., frequent repetition and a combination of practical, visual, and verbal learning). Still, pronounced difficulties in executive components (e.g., working memory) could present obstacles to learning the GMT strategies (Cicerone et al., 2019; Emmanouel et al., 2018). In the present study, objective executive function at baseline did not predict the treatment effect of GMT on self-reported executive function in real-world situations (BRIEF-A). This finding aligns with the literature on cognitive remediation in schizophrenia. The latest and most comprehensive meta-analysis indicates that persons who are older, have been ill for longer, and have greater cognitive and social dysfunction benefit the most from remediation (Vita et al., 2021).

The finding in the present study is considered robust. Even though on average the sample performed adequately on some of the executive tasks (e.g., the working memory task),

some participants in the sample had below average performance. The result is nevertheless encouraging, as people with schizophrenia have been found to have the most severe impairments in executive function across the mental disorders in a recent umbrella review (East-Richard et al., 2020).

Discrepancy Between Subjective and Subjective Executive Function

The discrepancy between subjective and objective cognition has problematic associations in schizophrenia. Greater subjective cognitive complaints are associated with greater self-reported depression, lower self-esteem, and more internalized stigma (Cella et al., 2014; Raffard et al., 2020; Shin et al., 2016). Consequently, greater subjective executive complaints than objective executive performance could be a challenge for engagement during GMT. Participants with this pattern of scores may perhaps have difficulties recognizing improvements after strategy use, due to negative thought patterns (Allott, Steele, et al., 2020; Beck et al., 2018). Greater objective cognitive dysfunction than subjective cognitive complaints is associated with poorer independent living skills and thought to reflect inaccurate self-assessment or poor insight into cognitive impairments (Gould et al., 2015; Harvey & Pinkham, 2015; Medalia et al., 2008; Silberstein & Harvey, 2019). In the context of the present study, having greater objective executive dysfunction than subjective executive complaints could present a challenge for engagement with treatment during GMT. Participants with this pattern of scores may face difficulties in recognizing situations where GMT strategies would be useful if they experience everyday situations as unproblematic.

The hypothesis that the discrepancy between subjective and objective executive function in either direction would be an obstacle for GMT was only partially supported in the present study (Paper III). GMT remained effective regardless of discrepancy, and no interaction effect between treatment and discrepancy was found. Still, when exploring subgroups of GMT participants, self-reported executive function improved significantly less

among those with mostly objective executive dysfunction (stoicism) compared to participants with both subjective and objective executive dysfunction. Participants with a discrepancy in the other direction, with mostly subjective complaints combined with adequate performance (sensitivity), improved as much as participants with both subjective and objective dysfunction. In the present study, it seems that only discrepancy in the direction of more objective than subjective executive function was an obstacle for GMT. However, the subgroups in the present study were small, and caution should be exercised in interpreting the findings. The results may mainly reflect that those with more initial subjective complaints had more room for improvement, whereas those with few initial complaints experienced a floor effect.

There is not much existing evidence of discrepancy as a moderator of cognitive remediation in schizophrenia (Seccomandi et al., 2020). A recent review identified only two studies exploring this question in the context of combined drill and strategy training. One found that more subjective cognitive complaints, at baseline, were associated with greater improvements in objective cognition following intervention (Twamley et al., 2011). The other study found that participants with and without discrepancy between subjective and objective cognition did not differ in attendance, satisfaction with the intervention, or self-reported cognitive strategy use (Burton & Twamley, 2015). Since then, another cognitive remediation trial in schizophrenia spectrum disorders has found that fewer subjective cognitive complaints are not detrimental to outcome of cognitive remediation, but may influence motivation and engagement during training (Saperstein et al., 2020). In a recent cognitive remediation trial in psychosis risk, subjective cognition did not moderate outcome after drill and practice training (Glenthøj et al., 2020). In sum, the evidence supporting the discrepancy between subjective and objective cognition being an obstacle to cognitive remediation is scant. Nonetheless, it is

a potential moderator worth pursuing to better understand the mechanisms of remediation (Saperstein et al., 2020).

Predictors of Discrepancy Between Subjective and Objective Executive Function

A substantial portion of individuals with schizophrenia have few cognitive complaints despite poor performance on neuropsychological tasks, though the opposite pattern also occurs (Harvey & Pinkham, 2015; Potvin et al., 2014). The present study used data from the participants with a diagnosis in the schizophrenia spectrum to confirm that discrepancy between subjective and objective measures also occurs in the executive domain (Paper I). This is in line with existing evidence of low correlations between self-reports and neuropsychological tasks of executive function from both healthy and clinical samples (Toplak et al., 2013). The exception in the present study was in inhibition, where self-reports were significantly correlated with test performance (*r* -.31). The discrepancy between subjective and objective executive function occurred in both directions, with some participants reporting more and others fewer subjective complaints than expected from their performance on objective measures. Using a framework from research on affective disorders allowed for the placing of discrepancy scores along a dimension showing that discrepancy was a normally distributed phenomenon ranging from stoicism (poorer test scores, but few subjective complaints) to sensitivity (many subjective complaints, but adequate performance; Miskowiak et al., 2016).

Self-Efficacy

The discrepancy between subjective and objective executive function was primarily explained by variations in self-efficacy: Participants who reported fewer executive difficulties in everyday life than expected from their performance on objective measures (stoicism) were

more likely to have positive self-efficacy beliefs. Participants who reported greater subjective executive dysfunction despite better performance on objective tests (sensitivity) were more likely to have negative self-efficacy beliefs.

The direction of the relationship between self-efficacy and discrepancy is unclear and will require further investigation. Generally, self-efficacy breeds more self-efficacy: Persons with positive self-efficacy beliefs are more likely to set more ambitious goals, sustain efforts despite resistance, and interpret success as the result of their own effort (Bandura, 1977; Bandura, 2011). People with negative self-efficacy beliefs, on the other hand, are less likely to attempt ambitious tasks, more likely to give up when faced with challenges, and more likely to attribute success to external factors (Bandura, 1977; Bandura, 2011). In schizophrenia, the direction of relationships between self-efficacy, negative symptoms, cognition, and real-world function are currently under debate (Beck et al., 2018; Chang et al., 2017). Positive self-efficacy beliefs may lead to mastery experiences (Cardenas et al., 2013). Positive mastery experiences may help individuals with schizophrenia compensate for their objective cognitive dysfunction, in turn precipitating fewer subjective complaints. It is also possible that self-efficacy remains high among individuals with avoidant coping strategies (Lysaker et al., 2001). Such individuals are less likely to attempt challenging tasks. As a consequence, their self-efficacy beliefs are perhaps rarely challenged. Both mechanisms may also co-exist among individuals with schizophrenia.

The finding that self-efficacy predicts discrepancy between subjective and objective executive function is an important contribution because previous research on discrepancy has largely neglected the importance of psychological variables (Cella et al., 2014). It is also important because self-efficacy has emerged as a potential mediator between cognition, negative symptoms, and function, including in the context of cognitive remediation (Allott, Steele, et al., 2020; Beck et al., 2018; Ventura et al., 2014; Wykes & Spaulding, 2011). A

recent study exploring subjective cognition as a moderator of cognitive remediation measured a construct similar to self-efficacy, namely perceived task competency (Saperstein et al., 2020). Participants in that study with more subjective complaints were more likely to report less task competency. These participants attended training sessions less frequently and, therefore, took longer to complete the program. Less frequent attendance was interpreted as signaling less engagement with the intervention. Given emerging knowledge, cognitive remediation studies may need to consider both subjective cognition and self-efficacy to improve treatment effects and avoid adverse effects (Bryce et al., 2018; Rose et al., 2008). A fourth paper based on a recent master thesis (not included in the present doctoral thesis) will explore change in self-efficacy following GMT and its relationship with the other outcomes of the trial (Øie, 2021).

Symptoms of Psychosis

To date, results have been inconsistent in the investigation of the relationship between symptoms of psychosis and the discrepancy between subjective and objective executive function (Homayoun et al., 2011). A five factor consensus model of psychotic symptoms was applied in the present study, distinguishing between positive, negative, disorganized, depressive, and excited symptoms (Wallwork et al., 2012). Higher levels of disorganized symptoms were expected to predict fewer executive difficulties in everyday life than expected from performance on objective measures (Rodriguez-Jimenez et al., 2013; Ventura et al., 2010). This hypothesis was supported in the present study. Disorganized symptoms were particularly relevant in the assessment of inhibition, where it was the strongest predictor of discrepancy. Few studies have examined the relationship between disorganized symptoms and the subjective versus objective cognition discrepancy, but the finding is supported by one study finding an association between an item of disorientation from PANSS and fewer subjective cognitive complaints (Baliga et al., 2020). Disorganized symptoms have also been

found to correlate with poorer performance on attentional tasks of inhibition similar to the CPT used in the present study (Dominguez Mde et al., 2009). One likely interpretation of these findings is that disorganized symptoms interfere with attention, impeding accurate self-assessment of executive function.

Higher levels of depressive symptoms were expected to predict more subjective than objective dysfunction similar to previous studies (Burton et al., 2016; Raffard et al., 2020; Sellwood et al., 2013). Surprisingly, this hypothesis was not supported in the present study. However, the present study differs from the previous studies in that depression was not self-reported but rather scored by a clinician. Self-reported measures of depression may confound clinical depression with emotional states (Moore & Fresco, 2012). Still, the level of depressive symptoms among the participants in the sample of the present study was moderate, leaving the possibility open that results would have differed if participants had suffered more severe depression. Mild depression has previously been associated with realistic self-evaluation rather than an underestimation of abilities in both healthy individuals and people with schizophrenia (Harvey et al., 2017; Moore & Fresco, 2012).

Contributions to the Understanding of Discrepancy

The causal explanations behind the relatively large disassociation between subjective and objective cognition in schizophrenia compared to healthy controls has not yet been fully understood. It is thought that self-assessment of cognitive difficulties is somehow affected by the disease for a portion of the patient population (Harvey & Pinkham, 2015). So far, the phenomenon has not been consistently related to insight into psychotic illness or the severity of psychotic symptoms (Homayoun et al., 2011). Mediational analysis appears able to elucidate some of the conflicting findings, showing that symptoms are differently associated with discrepancy depending on insight into psychotic symptoms (Santarelli et al., 2020). It has been suggested that a lack of subjective cognitive complaints accompanying objective

dysfunction is a sign of more severe pre-frontal dysfunction. However, an attempt to explain the discrepancy between subjective and objective cognition as an expression of more severe executive dysfunction was not successful (Burton et al., 2016). A promising avenue to further knowledge is the study of the relationships between discrepancy and metacognition (Lysaker et al., 2021).

The present study shows that discrepancy relates to self-appraisal more broadly, because of the association with perceived self-efficacy. Similar discrepancies between self-evaluation and objective measures have been observed in other domains, including social cognition and functional capacity (Olsson et al., 2019; Silberstein & Harvey, 2019; Silberstein et al., 2018). The association with disorganized symptoms should be further explored, as it may also support the notion that being less aware of cognitive difficulties is somehow an expression of illness. Nonetheless, the present study also shows that discrepancy should be viewed as a dimensional phenomenon and that there is great heterogeneity in discrepancy among individuals with schizophrenia. Causal explanations might therefore also differ between individuals.

Generalization of Findings

The sample in the present study is thought to be representative of the help-seeking population in early intervention for psychosis – at least in countries with a similar socioeconomic context to that of Norway. The gender balance in the sample reflects the incidence of schizophrenia in late adolescence and young adulthood, with slightly more males than females. The sample was young, with a mean age of 25 and largely consisting of people 16–35 years old. The use and dosage of antipsychotic drugs here was similar to that in other cognitive remediation studies (Lejeune et al., 2021; Vita et al., 2021). Treatment as usual in the Norwegian public health system is in line with recommendations in other Western

countries (American Psychiatric Association, 2021a; National Institute for Health and Care Excellence, 2013). Participants lived in both rural and more urban areas. The RCT was conducted in a clinical setting, and its results should be generalizable to people receiving treatment for early psychosis (Flather et al., 2006). The results from the present study can also be generalized to adults in mid-life, as GMT has already been used with individuals with treatment resistant schizophrenia in combination with occupational therapy (Vizzotto et al., 2021). GMT will likely be effective regardless of age and duration of illness. The cognitive heterogeneity of the sample, though a limitation for the present study, is likely not a problem for the generalization of the findings. If anything, the treatment effects of GMT may be greater for individuals with greater executive dysfunction (Carruthers et al., 2019; Vita et al., 2021). However, the optimal amount of therapist support between sessions must be determined.

There are challenges in comparing the effects of GMT with existing cognitive remediation programs for people with schizophrenia or psychosis risk. GMT may have both restorative and compensatory effects, but it differs from existing restorative and compensatory approaches in important ways (Chung et al., 2013). GMT varies from the most used drill and strategy programs in schizophrenia in that it offers a metacognitive strategy for everyday situations. As a result, the literature on effects and moderators of existing cognitive remediation programs for schizophrenia may only partially apply to GMT. For example, the greatest effects of GMT were seen in subjective executive function, whereas in other studies subjective cognition has not been found to improve even if objective cognition improves after drill and strategy training (Saperstein et al., 2020; Treichler et al., 2019). Thus, GMT may have different mechanisms and affect different outcomes than drill and strategy training. Comparing GMT to the literature on compensatory remediation may also present problems, as this category is wide and contains both mental strategies, practical aids, and adaptations of the

surroundings (Allott, van-der-El, et al., 2020). On its own, metacognitive strategy training is not widespread in studies of cognitive remediation in schizophrenia. Therefore it is difficult to find equivalent interventions to GMT for comparison within the same patient population. Further knowledge is necessary concerning the mechanisms in GMT and the most appropriate outcome measures.

Implications

Clinical Implications

The present study carries important clinical implications for the assessment and treatment of executive function among people with early schizophrenia spectrum disorders and psychosis risk syndromes. Metacognitive strategy training may be added to the treatment of schizophrenia spectrum disorders to improve real-world executive function (Vizzotto et al., 2021). GMT can be expected to provide clinically reliable and lasting improvement in subjective executive functioning for a majority of the patients with these disorders, especially if they have self-reported complaints of executive dysfunction. The improvement of subjective executive functioning, such as self-monitoring, planning, and initiation of activities, may positively impact adherence to treatment for psychosis. GMT could improve objective executive function and daily-life function, but may require therapist support in naturalistic tasks to achieve this improvement (Vizzotto et al., 2021). Moreover, GMT should be integrated into psychiatric rehabilitation (Vita et al., 2021). Because GMT can be administered in groups in nine sessions, it is a feasible, cost-effective intervention that is both theoretically sound and empirically supported (Stamenova & Levine, 2018). The manualized format eases implementation in clinical settings. GMT shows promise as an intervention for people with psychosis risk syndromes, but further evidence is required before a recommendation can be made for this patient population. Although adverse effects were not

measured systematically, few individuals reported adverse effects, suggesting that the intervention is safe.

More severe objective executive dysfunction should not prevent patients from participating in GMT, as it appears to not be an obstacle for successful strategy training. It is encouraging that objective executive dysfunction was not an obstacle for metacognitive strategy training in the present study because schizophrenia is associated with the most severe objective executive dysfunction of all the mental disorders (East-Richard et al., 2020).

Further research is needed before GMT can be recommended for persons with poor neuropsychological executive performance in the absence of subjective executive complaints.

Measures of subjective executive function should be included in cognitive assessment in psychosis (Bulzacka et al., 2013; Van Aken et al., 2022). The BRIEF questionnaire that can be administered to patients, family members, and teachers is sensitive to executive dysfunction in at-risk youth before the development of psychotic symptoms (Niendam et al., 2007). In the case of discrepancy between subjective and objective measures of executive function, a simultaneous assessment of symptoms of psychosis and self-efficacy may assist in understanding variations. In the clinic, the discrepancy between subjective and objective measures can offer a good starting point for conversations about executive function in real-world situations. Understanding and reducing the discrepancy between subjective and objective cognition may be important, since discrepancy in either direction is associated with worse outcomes in schizophrenia (Gould et al., 2015; Harvey & Pinkham, 2015; Shin et al., 2016). Efforts to improve awareness of cognitive difficulties should take care not to diminish self-efficacy, because it is important for wellbeing in severe mental illness (Bryce et al., 2018; Cella et al., 2014; Cella & Wykes, 2019; Gleeson et al., 2020; Hansson, 2006; Rose et al., 2008).

Implications for Future Research

Future studies of GMT in psychosis should investigate the potential to extend the impact to daily function. To design the most cost-efficient GMT intervention for psychosis, it will be necessary to discern how much between-session support is required to achieve durable changes in function, similar to those found when combining GMT and occupational therapy (Vizzotto et al., 2021). In addition, future studies should assess the duration of treatment effects from GMT beyond six months (Stamenova & Levine, 2018; Tornas et al., 2019). More studies could also assess metacognitive strategy training alone to better understand the contributions of the different components in cognitive remediation (Cella & Wykes, 2019; Wykes et al., 2011).

Since difficulties in executive function appear early in the development of psychosis and correlates strongly with role-function, metacognitive strategy training such as GMT may improve the prognosis for at-risk individuals (Guo et al., 2020; Squarcina et al., 2022). However, a larger sample of participants with psychosis risk syndromes is needed to fully assess the efficacy of GMT in this group. This is particularly important, as evidence for cognitive remediation in psychosis risk remains scarce and as the efficacy of standalone metacognitive strategy training does not appear to have been investigated (Glenthøj et al., 2017). Moreover, identifying the relevant subgroup of at-risk youth with executive difficulties will allow for targeted intervention (Allott et al., 2022).

The challenges in deciding the precise role of executive function to prognosis in schizophrenia may in part be attributed to varying methodology between studies (Haywood & Baughman, 2021; Hwang et al., 2019). The findings from the present study underline the importance of comprehensive assessment of executive function, covering several components and levels of measurement (Freedman & Brown, 2011; Hwang et al., 2019; Van Aken et al., 2022). To detect relevant treatment effects, future research on the cognitive remediation of

executive function in schizophrenia may benefit from the use of naturalistic or virtual observation (Levaux et al., 2012; Levine et al., 2000; Tyburski et al., 2021). Cognitive remediation studies may benefit from applying the Goal Attainment Scale as an outcome measure of progress on individual goals of everyday functioning (Ashford & Turner-Stokes, 2006; Wykes et al., 2018).

A significant contribution to the study of discrepancy between subjective and objective cognition is the adaptation of the Stoicism-Sensitivity framework, which allows for discrepancy to be assessed as a continuum (Miskowiak et al., 2016). Future studies on the discrepancy between subjective and objective cognition can benefit from the inclusion of psychological measures such as self-efficacy (Cella et al., 2014). The role of symptoms of psychosis should be expanded to encompass disorganized symptoms, and the research literature must distinguish between self-reported and clinician-rated symptoms (Dibben et al., 2009; Moore & Fresco, 2012).

Strengths and Weaknesses

Study Design and Methodology

The pre-registered, randomized design with masked conditions and the adherence to CONSORT guidelines for parallel group trials are considered strengths of the present study (Schulz et al., 2010). The study also uses a comprehensive test battery covering several aspects of executive function. However, systematic observation of familiar and novel real-life tasks might hold the key to unlocking the real potential of GMT (Levaux et al., 2012; Levine et al., 2000). Alternatively, naturalistic role-playing or virtual reality tasks offer standardized procedures to assess interacting executive functions in novel situations (Tyburski et al., 2021). The Goal Attainment Scale was originally pre-registered as an outcome measure of the trial, but was incorporated into the GMT manually for the treatment group only. This instrument has the advantage of measuring individual rehabilitation goals (Ashford & Turner-Stokes,

2006; Wykes et al., 2018). The scale was not used as a masked outcome, but several participants indicated improvement in their chosen activities as the training progressed. In addition, new task paradigms may have provided better specificity in separating out components of executive function (Barch et al., 2009).

The sample is well balanced in terms of gender, and it resembles other samples in cognitive remediation studies in the severity of psychotic symptoms and dosage of anti-psychotic medication (Vita et al., 2021). Ideally, a more balanced sample with regards to diagnosis and risk syndromes would have enabled the study to better conclude on the efficacy of GMT among at-risk participants.

Statistical power in the present study is sufficient to assess the efficacy of GMT on the primary outcome measure for subjective executive function (BRIEF-A), but a larger sample size might have yielded different results for other outcomes and moderators. Power-analysis for the other primary outcome measure for objective executive function (CPT3) was not performed a priori. The secondary outcome measures are considered exploratory, as this is the first study of GMT in early intervention for psychosis. The study combines an intervention originally developed for rehabilitation after traumatic brain injury with measures of functional capacity and daily life function developed for people with serious mental illness. Therefore, there was less existing literature on the basis of which to form predictions. The moderation analysis is also exploratory, and no power-calculations were performed for moderation. The analysis of discrepancy clusters needs replication, as clusters are small and thus the influence of individual trajectories may be exaggerated.

Heterogeneity in executive function in the sample may have obscured treatment effects and made moderating effects more difficult to interpret (Carruthers et al., 2019). In line with existing evidence from studies of first-episode psychosis and adults with schizophrenia, the participants in the present study showed significantly poorer executive function than did

healthy controls measured with self-reports (Bulzacka et al., 2013; Van Aken et al., 2022). On neuropsychological tasks, participants showed significantly lower mean scores than did normative samples on certain measures of inhibition and shifting, but not working memory nor planning. Thus, working memory performance was better compared to other studies with persons who had experienced their first episode of psychosis (Mesholam-Gately et al., 2009). Cognitive heterogeneity is perhaps exacerbated because the at-risk participants in the study may include both persons who will never experience a psychotic episode and participants who will (Catalan, Salazar de Pablo, et al., 2021; Millman et al., 2022). A recent study of trajectories on cognition among people at risk of psychosis found a subgroup of individuals with stable executive dysfunction over time, perhaps more likely to benefit from targeted intervention (Allott et al., 2022). Thus, to increase the certainty of detecting a treatment effect with neuropsychological tests, objective executive dysfunction could have been an inclusion criteria in the present study, and a larger sample size would have allowed the study to better account for heterogeneity.

Missing questionnaire data post-intervention and at follow-up is considered the main weakness of the study. No significant differences were found between those who completed one, two, or three questionnaires in demographical, clinical, or cognitive variables. This supports the assumption that data is missing at random due to logistical reasons, and it reduces the chance of bias. Mixed-model analysis is considered robust under the assumption that data is missing at random (Schielzeth et al., 2020).

Ethical Concerns

Several ethical challenges arise in research where participants are selected due to their experiences with psychotic symptoms. Among them are challenges with diagnosing participants with mental disorders who perhaps do not consider themselves ill (Hofmann, 2001). Moreover, the label of “risk of psychosis” may have adverse effects, such as futile

diagnosis or treatment, self-stigma, increased anxiety, or change in self-perception (Hofmann, 2019; Mittal et al., 2015; Sisti & Calkins, 2016). It is important to consider that individuals at risk of psychosis are usually discovered because they approach mental health services due to distress, even if they do not perceive that the distress as related to the at-risk syndromes (Falkenberg et al., 2015). Early detection offers access to treatment for the distressing symptoms, lowering the risk of psychosis. When accurate information about conversion rates and preventative measures is given, the at-risk label is perceived as hopeful rather than problematic (Corcoran, 2016). Participants in the present study are help-seeking individuals who have already received assessment and treatment for psychotic experiences by mental health professionals. GMT had little drop-out and few adverse effects, making it a safe intervention with the potential to protect against worse prognosis by preserving role-function (Cornblatt et al., 2003).

Conclusions

The first RCT of Goal Management Training (GMT) in people recently diagnosed with schizophrenia spectrum disorders or psychosis risk syndromes found clinically reliable improvement in subjective executive function in everyday situations following GMT. GMT may be recommended for persons with early schizophrenia regardless of the severity of objective executive dysfunction. People with schizophrenia who have more self-efficacy and more severe disorganized psychotic symptoms may be more likely to have a pattern of poor executive task performance, coupled with few subjectively experienced executive difficulties. This pattern of scores may represent an obstacle for GMT, but more evidence is needed to support this finding.

References

Adnan, A., Chen, A. J. W., Novakovic-Agopian, T., D'Esposito, M., & Turner, G. R. (2017). Brain Changes Following Executive Control Training in Older Adults. *Neurorehabil Neural Repair*, *31*(10-11), 910-922. https://doi.org/10.1177/1545968317728580

Aleman, A., Lincoln, T. M., Bruggeman, R., Melle, I., Arends, J., Arango, C., & Knegtering, H. (2017). Treatment of negative symptoms: Where do we stand, and where do we go? *Schizophr Res*, *186*, 55-62. https://doi.org/10.1016/j.schres.2016.05.015

Alfonso, J. P., Caracuel, A., Delgado-Pastor, L. C., & Verdejo-García, A. (2011). Combined goal management training and mindfulness meditation improve executive functions and decision-making performance in abstinent polysubstance abusers. *Drug and Alcohol Dependence*, *117*(1), 78-81. https://doi.org/10.1016/j.drugalcdep.2010.12.025

Allott, K., Liu, P., Proffitt, T. M., & Killackey, E. (2011). Cognition at illness onset as a predictor of later functional outcome in early psychosis: systematic review and methodological critique. *Schizophr Res*, *125*(2-3), 221-235. https://doi.org/10.1016/j.schres.2010.11.001

Allott, K., Schmidt, S. J., Yuen, H. P., Wood, S. J., Nelson, B., Markulev, C., . . . Hartmann, J. (2022). Twelve-month cognitive trajectories in individuals at ultra-high risk for psychosis: A latent class analysis. *Schizophrenia Bulletin Open*. https://doi.org/10.1093/schizbullopen/sgac008

Allott, K., Steele, P., Boyer, F., de Winter, A., Bryce, S., Alvarez-Jimenez, M., & Phillips, L. (2020). Cognitive strengths-based assessment and intervention in first-episode psychosis: A complementary approach to addressing functional recovery? *Clin Psychol Rev*, *79*. https://doi.org/10.1016/j.cpr.2020.101871

Allott, K., van-der-El, K., Bryce, S., Parrish, E. M., McGurk, S. R., Hetrick, S., . . . Velligan, D. (2020). Compensatory Interventions for Cognitive Impairments in Psychosis: A Systematic Review and Meta-Analysis. *Schizophr Bull*, *46*(4), 869-883. https://doi.org/10.1093/schbul/sbz134

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders : DSM-IV-TR* (4th ed., text revision. ed.). American Psychiatric Association.

American Psychiatric Association. (2021a). *The American Psychiatric Association practice guideline for the treatment of patients with schizophrenia*. Washington DC

American Psychiatric Association. (2021b). *Practice guideline for the treatment of patients with schizophrenia*. (Report Number 9780890424742). American Psychiatric Association

Anderson, K. K., Norman, R., MacDougall, A., Edwards, J., Palaniyappan, L., Lau, C., & Kurdyak, P. (2018). Effectiveness of Early Psychosis Intervention: Comparison of Service Users and Nonusers in Population-Based Health Administrative Data. *Am J Psychiatry*, *175*(5), 443-452. https://doi.org/10.1176/appi.ajp.2017.17050480

Andreasen, N. C. (1989). The American Concept of Schizophrenia. *Schizophr Bull*, *15*(4), 519-531. https://doi.org/10.1093/schbul/15.4.519

Ashford, S., & Turner-Stokes, L. (2006). Goal attainment for spasticity management using botulinum toxin. *Physiother Res Int*, *11*(1), 24-34. https://doi.org/10.1002/pri.36

Baddeley, A. (2012). Working memory: theories, models, and controversies. *Annu Rev Psychol*, *63*, 1-29. https://doi.org/10.1146/annurev-psych-120710-100422

Baddeley, A. D., & Hitch, G. (1974). Working Memory. In G. H. Bower (Ed.), *Psychology of Learning and Motivation* (Vol. 8, pp. 47-89). Academic Press. https://doi.org/https://doi.org/10.1016/S0079-7421(08)60452-1

Baliga, S. P., Kamath, R. M., & Kedare, J. S. (2020). Subjective cognitive complaints and its relation to objective cognitive performance, clinical profile, clinical insight, and social functioning in patients of schizophrenia: A cross-sectional study. *Indian J Psychiatry*, *62*(2), 178-185. https://doi.org/10.4103/psychiatry.IndianJPsychiatry_639_19

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev*, *84*(2), 191-215. https://doi.org/10.1037//0033-295X.84.2.191

Bandura, A. (2011). On the Functional Properties of Perceived Self-Efficacy Revisited. *J Manage*, *38*(1), 9-44. https://doi.org/10.1177/0149206311410606

Barch, D. M., Braver, T. S., Carter, C. S., Poldrack, R. A., & Robbins, T. W. (2009). CNTRICS final task selection: executive control. *Schizophr Bull*, *35*(1), 115-135. https://doi.org/10.1093/schbul/sbn154

Barlati, S., Deste, G., De Peri, L., Ariu, C., & Vita, A. (2013). Cognitive Remediation in Schizophrenia: Current Status and Future Perspectives. *Schizophr Res Treatment*, *2013*. https://doi.org/10.1155/2013/156084

Becattini-Oliveira, A. C., Dutra, D. F., Spenciere de Oliveira Campos, B., de Araujo, V. C., & Charchat-Fichman, H. (2018). A systematic review of a functional assessment Tool: UCSD Performance-based skill assessment (UPSA). *Psychiatry Res*, *267*, 12-18. https://doi.org/10.1016/j.psychres.2018.05.005

Bechdolf, A., Wagner, M., Ruhrmann, S., Harrigan, S., Putzfeld, V., Pukrop, R., . . . Klosterkötter, J. (2012). Preventing progression to first-episode psychosis in early initial prodromal states. *Br J Psychiatry*, *200*(1), 22-29. https://doi.org/10.1192/bjp.bp.109.066357

Beck, A. T., Himelstein, R., Bredemeier, K., Silverstein, S. M., & Grant, P. (2018). What accounts for poor functioning in people with schizophrenia: a re-evaluation of the contributions of neurocognitive v. attitudinal and motivational factors. *Psychol Med*, *48*(16), 2776-2785. https://doi.org/10.1017/S0033291718000442

Bellani, M., Ricciardi, C., Rossetti, M. G., Zovetti, N., Perlini, C., & Brambilla, P. (2019). Cognitive remediation in schizophrenia: the earlier the better? *Epidemiol Psychiatr Sci*, *29*, e57. https://doi.org/10.1017/s2045796019000532

Berberian, A. A., Gadelha, A., Dias, N. M., Mecca, T. P., Comfort, W. E., Bressan, R. A., & Lacerda, A. T. (2019). Component mechanisms of executive function in schizophrenia and their contribution to functional outcomes. *Braz J Psychiatry*, *41*(1), 22-30. https://doi.org/10.1590/1516-4446-2018-0021

Birchwood, M., Smith, J., Cochrane, R., Wetton, S., & Copestake, S. (1990). The Social Functioning Scale. The development and validation of a new scale of social adjustment for use in family intervention programmes with schizophrenic patients. *Br J Psychiatry*, *157*(12), 853-859. https://doi.org/10.1192/bjp.157.6.853

Bosnjak Kuharic, D., Kekin, I., Hew, J., Rojnic Kuzman, M., & Puljak, L. (2019). Interventions for prodromal stage of psychosis. *Cochrane Database Syst Rev*, *2019*(11). https://doi.org/10.1002/14651858.CD012236.pub2

Bowie, C. R., Bell, M. D., Fiszdon, J. M., Johannesen, J. K., Lindenmayer, J. P., McGurk, S. R., . . . Wykes, T. (2020). Cognitive remediation for schizophrenia: An expert working group white paper on core techniques. *Schizophr Res*, *215*, 49-53. https://doi.org/10.1016/j.schres.2019.10.047

Bowie, C. R., Grossman, M., Gupta, M., Holshausen, K., & Best, M. W. (2017). Action-based cognitive remediation for individuals with serious mental illnesses: Effects of real-world simulations and goal setting on functional and vocational outcomes. *Psychiatric Rehabilitation Journal*, *40*(1), 53-60. https://doi.org/10.1037/prj0000189

Bowie, C. R., Grossman, M., Gupta, M., Oyewumi, L. K., & Harvey, P. D. (2014). Cognitive remediation in schizophrenia: efficacy and effectiveness in patients with early versus

long-term course of illness. *Early Interv Psychiatry*, *8*(1), 32-38. https://doi.org/10.1111/eip.12029

Boyd, J. E., O'Connor, C., Protopopescu, A., Jetly, R., Rhind, S. G., Lanius, R. A., & McKinnon, M. C. (2019). An Open-Label Feasibility Trial Examining the Effectiveness of a Cognitive Training Program, Goal Management Training, in Individuals With Posttraumatic Stress Disorder. *Chronic Stress (Thousand Oaks)*, *3*, 2470547019841599. https://doi.org/10.1177/2470547019841599

Brown, A. S., & Lau, F. S. (2016). A review of the epidemiology of schizophrenia. In *Modeling the psychopathological dimensions of schizophrenia: From molecules to behavior* (pp. 17-30). Elsevier Academic Press; US.

Bryce, S., Warren, N., Ponsford, J., Rossell, S., & Lee, S. (2018). Understanding the lived experience of cognitive remediation in schizophrenia: A qualitative comparison with an active control. *Psychiatr Rehabil J*, *41*(4), 302-311. https://doi.org/10.1037/prj0000309

Bryce, S., Zbukvic, I., Wood, S. J., & Allott, K. (2021). Cognitive remediation to address impairment in schizophrenia: Moving beyond effectiveness and toward implementation. *Psychiatry Res*, *305*, 114232. https://doi.org/10.1016/j.psychres.2021.114232

Buckley, P. F., Miller, B. J., Lehrer, D. S., & Castle, D. J. (2009). Psychiatric comorbidities and schizophrenia. *Schizophr Bull*, *35*(2), 383-402. https://doi.org/10.1093/schbul/sbn135

Bulzacka, E., Vilain, J., Schurhoff, F., Meary, A., Leboyer, M., & Szoke, A. (2013). A self administered executive functions ecological questionnaire (the behavior rating inventory of executive function - adult version) shows impaired scores in a sample of patients with schizophrenia. *Ment Illn*, *5*(1), e4. https://doi.org/10.4081/mi.2013.e4

Buonocore, M., Spangaro, M., Bechi, M., Trezzani, S., Terragni, R., Martini, F., . . . Cavallaro, R. (2022). Cognitive remediation in schizophrenia: What happens after 10 years? *Schizophr Res Cogn*, *29*, 100251. https://doi.org/10.1016/j.scog.2022.100251

Burgess, P. W., Alderman, N., Forbes, C., Costello, A., Coates, L. M., Dawson, D. R., . . . Channon, S. (2006). The case for the development and use of "ecologically valid" measures of executive function in experimental and clinical neuropsychology. *J Int Neuropsychol Soc*, *12*(2), 194-209. https://doi.org/10.1017/S1355617706060310

Burgin, S., Reniers, R., & Humpston, C. (2022). Prevalence and assessment of self-disorders in the schizophrenia spectrum: a systematic review and meta-analysis. *Scientific Reports*, *12*(1), 1165. https://doi.org/10.1038/s41598-022-05232-9

Burton, C. Z., Harvey, P. D., Patterson, T. L., & Twamley, E. W. (2016). Neurocognitive insight and objective cognitive functioning in schizophrenia. *Schizophr Res*, *171*(1-3), 131-136. https://doi.org/10.1016/j.schres.2016.01.021

Burton, C. Z., & Twamley, E. W. (2015). Neurocognitive insight, treatment utilization, and cognitive training outcomes in schizophrenia. *Schizophr Res*, *161*(2-3), 399-402. https://doi.org/10.1016/j.schres.2014.12.002

Cameron, D. H., McCabe, R. E., Rowa, K., O'Connor, C., & McKinnon, M. C. (2020). A pilot study examining the use of Goal Management Training in individuals with obsessive-compulsive disorder. *Pilot Feasibility Stud*, *6*, 151. https://doi.org/10.1186/s40814-020-00684-0

Cardenas, V., Abel, S., Bowie, C. R., Tiznado, D., Depp, C. A., Patterson, T. L., . . . Mausbach, B. T. (2013). When functional capacity and real-world functioning converge: the role of self-efficacy. *Schizophrenia Bulletin*, *39*(4), 908-916. https://doi.org/10.1093/schbul/sbs004

Carruthers, S. P., Van Rheenen, T. E., Gurvich, C., Sumner, P. J., & Rossell, S. L. (2019). Characterising the structure of cognitive heterogeneity in schizophrenia spectrum disorders. A systematic review and narrative synthesis. *Neurosci Biobehav Rev*, *107*, 252-278. https://doi.org/10.1016/j.neubiorev.2019.09.006

Castelein, S., Timmerman, M. E., investigators, P., van der Gaag, M., & Visser, E. (2021). Clinical, societal and personal recovery in schizophrenia spectrum disorders across time: states and annual transitions. *Br J Psychiatry*, *219*(1), 401-408. https://doi.org/10.1192/bjp.2021.48

Catalan, A., Richter, A., Salazar de Pablo, G., Vaquerizo-Serrano, J., Mancebo, G., Pedruzo, B., . . . Fusar-Poli, P. (2021). Proportion and predictors of remission and recovery in first-episode psychosis: Systematic review and meta-analysis. *Eur Psychiatry*, *64*(1), e69. https://doi.org/10.1192/j.eurpsy.2021.2246

Catalan, A., Salazar de Pablo, G., Aymerich, C., Damiani, S., Sordi, V., Radua, J., . . . Fusar-Poli, P. (2021). Neurocognitive Functioning in Individuals at Clinical High Risk for Psychosis: A Systematic Review and Meta-analysis. *JAMA Psychiatry*. https://doi.org/10.1001/jamapsychiatry.2021.1290

Cella, M., Preti, A., Edwards, C., Dow, T., & Wykes, T. (2017). Cognitive remediation for negative symptoms of schizophrenia: A network meta-analysis. *Clin Psychol Rev*, *52*, 43-51. https://doi.org/10.1016/j.cpr.2016.11.009

Cella, M., Reeder, C., & Wykes, T. (2015). Cognitive remediation in schizophrenia—now it is really getting personal. *Current opinion in behavioral sciences*, *4*, 147-151. https://doi.org/10.1016/j.cobeha.2015.05.005

Cella, M., Swan, S., Medin, E., Reeder, C., & Wykes, T. (2014). Metacognitive awareness of cognitive problems in schizophrenia: exploring the role of symptoms and self-esteem. *Psychol Med*, *44*(3), 469-476. https://doi.org/10.1017/S0033291713001189

Cella, M., & Wykes, T. (2019). The nuts and bolts of Cognitive Remediation: Exploring how different training components relate to cognitive and functional gains. *Schizophr Res*, *203*, 12-16. https://doi.org/10.1016/j.schres.2017.09.012

Chang, W. C., Kwong, V. W., Hui, C. L., Chan, S. K., Lee, E. H., & Chen, E. Y. (2017). Relationship of amotivation to neurocognition, self-efficacy and functioning in first-episode psychosis: a structural equation modeling approach. *Psychol Med*, *47*(4), 755-765. https://doi.org/10.1017/S0033291716003044

Charlson, F. J., Ferrari, A. J., Santomauro, D. F., Diminic, S., Stockings, E., Scott, J. G., . . . Whiteford, H. A. (2018). Global Epidemiology and Burden of Schizophrenia: Findings From the Global Burden of Disease Study 2016. *Schizophr Bull*, *44*(6), 1195-1203. https://doi.org/10.1093/schbul/sby058

Chen, E. Y. H., Chan, S. K.-w., Chang, W.-c., Hui, C. L.-m., Lee, E. H.-m., Lo, T.-l., . . . Poon, L.-t. (2019). Early intervention for psychosis: Perspective after 15 years of development. In *Early intervention in psychiatric disorders across cultures.* (pp. 87-100). Oxford University Press. https://doi.org/10.1093/med/9780198820833.003.0008

Chiu, F. P. F., & Tsang, H. W. H. (2004). Validation of the Chinese general self-efficacy scale among individuals with schizophrenia in Hong Kong. *Int J Rehabil Res*, *27*(2), 159-161. https://doi.org/10.1097/01.mrr.0000127640.55118.6b

Chung, C. S., Pollock, A., Campbell, T., Durward, B. R., & Hagen, S. (2013). Cognitive rehabilitation for executive dysfunction in adults with stroke or other adult non-progressive acquired brain damage. *Cochrane Database Syst Rev*(4), CD008391. https://doi.org/10.1002/14651858.CD008391.pub2

Cicerone, K. D., Goldin, Y., Ganci, K., Rosenbaum, A., Wethe, J. V., Langenbahn, D. M., . . . Harley, J. P. (2019). Evidence-Based Cognitive Rehabilitation: Systematic Review of

the Literature From 2009 Through 2014. *Arch Phys Med Rehabil*, *100*(8), 1515-1533. https://doi.org/10.1016/j.apmr.2019.02.011

Collette, F., Van der Linden, M., Laureys, S., Delfiore, G., Degueldre, C., Luxen, A., & Salmon, E. (2005). Exploring the unity and diversity of the neural substrates of executive functioning. *Hum Brain Mapp*, *25*(4), 409-423. https://doi.org/10.1002/hbm.20118

Collins, A. G., Brown, J. K., Gold, J. M., Waltz, J. A., & Frank, M. J. (2014). Working memory contributions to reinforcement learning impairments in schizophrenia. *J Neurosci*, *34*(41), 13747-13756. https://doi.org/10.1523/JNEUROSCI.0989-14.2014

Conners, K. C. (2014). *Conners Continuous Performance Test* (3rd ed.). Multi-Health Systems Inc.

Corbera, S., Wexler, B. E., Poltorak, A., Thime, W. R., & Kurtz, M. M. (2017). Cognitive remediation for adults with schizophrenia: Does age matter? *Psychiatry Res*, *247*, 21-27. https://doi.org/10.1016/j.psychres.2016.10.084

Corcoran, C. M. (2016). Ethical and Epidemiological Dimensions of Labeling Psychosis Risk. *AMA J Ethics*, *18*(6), 633-642. https://doi.org/10.1001/journalofethics.2016.18.6.msoc2-1606

Cornblatt, B. A., Lencz, T., Smith, C. W., Correll, C. U., Auther, A. M., & Nakayama, E. (2003). The Schizophrenia Prodrome Revisited: A Neurodevelopmental Perspective. *Schizophr Bull*, *29*(4), 633-651. https://doi.org/10.1093/oxfordjournals.schbul.a007036

Correll, C. U., Galling, B., Pawar, A., Krivko, A., Bonetto, C., Ruggeri, M., . . . Kane, J. M. (2018). Comparison of Early Intervention Services vs Treatment as Usual for Early-Phase Psychosis: A Systematic Review, Meta-analysis, and Meta-regression. *JAMA Psychiatry*, *75*(6), 555-565. https://doi.org/10.1001/jamapsychiatry.2018.0623

Correll, C. U., Solmi, M., Croatto, G., Schneider, L. K., Rohani-Montez, S. C., Fairley, L., . . . Tiihonen, J. (2022). Mortality in people with schizophrenia: a systematic review and meta-analysis of relative risk and aggravating or attenuating factors. *World Psychiatry*, *21*(2), 248-271. https://doi.org/https://doi.org/10.1002/wps.20994

Cowman, M., Holleran, L., Lonergan, E., O'Connor, K., Birchwood, M., & Donohoe, G. (2021). Cognitive Predictors of Social and Occupational Functioning in Early Psychosis: A Systematic Review and Meta-analysis of Cross-Sectional and Longitudinal Data. *Schizophr Bull*, *47*(5), 1243-1253. https://doi.org/10.1093/schbul/sbab033

Crespo-Facorro, B., Such, P., Nylander, A.-G., Madera, J., Resemann, H. K., Worthington, E., . . . Newton, R. (2021). The burden of disease in early schizophrenia - a systematic literature review. *Curr Med Res Opin*, *37*(1), 109-121. https://doi.org/10.1080/03007995.2020.1841618

Datta, S. S., Daruvala, R., & Kumar, A. (2020). Psychological interventions for psychosis in adolescents. *Cochrane Database Syst Rev*, *7*, CD009533. https://doi.org/10.1002/14651858.CD009533.pub2

Davies, C., Segre, G., Estradé, A., Radua, J., De Micheli, A., Provenzani, U., . . . Fusar-Poli, P. (2020). Prenatal and perinatal risk and protective factors for psychosis: a systematic review and meta-analysis. *The Lancet Psychiatry*, *7*(5), 399-410. https://doi.org/10.1016/s2215-0366(20)30057-2

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis–Kaplan Executive Function System*. NCS Pearson, Inc.

Derogatis, L. R., Lipman, R. S., Rickels, K., Uhlenhuth, E. H., & Covi, L. (1974). The Hopkins Symptom Checklist (HSCL): A self-report symptom inventory. *Behavioral Science*, *19*(1), 1-15. https://doi.org/https://doi.org/10.1002/bs.3830190102

Deste, G., Barlati, S., Galluzzo, A., Corsini, P., Valsecchi, P., Turrina, C., & Vita, A. (2019). Effectiveness of Cognitive Remediation in Early Versus Chronic Schizophrenia: A Preliminary Report. *Front Psychiatry*, *10*, 236-236. https://doi.org/10.3389/fpsyt.2019.00236

DeTore, N. R., Mueser, K. T., Byrd, J. A., & McGurk, S. R. (2019). Cognitive functioning as a predictor of response to comprehensive cognitive remediation. *J Psychiatr Res*, *113*, 117-124. https://doi.org/10.1016/j.jpsychires.2019.03.012

Devoe, D. J., Farris, M. S., Townes, P., & Addington, J. (2019). Interventions and social functioning in youth at risk of psychosis: A systematic review and meta-analysis. *Early Interv Psychiatry*, *13*(2), 169-180. https://doi.org/10.1111/eip.12689

Diamond, A. (2013). Executive Functions. *Annu Rev Psychol*, *64*(1), 135-168. https://doi.org/10.1146/annurev-psych-113011-143750

Dibben, C. R., Rice, C., Laws, K., & McKenna, P. J. (2009). Is executive impairment associated with schizophrenic syndromes? A meta-analysis. *Psychol Med*, *39*(3), 381-392. https://doi.org/10.1017/S0033291708003887

Dominguez Mde, G., Viechtbauer, W., Simons, C. J., van Os, J., & Krabbendam, L. (2009). Are psychotic psychopathology and neurocognition orthogonal? A systematic review of their associations. *Psychol Bull*, *135*(1), 157-171. https://doi.org/10.1037/a0014415

Duncan, J. (1986). Disorganisation of behaviour after frontal lobe damage. *Cognitive neuropsychology*, *3*(3), 271-290.

Duncan, J., Emslie, H., Williams, P., Johnson, R., & Freer, C. (1996). Intelligence and the Frontal Lobe: The Organization of Goal-Directed Behavior. *Cognitive Psychology*, *30*(3), 257-303. https://doi.org/10.1006/cogp.1996.0008

East-Richard, C., R. -Mercier, A., Nadeau, D., & Cellard, C. (2020). Transdiagnostic neurocognitive deficits in psychiatry: A review of meta-analyses. *Can Psychol*, *61*(3), 190-214. https://doi.org/10.1037/cap0000196

Emmanouel, A., Kontrafouri, E., Nikolaos, P., Kessels, R. P. C., & Fasotti, L. (2018). Incorporation of a working memory strategy in GMT to facilitate serial-order behaviour in brain-injured patients. *Neuropsychol Rehabil*, 1-27. https://doi.org/10.1080/09602011.2018.1517369

Eslami, A., Jahshan, C., & Cadenhead, K. S. (2011). Disorganized Symptoms and Executive Functioning Predict Impaired Social Functioning in Subjects at Risk for Psychosis. *The journal of neuropsychiatry and clinical neurosciences*, *23*(4), 457-460. https://doi.org/10.1176/jnp.23.4.jnp457

Falkenberg, I., Valmaggia, L., Byrnes, M., Frascarelli, M., Jones, C., Rocchetti, M., . . . Fusar-Poli, P. (2015). Why are help-seeking subjects at ultra-high risk for psychosis help-seeking? *Psychiatry Res*, *228*(3), 808-815. https://doi.org/10.1016/j.psychres.2015.05.018

Fatouros-Bergman, H., Cervenka, S., Flyckt, L., Edman, G., & Farde, L. (2014). Meta-analysis of cognitive performance in drug-naive patients with schizophrenia. *Schizophr Res*, *158*(1-3), 156-162. https://doi.org/10.1016/j.schres.2014.06.034

Fett, A. J., Reichenberg, A., & Velthorst, E. (2022). Lifespan evolution of neurocognitive impairment in schizophrenia - A narrative review. *Schizophr Res Cogn*, *28*, 100237. https://doi.org/10.1016/j.scog.2022.100237

Fiedorowicz, J. G., Epping, E. A., & Flaum, M. (2008). Toward defining schizophrenia as a more useful clinical concept. *Curr Psychiatry Rep*, *10*(4), 344-351. https://doi.org/10.1007/s11920-008-0055-9

Fioravanti, M., Bianchi, V., & Cinti, M. E. (2012). Cognitive deficits in schizophrenia: An updated metanalysis of the scientific evidence. *BMC Psychiatry Vol 12 2012, ArtID 64*, *12*.

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. (2005). *Structured clinical interview for DSM-IV-TR Axis I disorders: patient edition*. Biometrics Research Department, Columbia University New York, NY.
Fish, J., Evans, J. J., Nimmo, M., Martin, E., Kersel, D., Bateman, A., . . . Manly, T. (2007). Rehabilitation of executive dysfunction following brain injury: "Content-free" cueing improves everyday prospective memory performance. *Neuropsychologia*, *45*(6), 1318-1330. https://doi.org/10.1016/j.neuropsychologia.2006.09.015
Flather, M., Delahunty, N., & Collinson, J. (2006). Generalizing results of randomized trials to clinical practice: reliability and cautions. *Clin Trials*, *3*(6), 508-512. https://doi.org/10.1177/1740774506073464
Forbes, N. F., Carrick, L. A., McIntosh, A. M., & Lawrie, S. M. (2009). Working memory in schizophrenia: a meta-analysis. *Psychol Med*, *39*(6), 889-905. https://doi.org/10.1017/S0033291708004558
Frawley, E., Cowman, M., Lepage, M., & Donohoe, G. (2021). Social and occupational recovery in early psychosis: a systematic review and meta-analysis of psychosocial interventions. *Psychological Medicine*, 1-12. https://doi.org/10.1017/S003329172100341X
Freedman, D., & Brown, A. S. (2011). The developmental course of executive functioning in schizophrenia. *Int J Dev Neurosci*, *29*(3), 237-243. https://doi.org/10.1016/j.ijdevneu.2010.11.003
Friedman-Yakoobian, M. S., Parrish, E. M., Eack, S. M., & Keshavan, M. S. (2020). *Neurocognitive and social cognitive training for youth at clinical high risk (chr) for psychosis: A randomized controlled feasibility trial*. Schizophrenia Research. 2020. https://doi.org/10.1016/j.schres.2020.09.005
Friedman, N. P., & Banich, M. T. (2019). Questionnaires and task-based measures assess different aspects of self-regulation: Both are needed. *Proc Natl Acad Sci U S A*, *116*(49), 24396-24397. https://doi.org/10.1073/pnas.1915315116
Friedman, N. P., & Miyake, A. (2017). Unity and diversity of executive functions: Individual differences as a window on cognitive structure. *Cortex*, *86*, 186-204. https://doi.org/10.1016/j.cortex.2016.04.023
Friedman, N. P., & Robbins, T. W. (2022). The role of prefrontal cortex in cognitive control and executive function. *Neuropsychopharmacology*, *47*(1), 72-89. https://doi.org/10.1038/s41386-021-01132-0
Friis, S., Larsen, T. K., Melle, I., Opjordsmoen, S., Johannessen, J. O., Haahr, U., . . . McGlashan, T. (2003). Methodological pitfalls in early detection studies - the NAPE Lecture 2002. *Acta psychiatrica Scandinavica*, *107*(1), 3-9. https://doi.org/10.1034/j.1600-0447.2003.02600.x
Fujii, D. E., Wylie, A. M., & Nathan, J. H. (2004). Neurocognition and long-term prediction of quality of life in outpatients with severe and persistent mental illness. *Schizophrenia Research*, *69*(1), 67-73. https://doi.org/10.1016/S0920-9964(03)00122-1
Fulford, D., Meyer-Kalos, P. S., & Mueser, K. T. (2020). *Focusing on recovery goals improves motivation in first-episode psychosis*. Social Psychiatry and Psychiatric Epidemiology: The International Journal for Research in Social and Genetic Epidemiology and Mental Health Services. 2020. https://doi.org/10.1007/s00127-020-01877-x
Fusar-Poli, P., Cappucciati, M., Rutigliano, G., Heslin, M., Stahl, D., Brittenden, Z., . . . Carpenter, W. T. (2016). Diagnostic Stability of ICD/DSM First Episode Psychosis Diagnoses: Meta-analysis. *Schizophr Bull*, *42*(6), 1395-1406. https://doi.org/10.1093/schbul/sbw020

Fusar-Poli, P., Davies, C., Solmi, M., Brondino, N., De Micheli, A., Kotlicka-Antczak, M., . . . Radua, J. (2019). Preventive Treatments for Psychosis: Umbrella Review (Just the Evidence). *Front Psychiatry*, *10*, 764. https://doi.org/10.3389/fpsyt.2019.00764

Fusar-Poli, P., Rocchetti, M., Sardella, A., Avila, A., Brandizzi, M., Caverzasi, E., . . . McGuire, P. (2015). Disorder, not just state of risk: meta-analysis of functioning and quality of life in people at high risk of psychosis. *Br J Psychiatry*, *207*(3), 198-206. https://doi.org/10.1192/bjp.bp.114.157115

Gergov, V., Milic, B., Loffler-Stastka, H., Ulberg, R., Vousoura, E., & Poulsen, S. (2022). Psychological Interventions for Young People With Psychotic Disorders: A Systematic Review. *Front Psychiatry*, *13*, 859042. https://doi.org/10.3389/fpsyt.2022.859042

Gleeson, J. F. M., Eleftheriadis, D., Santesteban-Echarri, O., Koval, P., Bastian, B., Penn, D. L., . . . Alvarez-Jimenez, M. (2020). Positive and meaningful lives: Systematic review and meta-analysis of eudaimonic well-being in first-episode psychosis. *Early Interv Psychiatry*. https://doi.org/10.1111/eip.13049

Glenthøj, L. B., Hjorthøj, C., Kristensen, T. D., Davidson, C. A., & Nordentoft, M. (2017). The effect of cognitive remediation in individuals at ultra-high risk for psychosis: a systematic review. *NPJ Schizophr*, *3*, 20. https://doi.org/10.1038/s41537-017-0021-9

Glenthøj, L. B., Mariegaard, L., Kristensen, T. D., Wenneberg, C., Medalia, A., & Nordentoft, M. (2020). Self-perceived cognitive impairments in psychosis ultra-high risk individuals: associations with objective cognitive deficits and functioning. *NPJ Schizophr*, *6*(1), 31. https://doi.org/10.1038/s41537-020-00124-1

Gould, F., McGuire, L. S., Durand, D., Sabbag, S., Larrauri, C., Patterson, T. L., . . . Harvey, P. D. (2015). Self-assessment in schizophrenia: Accuracy of evaluation of cognition and everyday functioning. *Neuropsychology*, *29*(5), 675-682. https://doi.org/10.1037/neu0000175

Grant, P. M., Best, M. W., & Beck, A. T. (2019). The meaning of group differences in cognitive test performance. *World Psychiatry*, *18*(2), 163-164. https://doi.org/10.1002/wps.20645

Green, M. F., Horan, W. P., & Lee, J. (2019). Nonsocial and social cognition in schizophrenia: current evidence and future directions. *World Psychiatry*, *18*(2), 146-161. https://doi.org/10.1002/wps.20624

Grunder, G., Bauknecht, P., Klingberg, S., Leopold, K., Paulzen, M., Schell, S., . . . Leucht, S. (2021). Treatment goals for patients with schizophrenia-A narrative review of physician and patient perspectives [Professional Psychological & Health Personnel Issues 3400]. *Pharmacopsychiatry*, *54*(2), 53-59. https://doi.org/http://dx.doi.org/10.1055/a-1298-4546

Guloksuz, S., & van Os, J. (2018). The slow death of the concept of schizophrenia and the painful birth of the psychosis spectrum. *Psychol Med*, *48*(2), 229-244. https://doi.org/10.1017/S0033291717001775

Guo, J. Y., Niendam, T. A., Auther, A. M., Carrion, R. E., Cornblatt, B. A., Ragland, J. D., . . . Carter, C. S. (2020). Predicting psychosis risk using a specific measure of cognitive control: a 12-month longitudinal study. *Psychol Med*, *50*(13), 2230-2239. https://doi.org/10.1017/S0033291719002332

Gupta, S. K. (2011). Intention-to-treat concept: A review. *Perspect Clin Res*, *2*(3), 109-112. https://doi.org/10.4103/2229-3485.83221

Hagen, B. I., Lau, B., Joormann, J., Smastuen, M. C., Landro, N. I., & Stubberud, J. (2020). Goal management training as a cognitive remediation intervention in depression: A randomized controlled trial. *J Affect Disord*, *275*, 268-277. https://doi.org/10.1016/j.jad.2020.07.015

Hansson, L. (2006). Determinants of quality of life in people with severe mental illness. *Acta Psychiatr Scand*(429), 46-50. https://doi.org/10.1111/j.1600-0447.2005.00717.x
Harvey, P. D. (2012). Clinical applications of neuropsychological assessment. *Dialogues Clin Neurosci*, *14*(1), 91-99. https://doi.org/10.31887/DCNS.2012.14.1/pharvey
Harvey, P. D. (2019). Domains of cognition and their assessment. *Dialogues Clin Neurosci*, *21*(3), 227-237. https://doi.org/10.31887/DCNS.2019.21.3/pharvey
Harvey, P. D., Heaton, R. K., Carpenter, W. T., Jr., Green, M. F., Gold, J. M., & Schoenbaum, M. (2012). Diagnosis of schizophrenia: consistency across information sources and stability of the condition. *Schizophr Res*, *140*(1-3), 9-14. https://doi.org/10.1016/j.schres.2012.03.026
Harvey, P. D., & Pinkham, A. (2015). Impaired self-assessment in schizophrenia: Why patients misjudge their cognition and functioning. *Curr Psychiatr*, *14*(4), 53-59.
Harvey, P. D., Strassnig, M. T., & Silberstein, J. (2019). Prediction of disability in schizophrenia: Symptoms, cognition, and self-assessment. *Journal of Experimental Psychopathology*, *10*(3). https://doi.org/10.1177/2043808719865693
Harvey, P. D., Twamley, E. W., Pinkham, A. E., Depp, C. A., & Patterson, T. L. (2017). Depression in Schizophrenia: Associations With Cognition, Functional Capacity, Everyday Functioning, and Self-Assessment. *Schizophr Bull*, *43*(3), 575-582. https://doi.org/10.1093/schbul/sbw103
Hauser, M., Zhang, J. P., Sheridan, E. M., Burdick, K. E., Mogil, R., Kane, J. M., . . . Correll, C. U. (2017). Neuropsychological Test Performance to Enhance Identification of Subjects at Clinical High Risk for Psychosis and to Be Most Promising for Predictive Algorithms for Conversion to Psychosis: A Meta-Analysis. *J Clin Psychiatry*, *78*(1), e28-e40. https://doi.org/10.4088/JCP.15r10197
Haywood, D., & Baughman, F. D. (2021). Multidimensionality in Executive Function Profiles in Schizophrenia: a Computational Approach Using the Wisconsin Card Sorting Task. *Computational Brain & Behavior*, *4*(4), 381-394. https://doi.org/10.1007/s42113-021-00106-1
Helldin, L., Hjarthag, F., Olsson, A. K., & Harvey, P. D. (2015). Cognitive performance, symptom severity, and survival among patients with schizophrenia spectrum disorder: A prospective 15-year study. *Schizophr Res*, *169*(1-3), 141-146. https://doi.org/10.1016/j.schres.2015.09.009
Hellvin, T., Sundet, K., Vaskinn, A., Simonsen, C., Ueland, T., Andreassen, O. A., & Melle, I. (2010). Validation of the Norwegian version of the Social Functioning Scale (SFS) for schizophrenia and bipolar disorder. *Scand J Psychol*, *51*(6), 525-533. https://doi.org/10.1111/j.1467-9450.2010.00839.x
Hilker, R., Helenius, D., Fagerlund, B., Skytthe, A., Christensen, K., Werge, T. M., . . . Glenthoj, B. (2018). Heritability of Schizophrenia and Schizophrenia Spectrum Based on the Nationwide Danish Twin Register. *Biol Psychiatry*, *83*(6), 492-498. https://doi.org/10.1016/j.biopsych.2017.08.017
Hofmann, B. (2001). Complexity of the concept of disease as shown through rival theoretical frameworks. *Theoretical Medicine and Bioethics*, *22*(3), 211-236. https://doi.org/10.1023/a:1011416302494
Hofmann, B. (2019). Expanding disease and undermining the ethos of medicine. *Eur J Epidemiol*, *34*(7), 613-619. https://doi.org/10.1007/s10654-019-00496-4
Holshausen, K., Bowie, C. R., Mausbach, B. T., Patterson, T. L., & Harvey, P. D. (2014). Neurocognition, functional capacity, and functional outcomes: The cost of inexperience. *Schizophrenia Research*, *152*(2), 430-434. https://doi.org/https://doi.org/10.1016/j.schres.2013.08.004

Homayoun, S., Nadeau-Marcotte, F., Luck, D., & Stip, E. (2011). Subjective and Objective Cognitive Dysfunction in Schizophrenia - is there a Link? *Front Psychol*, *2*, 148. https://doi.org/10.3389/fpsyg.2011.00148

Horan, W. P., Harvey, P.-O., Kern, R. S., & Green, M. F. (2011). Neurocognition, social cognition and functional outcome in schizophrenia. In W. Gaebel (Ed.), *Schizophrenia: Current science and clinical practice* (pp. 67-107). Wiley-Blackwell.

Husain, M. (2021). On Task: How Our Brain Gets Things Done. OXFORD: Oxford Univ Press.

Hwang, W. J., Lee, T. Y., Shin, W. G., Kim, M., Kim, J., Lee, J., & Kwon, J. S. (2019). Global and Specific Profiles of Executive Functioning in Prodromal and Early Psychosis. *Front Psychiatry*, *10*, 356. https://doi.org/10.3389/fpsyt.2019.00356

In de Braek, D. M. J. M., Dijkstra, J. B., Ponds, R. W., & Jolles, J. (2017). Goal Management Training in Adults With ADHD: An Intervention Study. *Journal of Attention Disorders*, *21*(13), 1130-1137. https://doi.org/10.1177/1087054712468052

Institute of Health Metrics and Evaluation. (2019). *Global Health Data Exchange (GHDx)* http://ghdx.healthdata.org/

Isquith, P. K., Roth, R. M., & Gioia, G. (2013). Contribution of Rating Scales to the Assessment of Executive Functions. *Applied Neuropsychology: Child*, *2*(2), 125-132. https://doi.org/10.1080/21622965.2013.748389

Jacobson, N. S., & Truax, P. (1991). Clinical Significance: A Statistical Approach to Defining Meaningful Change in Psychotherapy Research. *J Consult Clin Psychol*, *59*(1), 12-19. https://doi.org/10.1037/0022-006X.59.1.12

Javitt, D. C. (2015). Current and emergent treatments for symptoms and neurocognitive impairment in schizophrenia. *Curr Treat Options Psychiatry*, *1*(2), 107-120. https://doi.org/10.1007/s40501-014-0010-9

Jensen, D. A., Halmoy, A., Stubberud, J., Haavik, J., Lundervold, A. J., & Sorensen, L. (2021). An Exploratory Investigation of Goal Management Training in Adults With ADHD: Improvements in Inhibition and Everyday Functioning. *Front Psychol*, *12*, 659480. https://doi.org/10.3389/fpsyg.2021.659480

Kabat-Zinn, J. (1990). *Full catastrophe living: Using the wisdom of your body and mind to face stress, pain and illness* (15th anniversary ed. ed.). Delta Trade.

Kadakia, A., Fan, Q., Shepherd, J., Dembek, C., Bailey, H., Walker, C., & Williams, G. R. (2022). Healthcare resource utilization and quality of life by cognitive impairment in patients with schizophrenia. *Schizophr Res Cogn*, *28*, 100233. https://doi.org/10.1016/j.scog.2021.100233

Kay, S. R., Fiszbein, A., & Opler, L. A. (1987). The Positive and Negative Syndrome Scale (PANSS) for Schizophrenia. *Schizophr Bull*, *13*(2), 261-276. https://doi.org/10.1093/schbul/13.2.261

Keefe, R. S. E., Davis, V. G., Harvey, P. D., Atkins, A. S., Haig, G. M., Hagino, O., . . . Umbricht, D. (2017). Placebo Response and Practice Effects in Schizophrenia Cognition Trials. *JAMA Psychiatry*, *74*(8), 807-814. https://doi.org/10.1001/jamapsychiatry.2017.1574

Kharawala, S., Hastedt, C., Podhorna, J., Shukla, H., Kappelhoff, B., & Harvey, P. D. (2022). The relationship between cognition and functioning in schizophrenia: A semi-systematic review. *Schizophr Res Cogn*, *27*, 100217. https://doi.org/10.1016/j.scog.2021.100217

Kim, H. K., Park, H. Y., Seo, E., Bang, M., Song, Y. Y., Lee, S. Y., . . . An, S. K. (2019). Factors Associated With Psychosocial Functioning and Outcome of Individuals With Recent-Onset Schizophrenia and at Ultra-High Risk for Psychosis. *Front Psychiatry*, *10*, 459. https://doi.org/10.3389/fpsyt.2019.00459

Kluwe-Schiavon, B., Sanvicente-Vieira, B., Kristensen, C. H., & Grassi-Oliveira, R. (2013). Executive functions rehabilitation for schizophrenia: a critical systematic review. *J Psychiatr Res*, *47*(1), 91-104. https://doi.org/10.1016/j.jpsychires.2012.10.001

Krasny-Pacini, A., Evans, J., & Chevignard, M. (2014). Goal management training for rehabilitation of executive functions: A systematic review of effectiveness in patients with acquired brain injury. *Ann Phys Rehabil Med*, *57*, 67. https://doi.org/10.1016/j.rehab.2014.03.242

Krebs, M. D., Themudo, G. E., Benros, M. E., Mors, O., Borglum, A. D., Hougaard, D., . . . Thompson, W. K. (2021). Associations between patterns in comorbid diagnostic trajectories of individuals with schizophrenia and etiological factors. *Nat Commun*, *12*(1), 6617. https://doi.org/10.1038/s41467-021-26903-7

Krueger, C., & Tian, L. (2004). A comparison of the general linear mixed model and repeated measures ANOVA using a dataset with multiple missing data points. *Biol Res Nurs*, *6*(2), 151-157. https://doi.org/10.1177/1099800404267682

Laere, E., Tee, S. F., & Tang, P. Y. (2018). Assessment of Cognition in Schizophrenia Using Trail Making Test: A Meta-Analysis. *Psychiatry Investig*, *15*(10), 945-955. https://doi.org/10.30773/pi.2018.07.22

Laskemoen, J. F., Simonsen, C., Buchmann, C., Barrett, E. A., Bjella, T., Lagerberg, T. V., . . . Aas, M. (2019). Sleep disturbances in schizophrenia spectrum and bipolar disorders - a transdiagnostic perspective. *Compr Psychiatry*, *91*, 6-12. https://doi.org/10.1016/j.comppsych.2019.02.006

Lejeune, J. A., Northrop, A., & Kurtz, M. M. (2021). A Meta-analysis of Cognitive Remediation for Schizophrenia: Efficacy and the Role of Participant and Treatment Factors. *Schizophrenia Bulletin*, *47*(4), 997-1006. https://doi.org/10.1093/schbul/sbab022

Levaux, M. N., Laroi, F., Malmedier, M., Offerlin-Meyer, I., Danion, J. M., & Van Der Linden, M. (2012). Rehabilitation of Executive Functions in a Real-Life Setting: Goal Management Training Applied to a Person with Schizophrenia. *Case Rep Psychiatry*, *2012*, 1-15. https://doi.org/10.1155/2012/503023

Levine, B., Robertson, I. H., Clare, L., Carter, G., Hong, J., Wilson, B. A., . . . Stuss, D. T. (2000). Rehabilitation of executive functioning: an experimental-clinical validation of goal management training. *J Int Neuropsychol Soc*, *6*(3), 299. https://doi.org/10.1017/S1355617700633052

Levine, B., Schweizer, T. A., O'Connor, C., Turner, G., Gillingham, S., Stuss, D. T., . . . Robertson, I. H. (2011). Rehabilitation of executive functioning in patients with frontal lobe brain damage with goal management training. *Front Hum Neurosci*, *5*, 9. https://doi.org/10.3389/fnhum.2011.00009

Lewandowski, K. E. (2016). Cognitive Remediation for the Treatment of Cognitive Dysfunction in the Early Course of Psychosis. *Harv Rev Psychiatry*, *24*(2), 164-172. https://doi.org/10.1097/HRP.0000000000000108

Lysaker, P. H., Chernov, N., Moiseeva, T., Sozinova, M., Dmitryeva, N., Alyoshin, V., . . . Kostyuk, G. (2021). Clinical insight, cognitive insight and metacognition in psychosis: Evidence of mediation. *J Psychiatr Res*, *140*, 1-6. https://doi.org/10.1016/j.jpsychires.2021.05.030

Lysaker, P. H., Clements, C. A., Wright, D. E., Evans, J., & Marks, K. A. (2001). Neurocognitive correlates of helplessness, hopelessness, and well-being in schizophrenia. *J Nerv Ment Dis*, *189*(7), 457-462. https://doi.org/10.1097/00005053-200107000-00007

Løvstad, M., Sigurdardottir, S., Andersson, S., Grane, V. A., Moberget, T., Stubberud, J., & Solbakk, A. K. (2016). Behavior Rating Inventory of Executive Function Adult

Version in Patients with Neurological and Neuropsychiatric Conditions: Symptom Levels and Relationship to Emotional Distress. *J Int Neuropsychol Soc*, *22*(6), 682-694. https://doi.org/10.1017/S135561771600031X

Mahmood, Z., Kelsven, S., Cadenhead, K., Wyckoff, J., Reyes-Madrigal, F., de la Fuente-Sandoval, C., & Twamley, E. W. (2019). Compensatory Cognitive Training for Latino Youth at Clinical High Risk for Psychosis: Study Protocol for a Randomized Controlled Trial. *Front Psychiatry*, *10*, 951. https://doi.org/10.3389/fpsyt.2019.00951

Manly, T., Hawkins, K., Evans, J., Woldt, K., & Robertson, I. H. (2002). Rehabilitation of executive function: facilitation of effective goal management on complex tasks using periodic auditory alerts. *Neuropsychologia*, *40*(3), 271. https://doi.org/10.1016/S0028-3932(01)00094-X

McCaffrey, R. J., & Westervelt, H. J. (1995). Issues associated with repeated neuropsychological assessments. *Neuropsychol Rev*, *5*(3), 203-221. https://doi.org/10.1007/BF02214762

McGurk, S. R., & Mueser, K. T. (2006). Cognitive and clinical predictors of work outcomes in clients with schizophrenia receiving supported employment services: 4-year follow-up. *Adm Policy Ment Health & Ment Health Serv Res*, *33*(5), 598-606. https://doi.org/10.1007/s10488-006-0070-2

McGurk, S. R., Twamley, E. W., Sitzer, D. I., McHugo, G. J., & Mueser, K. T. (2007). A meta-analysis of cognitive remediation in schizophrenia. *Am J Psychiatry*, *164*(12), 1791-1802. https://doi.org/10.1176/appi.ajp.2007.07060906

McGurk, S. R., Xie, H., Bond, G. R., & Mueser, K. T. (2022). Impact of cognitive remediation on the prediction of employment outcomes in severe mental illness. *Schizophr Res*, *241*, 149-155. https://doi.org/10.1016/j.schres.2022.01.011

McKenna, P. J. (2007). *Schizophrenia and related syndromes* (2nd ed. ed.). Routledge.

Medalia, A., & Saperstein, A. M. (2013). Does cognitive remediation for schizophrenia improve functional outcomes? *Curr Opin Psychiatry*, *26*(2), 151-157. https://doi.org/10.1097/YCO.0b013e32835dcbd4

Medalia, A., Thysen, J., & Freilich, B. (2008). Do people with schizophrenia who have objective cognitive impairment identify cognitive deficits on a self report measure? *Schizophr Res*, *105*(1-3), 156-164. https://doi.org/10.1016/j.schres.2008.07.007

Mei, C., van der Gaag, M., Nelson, B., Smit, F., Yuen, H. P., Berger, M., . . . McGorry, P. D. (2021). *Preventive interventions for individuals at ultra high risk for psychosis: An updated and extended meta-analysis*. Clinical Psychology Review. Vol.86 2021, ArtID 102005. https://doi.org/10.1016/j.cpr.2021.102005

Melle, I. (2019). Cognition in schizophrenia: a marker of underlying neurodevelopmental problems? *World Psychiatry*, *18*(2), 164-165. https://doi.org/10.1002/wps.20646

Mesholam-Gately, R. I., Giuliano, A. J., Goff, K. P., Faraone, S. V., & Seidman, L. J. (2009). Neurocognition in First-Episode Schizophrenia: A Meta-Analytic Review. *Neuropsychology*, *23*(3), 315-336. https://doi.org/10.1037/a0014708

Miller, T., McGlashan, T., Woods, S., Stein, K., Driesen, N., Corcoran, C., . . . Davidson, L. (1999). Symptom Assessment in Schizophrenic Prodromal States. *Psychiatr Q*, *70*(4), 273-287. https://doi.org/10.1023/A:1022034115078

Millman, Z. B., Roemer, C., Vargas, T., Schiffman, J., Mittal, V. A., & Gold, J. M. (2022). Neuropsychological Performance Among Individuals at Clinical High-Risk for Psychosis vs Putatively Low-Risk Peers With Other Psychopathology: A Systematic Review and Meta-Analysis. *Schizophr Bull*. https://doi.org/10.1093/schbul/sbac031

Miskowiak, K. W., Petersen, J. Z., Ott, C. V., Knorr, U., Kessing, L. V., Gallagher, P., & Robinson, L. (2016). Predictors of the discrepancy between objective and subjective

cognition in bipolar disorder: a novel methodology. *Acta Psychiatr Scand*, *134*(6), 511-521. https://doi.org/10.1111/acps.12649
Mittal, V. A., Dean, D. J., Mittal, J., & Saks, E. R. (2015). Ethical, Legal, and Clinical Considerations when Disclosing a High-Risk Syndrome for Psychosis. *Bioethics*, *29*(8), 543-556. https://doi.org/10.1111/bioe.12155
Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "Frontal Lobe" tasks: a latent variable analysis. *Cogn Psychol*, *41*(1), 49-100. https://doi.org/10.1006/cogp.1999.0734
Moher, D., Hopewell, S., Schulz, K. F., Montori, V., Gotzsche, P. C., Devereaux, P. J., . . . Consolidated Standards of Reporting Trials, G. (2010). CONSORT 2010 Explanation and Elaboration: Updated guidelines for reporting parallel group randomised trials. *J Clin Epidemiol*, *63*(8), e1-37. https://doi.org/10.1016/j.jclinepi.2010.03.004
Mohn-Haugen, C. R., Mohn, C., Laroi, F., Teigset, C. M., Oie, M. G., & Rund, B. R. (2022). A systematic review of premorbid cognitive functioning and its timing of onset in schizophrenia spectrum disorders. *Schizophr Res Cogn*, *28*, 100246. https://doi.org/10.1016/j.scog.2022.100246
Mollon, J., David, A. S., Zammit, S., Lewis, G., & Reichenberg, A. (2018). Course of Cognitive Development From Infancy to Early Adulthood in the Psychosis Spectrum. *JAMA Psychiatry*, *75*(3), 270-279. https://doi.org/10.1001/jamapsychiatry.2017.4327
Moore, M. T., & Fresco, D. M. (2012). Depressive realism: A meta-analytic review. *Clin Psychol Rev*, *32*(6), 496-509. https://doi.org/10.1016/j.cpr.2012.05.004
Moradi, H., Harvey, P. D., & Helldin, L. (2018). Correlates of risk factors for reduced life expectancy in schizophrenia: Is it possible to develop a predictor profile? *Schizophr Res*, *201*, 388-392. https://doi.org/10.1016/j.schres.2018.05.035
Moreno-Kustner, B., Martin, C., & Pastor, L. (2018). Prevalence of psychotic disorders and its association with methodological issues. A systematic review and meta-analyses. *PLoS One*, *13*(4), e0195687. https://doi.org/10.1371/journal.pone.0195687
Muth, C., Bales, K. L., Hinde, K., Maninger, N., Mendoza, S. P., & Ferrer, E. (2016). Alternative Models for Small Samples in Psychological Research: Applying Linear Mixed Effects Models and Generalized Estimating Equations to Repeated Measures Data. *Educ Psychol Meas*, *76*(1), 64-87. https://doi.org/10.1177/0013164415580432
National Institute for Health and Care Excellence. (2013). *Psychosis and schizophrenia in children and young people: Recognition and management. Clinical Guideline CG155.* Retrieved from https://www.nice.org.uk/guidance/cg155
Neill, E., & Rossell, S. L. (2013). Executive functioning in schizophrenia: The result of impairments in lower order cognitive skills? *Schizophr Res*, *150*(1), 76-80. https://doi.org/10.1016/j.schres.2013.07.034
Niendam, T. A., Horwitz, J., Bearden, C. E., & Cannon, T. D. (2007). Ecological assessment of executive dysfunction in the psychosis prodrome: a pilot study. *Schizophr Res*, *93*(1-3), 350-354. https://doi.org/10.1016/j.schres.2007.03.009
Niendam, T. A., Laird, A. R., Ray, K. L., Dean, Y. M., Glahn, D. C., & Carter, C. S. (2012). Meta-analytic evidence for a superordinate cognitive control network subserving diverse executive functions. *Cogn Affect Behav Neurosci*, *12*(2), 241-268. https://doi.org/10.3758/s13415-011-0083-5
Norman, D. A., & Shallice, T. (1980). *Attention to Action: Willed and Automatic Control of Behavior*. Cognitive Neuroscience: A reader. Plenum Press.
Norwegian Health Authority. (2013). National guideline for assessment, treatment and follow-up care of persons with psychotic illness. https://www.helsedirektoratet.no/

Nuechterlein, K. H., Green, M. F., Calkins, M. E., Greenwood, T. A., Gur, R. E., Gur, R. C., . . . Braff, D. L. (2015). Attention/vigilance in schizophrenia: performance results from a large multi-site study of the Consortium on the Genetics of Schizophrenia (COGS). *Schizophr Res*, *163*(1-3), 38-46. https://doi.org/10.1016/j.schres.2015.01.017

Nuechterlein, K. H., Ventura, J., Subotnik, K. L., Hayata, J. N., Medalia, A., & Bell, M. D. (2014). Developing a Cognitive Training Strategy for First-Episode Schizophrenia: Integrating Bottom-Up and Top-Down Approaches. *Am J Psychiatr Rehabil*, *17*(3), 225-253. https://doi.org/10.1080/15487768.2014.935674

Ohi, K., Muto, Y., Sugiyama, S., & Shioiri, T. (2020). Safety and Efficacy in Randomized Controlled Trials of Second-Generation Antipsychotics Versus Placebo for Cognitive Impairments in Schizophrenia: A Meta-Analysis. *Journal of clinical psychopharmacology*, *Publish Ahead of Print*. https://doi.org/10.1097/JCP.0000000000001232

Olsson, A.-K., Hjärthag, F., & Helldin, L. (2019). Overestimated function in patients with schizophrenia: A possible risk factor for inadequate support? *Schizophr Res*, *206*, 194-199. https://doi.org/10.1016/j.schres.2018.11.027

Patterson, T. L., Goldman, S., McKibbin, C. L., Hughs, T., & Jeste, D. V. (2001). UCSD Performance-Based Skills Assessment: Development of a New Measure of Everyday Functioning for Severely Mentally Ill Adults. *Schizophrenia Bulletin*, *27*(2), 235-245. https://doi.org/10.1093/oxfordjournals.schbul.a006870

Patterson, T. L., & Mausbach, B. (2006). *UCSD Performance-Based Skills Assessement-Brief (UPSA-B)* (T. Ueland, A. Vaskinn, & M. Tandberg, Trans.). University of California.

Paudel, S., Coman, D., & Freudenreich, O. (2020). Subjective experience of cognitive difficulties as an important attribute of quality of life among individuals with schizophrenia spectrum disorders. *Schizophr Res*, *215*, 476-478. https://doi.org/10.1016/j.schres.2019.09.008

Pedersen, G., Hagtvet, K. A., & Karterud, S. (2007). Generalizability studies of the Global Assessment of Functioning-Split version. *Compr Psychiatry*, *48*(1), 88-94. https://doi.org/10.1016/j.comppsych.2006.03.008

Penadés, R., Catalán, R., Puig, O., Masana, G., Pujol, N., Navarro, V., . . . Gastó, C. (2009). Executive function needs to be targeted to improve social functioning with Cognitive Remediation Therapy (CRT) in schizophrenia. *Psychiatry Res*, *177*(1), 41-45. https://doi.org/10.1016/j.psychres.2009.01.032

Penttila, M., Jaaskelainen, E., Hirvonen, N., Isohanni, M., & Miettunen, J. (2014). Duration of untreated psychosis as predictor of long-term outcome in schizophrenia: systematic review and meta-analysis. *Br J Psychiatry*, *205*(2), 88-94. https://doi.org/10.1192/bjp.bp.113.127753

Peralta, V., Garcia de Jalon, E., Moreno-Izco, L., Peralta, D., Janda, L., Sanchez-Torres, A. M., . . . Group, S. E. (2022). Long-Term Outcomes of First-Admission Psychosis: A Naturalistic 21-Year Follow-Up Study of Symptomatic, Functional and Personal Recovery and Their Baseline Predictors. *Schizophr Bull*. https://doi.org/10.1093/schbul/sbab145

Pijnenborg, G. H. M., Van Beilen, M., Arends, J., Holthausen, E. A. E., & Withaar, F. K. (2003). Disturbed cognitive functioning and clinical symptoms: two independent problem areas in schizophrenia. *Acta Neuropsychiatrica*, *15*(5), 280-283. https://doi.org/https://doi.org/10.1034/j.1601-5215.2003.00042.x

Pijnenborg, G. H. M., Withaar, F. K., Evans, J., Bosch, R. J., & Brouwer, W. (2007). SMS text messages as a prosthetic aid in the cognitive rehabilitation of schizophrenia. *Rehabilitation Psychology*, *52*. https://doi.org/10.1037/0090-5550.52.2.236

Pillinger, T., D'Ambrosio, E., McCutcheon, R., & Howes, O. D. (2019). Is psychosis a multisystem disorder? A meta-review of central nervous system, immune, cardiometabolic, and endocrine alterations in first-episode psychosis and perspective on potential models. *Mol Psychiatry*, *24*(6), 776-794. https://doi.org/10.1038/s41380-018-0058-9

Pipkin, A. (2020). *Evidence base for early intervention in psychosis services in rural areas: A critical review*. Early Intervention in Psychiatry. https://doi.org/10.1111/eip.13019

Potvin, S., Pelletier, J., & Stip, E. (2014). La conscience des déficits neurocognitifs dans la schizophrénie : une méta-analyse [Neurocognitive insight in schizophrenia: a meta-analysis]. *Sante Ment Que*, *39*(2), 183. https://doi.org/10.7202/1027839ar

Radua, J., Ramella-Cravaro, V., Ioannidis, J. P. A., Reichenberg, A., Phiphopthatsanee, N., Amir, T., . . . Fusar-Poli, P. (2018). What causes psychosis? An umbrella review of risk and protective factors. *World Psychiatry*, *17*(1), 49-66. https://doi.org/10.1002/wps.20490

Raffard, S., Lebrun, C., Bayard, S., Macgregor, A., & Capdevielle, D. (2020). Self-Awareness Deficits of Cognitive Impairment in Individuals With Schizophrenia. Really? *Front Psychiatry*, *11*, 731. https://doi.org/10.3389/fpsyt.2020.00731

Reeder, C., Newton, E., Frangou, S., & Wykes, T. (2004). Which Executive Skills Should We Target to Affect Social Functioning and Symptom Change? A Study of a Cognitive Remediation Therapy Program. *Schizophrenia Bulletin*, *30*(1), 87-100. https://doi.org/10.1093/oxfordjournals.schbul.a007070

Reichenberg, A., Velthorst, E., & Davidson, M. (2019). Cognitive impairment and psychosis in schizophrenia: independent or linked conditions? *World Psychiatry*, *18*(2), 162-163. https://doi.org/10.1002/wps.20644%20

Revell, E. R., Neill, J. C., Harte, M., Khan, Z., & Drake, R. J. (2015). A systematic review and meta-analysis of cognitive remediation in early schizophrenia. *Schizophr Res*, *168*(1-2), 213-222. https://doi.org/10.1016/j.schres.2015.08.017

Ritsner, M. S., & Gottesman, I. I. (2011). The Schizophrenia Construct After 100 Years of Challenges. In: Ritsner, M. (eds) Handbook of Schizophrenia Spectrum Disorders, Volume I. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-0837-2_1

Robertson, I. H. (1996). *Goal Management Training: A Clinical Manual*. PsyConsult.

Robertson, I. H., & Garavan, H. (2000). Vigilant attention. In G. M. (Ed.), *The new cognitive neurosciences* (2nd ed., pp. 563-578). MIT Press.

Rodriguez-Jimenez, R., Bagney, A., Mezquita, L., Martinez-Gras, I., Sanchez-Morla, E. M., Mesa, N., . . . Parg. (2013). Cognition and the five-factor model of the positive and negative syndrome scale in schizophrenia. *Schizophr Res*, *143*(1), 77-83. https://doi.org/10.1016/j.schres.2012.10.020

Romer, A. L., & Pizzagalli, D. A. (2021). Is executive dysfunction a risk marker or consequence of psychopathology? A test of executive function as a prospective predictor and outcome of general psychopathology in the adolescent brain cognitive development study(R). *Dev Cogn Neurosci*, *51*, 100994. https://doi.org/10.1016/j.dcn.2021.100994

Rose, D., Farrier, D., Doran, A.-M., Sporle, T., & Bogner, D. (2008). What do clients think of cognitive remediation therapy? A consumer-led investigation of satisfaction and side-effects. *Am J Psychiatr Rehabil*, *11*(2), 181-204. https://doi.org/10.1080/15487760801963694

Roth, R. M., & Gioia, G. A. (2005). *Behavior rating inventory of executive function- Adult version*. Psychological Assessment Resources.

Salazar de Pablo, G., Radua, J., Pereira, J., Bonoldi, I., Arienti, V., Besana, F., . . . Fusar-Poli, P. (2021). Probability of Transition to Psychosis in Individuals at Clinical High Risk:

An Updated Meta-analysis. *JAMA Psychiatry*, *78*(9), 970-978. https://doi.org/10.1001/jamapsychiatry.2021.0830
Salazar de Pablo, G., Woods, S. W., Drymonitou, G., de Diego, H., & Fusar-Poli, P. (2021). Prevalence of Individuals at Clinical High-Risk of Psychosis in the General Population and Clinical Samples: Systematic Review and Meta-Analysis. *Brain Sci*, *11*(11). https://doi.org/10.3390/brainsci11111544
Sanchez-Torres, A. M., Peralta, V., Gil-Berrozpe, G. J., Mezquida, G., Ribeiro, M., Molina-Garcia, M., . . . Group, P. E. (2022). The network structure of cognitive deficits in first episode psychosis patients. *Schizophr Res*, *244*, 46-54. https://doi.org/10.1016/j.schres.2022.05.005
Santarelli, V., Marucci, C., Collazzoni, A., Rossetti, M. C., Pizziconi, G., Pacitti, F., . . . Rossi, R. (2020). Could the severity of symptoms of schizophrenia affect ability of self-appraisal of cognitive deficits in patients with schizophrenia? Lack of insight as a mediator between the two domains. *Eur Arch Psychiatry Clin Neurosci*, *270*(6), 723-728. https://doi.org/10.1007/s00406-019-01082-1
Santelmann, H., Franklin, J., Busshoff, J., & Baethge, C. (2016). Interrater reliability of schizoaffective disorder compared with schizophrenia, bipolar disorder, and unipolar depression - A systematic review and meta-analysis. *Schizophr Res*, *176*(2-3), 357-363. https://doi.org/10.1016/j.schres.2016.07.012
Saperstein, A. M., & Kurtz, M. M. (2013). Current Trends in the Empirical Study of Cognitive Remediation for Schizophrenia. *Can J Psychiatry*, *58*(6), 311-318. https://doi.org/10.1177/070674371305800602
Saperstein, A. M., Lynch, D. A., Qian, M., & Medalia, A. (2020). How does awareness of cognitive impairment impact motivation and treatment outcomes during cognitive remediation for schizophrenia? *Schizophr Res*, *218*, 70-75. https://doi.org/10.1016/j.schres.2020.02.014
Savla, G. N., Twamley, E. W., Thompson, W. K., Delis, D. C., Jeste, D. V., & Palmer, B. W. (2010). Evaluation of Specific Executive Functioning Skills and the Processes Underlying Executive Control in Schizophrenia. *J Int Neuropsychol Soc*, *17*(1), 14-23. https://doi.org/10.1017/S1355617710001177
Sbordone, R. J. (2014). The hazards of strict reliance on neuropsychological tests. *Appl Neuropsychol Adult*, *21*(2), 98-107. https://doi.org/10.1080/09084282.2012.762630
Schielzeth, H., Dingemanse, N. J., Nakagawa, S., Westneat, D. F., Allegue, H., Teplitsky, C., . . . Sutherland, C. (2020). Robustness of linear mixed-effects models to violations of distributional assumptions. *Methods Ecol Evol*, *11*(9), 1141-1152. https://doi.org/10.1111/2041-210x.13434
Schulz, K. F., Altman, D. G., & Moher, D. (2010). CONSORT 2010 Statement: updated guidelines for reporting parallel group randomised trials. *BMJ*, *340*, c332. https://doi.org/10.1136/bmj.c332
Schwarzer, R., & Jerusalem, M. (1995). Generalized Self-Efficacy scale. In J. Weinman, S. Wright, & M. Johnston (Eds.), *Measures in health psychology: A user's portfolio.* (pp. 35-37). nferNelson.
Seccomandi, B., Tsapekos, D., Newbery, K., Wykes, T., & Cella, M. (2020). A systematic review of moderators of cognitive remediation response for people with schizophrenia. *Schizophr Res Cogn*, *19*, 100160. https://doi.org/10.1016/j.scog.2019.100160
Seidman, L. J., Shapiro, D. I., Stone, W. S., Woodberry, K. A., Ronzio, A., Cornblatt, B. A., . . . Woods, S. W. (2016). Association of Neurocognition With Transition to Psychosis: Baseline Functioning in the Second Phase of the North American Prodrome Longitudinal Study. *JAMA Psychiatry*, *73*(12), 1239-1248. https://doi.org/10.1001/jamapsychiatry.2016.2479

Sellwood, W., Morrison, A. P., Beck, R., Heffernan, S., Law, H., & Bentall, R. P. (2013). Subjective cognitive complaints in schizophrenia: relation to antipsychotic medication dose, actual cognitive performance, insight and symptoms. *PLoS One*, *8*(12), e83774. https://doi.org/10.1371/journal.pone.0083774

Shakoor, S., Zavos, H. M., Haworth, C. M., McGuire, P., Cardno, A. G., Freeman, D., & Ronald, A. (2016). Association between stressful life events and psychotic experiences in adolescence: evidence for gene-environment correlations. *Br J Psychiatry*, *208*(6), 532-538. https://doi.org/10.1192/bjp.bp.114.159079

Shallice, T. I. M., & Burgess, P. W. (1991). Deficits in strategy application following frontal lobe damage in man. *Brain*, *114*(2), 727-741. https://doi.org/10.1093/brain/114.2.727

Sheffield, J. M., Karcher, N. R., & Barch, D. M. (2018). Cognitive Deficits in Psychotic Disorders: A Lifespan Perspective. *Neuropsychol Rev*, *28*(4), 509-533. https://doi.org/10.1007/s11065-018-9388-2

Shin, Y. J., Joo, Y. H., & Kim, J. H. (2016). Self-perceived cognitive deficits and their relationship with internalized stigma and quality of life in patients with schizophrenia. *Neuropsychiatr Dis Treat*, *12*, 1411-1417. https://doi.org/10.2147/NDT.S108537

Shwartz, S. K., Roper, B. L., Arentsen, T. J., Crouse, E. M., & Adler, M. C. (2020). The Behavior Rating Inventory of Executive Function®-Adult Version is related to emotional distress, not executive dysfunction, in a veteran sample. *Arch Clin Neuropsychol*, *35*(6), 701-716. https://doi.org/10.1093/arclin/acaa024

Silberstein, J., & Harvey, P. D. (2019). Cognition, social cognition, and Self-assessment in schizophrenia: prediction of different elements of everyday functional outcomes. *CNS Spectr*, *24*(1), 88-93. https://doi.org/10.1017/S1092852918001414

Silberstein, J. M., Pinkham, A. E., Penn, D. L., & Harvey, P. D. (2018). Self-assessment of social cognitive ability in schizophrenia: Association with social cognitive test performance, informant assessments of social cognitive ability, and everyday outcomes. *Schizophr Res*, *199*, 75-82. https://doi.org/10.1016/j.schres.2018.04.015

Sisti, D. A., & Calkins, M. E. (2016). Psychosis Risk: What Is It and How Should We Talk About It? *AMA J Ethics*, *18*(6), 624-632. https://doi.org/10.1001/journalofethics.2016.18.6.msoc1-1606

Sizer, H., Brown, E., Geros, H., Yung, A., Nelson, B., McGorry, P., & O'Donoghue, B. (2022). Outcomes for first-episode psychosis after entry via an at-risk mental state clinic compared to direct entry to a first episode of psychosis service: A systematic review and meta-analysis. *Schizophrenia Research*, *240*, 214-219. https://doi.org/https://doi.org/10.1016/j.schres.2021.12.019

Skar-Fröding, R., Clausen, H. K., Šaltytė Benth, J., Ruud, T., Slade, M., & Sverdvik Heiervang, K. (2021). The Importance of Personal Recovery and Perceived Recovery Support Among Service Users With Psychosis. *Psychiatric Services*, https://doi.org/10.1176/appi.ps.202000223

Smeland, O. B., Frei, O., Dale, A. M., & Andreassen, O. A. (2020). The polygenic architecture of schizophrenia - rethinking pathogenesis and nosology. *Nat Rev Neurol*, *16*(7), 366-379. https://doi.org/10.1038/s41582-020-0364-0

Smucny, J., Dienel, S. J., Lewis, D. A., & Carter, C. S. (2022). Mechanisms underlying dorsolateral prefrontal cortex contributions to cognitive dysfunction in schizophrenia. *Neuropsychopharmacology*, *47*(1), 292-308. https://doi.org/10.1038/s41386-021-01089-0

Snyder, H. R., Friedman, N. P., & Hankin, B. L. (2019). Transdiagnostic mechanisms of psychopathology in youth: Executive functions, dependent stress, and rumination. *Cognit Ther Res*, *43*(5), 834-851. https://doi.org/10.1007/s10608-019-10016-z

Snyder, H. R., Miyake, A., & Hankin, B. L. (2015). Advancing understanding of executive function impairments and psychopathology: bridging the gap between clinical and cognitive approaches. *Front Psychol*, *6*, 328. https://doi.org/10.3389/fpsyg.2015.00328

Spaulding, W. D., Silverstein, S. M., & Menditto, A. A. (2017). *The schizophrenia spectrum* (2nd edition. ed., Vol. 5). Hogrefe.

Squarcina, L., Kambeitz-Ilankovic, L., Bonivento, C., Prunas, C., Oldani, L., Wenzel, J., . . . consortium, P. (2022). Relationships between global functioning and neuropsychological predictors in subjects at high risk of psychosis or with a recent onset of depression. *World J Biol Psychiatry*, 1-9. https://doi.org/10.1080/15622975.2021.2014955

Stamenova, V., & Levine, B. (2018). Effectiveness of goal management training® in improving executive functions: A meta-analysis. *Neuropsychol Rehabil*, 1-31. https://doi.org/10.1080/09602011.2018.1438294

Strand, B. H., Dalgard, O. S., Tambs, K., & Rognerud, M. (2003). Measuring the mental health status of the Norwegian population: a comparison of the instruments SCL-25, SCL-10, SCL-5 and MHI-5 (SF-36). *Nord J Psychiatry*, *57*(2), 113-118. https://doi.org/10.1080/08039480310000932

Stubberud, J., Langenbahn, D., Levine, B., Stanghelle, J., & Schanke, A.-K. (2013a). Goal Management Training improves everyday executive functioning for persons with spina bifida: Self-and informant reports six months post-training. *Neuropsychological Rehabilitation*, 1-35. https://doi.org/10.1080/09602011.2013.847847

Stubberud, J., Langenbahn, D., Levine, B., Stanghelle, J., & Schanke, A.-K. (2013b). Goal management training of executive functions in patients with spina bifida: a randomized controlled trial. *J Int Neuropsychol Soc*, *19*(6), 672-685. https://doi.org/10.1017/S1355617713000209

Sullivan, P. F., Kendler, K. S., & Neale, M. C. (2003). Schizophrenia as a Complex Trait: Evidence From a Meta-analysis of Twin Studies. *Arch Gen Psychiatry*, *60*(12), 1187-1192. https://doi.org/10.1001/archpsyc.60.12.1187

Szabo, S., Merikle, E., Lozano-Ortega, G., Powell, L., Macek, T., & Cline, S. (2018). Assessing the Relationship between Performance on the University of California Performance Skills Assessment (UPSA) and Outcomes in Schizophrenia: A Systematic Review and Evidence Synthesis. *Schizophr Res Treatment*, *2018*, 9075174. https://doi.org/10.1155/2018/9075174

Thai, M. L., Andreassen, A. K., & Bliksted, V. (2019). A meta-analysis of executive dysfunction in patients with schizophrenia: Different degree of impairment in the ecological subdomains of the Behavioural Assessment of the Dysexecutive Syndrome. *Psychiatry Res*, *272*, 230-236. https://doi.org/10.1016/j.psychres.2018.12.088

Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner review: Do performance-based measures and ratings of executive function assess the same construct? *J Child Psychol Psychiatry*, *54*(2), 131-143. https://doi.org/10.1111/jcpp.12001

Tornas, S., Lovstad, M., Solbakk, A. K., Schanke, A. K., & Stubberud, J. (2019). Use It or Lose It? A 5-Year Follow-up Study of Goal Management Training in Patients with Acquired Brain Injury. *J Int Neuropsychol Soc*, *25*(10), 1082-1087. https://doi.org/10.1017/S1355617719000626

Treichler, E. B. H., Thomas, M. L., Bismark, A. W., Hochberger, W. C., Tarasenko, M., Nungaray, J., . . . Light, G. A. (2019). Divergence of subjective and performance-based cognitive gains following cognitive training in schizophrenia. *Schizophr Res*, *210*, 215-220. https://doi.org/10.1016/j.schres.2018.12.034

Turner, G. R., Novakovic-Agopian, T., Kornblith, E., Adnan, A., Madore, M., Chen, A. J. W., & D'Esposito, M. (2020). Goal-Oriented Attention Self-Regulation (GOALS) training in older adults. *Aging Ment Health*, *24*(3), 464-473. https://doi.org/10.1080/13607863.2018.1534080

Twamley, E. W., Burton, C. Z., & Vella, L. (2011). Compensatory cognitive training for psychosis: who benefits? Who stays in treatment? *Schizophr Bull*, *37 Suppl 2*, S55-62. https://doi.org/10.1093/schbul/sbr059

Twamley, E. W., Vella, L., Burton, C. Z., Heaton, R. K., & Jeste, D. V. (2012). Compensatory cognitive training for psychosis: effects in a randomized controlled trial. *J Clin Psychiatry*, *73*(9), 1212-1219. https://doi.org/10.4088/JCP.12m07686

Twisk, J., Bosman, L., Hoekstra, T., Rijnhart, J., & Welten, M. H., M. (2018). Different ways to estimate treatment effects in randomised controlled trials. *Contemp Clin Trials Commun*, *10*, 80-85. https://doi.org/10.1016/j.conctc.2018.03.008

Tyburski, E., Mak, M., Sokolowski, A., Starkowska, A., Karabanowicz, E., Kerestey, M., . . . Jansari, A. S. (2021). Executive Dysfunctions in Schizophrenia: A Critical Review of Traditional, Ecological, and Virtual Reality Assessments. *J Clin Med*, *10*(13). https://doi.org/10.3390/jcm10132782

Ueland, T., & Rund, B. R. (2005). Cognitive remediation for adolescents with early onset psychosis: a 1-year follow-up study. *Acta Psychiatr Scand*, *111*(3), 193-201. https://doi.org/10.1111/j.1600-0447.2004.00503.x

Valls-Serrano, C., Caracuel, A., & Verdejo-Garcia, A. (2016). Goal Management Training and Mindfulness Meditation improve executive functions and transfer to ecological tasks of daily life in polysubstance users enrolled in therapeutic community treatment. *Drug Alcohol Depend*, *165*, 9-14. https://doi.org/10.1016/j.drugalcdep.2016.04.040

Van Aken, B., Wierdsma, A. I., Voskes, Y., Pijnenborg, G., Weeghel, J., & Mulder, C. (2022). The association between executive functioning and personal recovery in people with psychotic disorders. *Schizophrenia Bulletin Open*. https://doi.org/10.1093/schizbullopen/sgac023

van Duin, D., de Winter, L., Oud, M., Kroon, H., Veling, W., & van Weeghel, J. (2019). The effect of rehabilitation combined with cognitive remediation on functioning in persons with severe mental illness: systematic review and meta-analysis. *Psychol Med*, *49*(9), 1414-1425. https://doi.org/10.1017/S003329171800418X

van Os, J. (2009). 'Salience syndrome' replaces 'schizophrenia' in DSM-V and ICD-11: psychiatry's evidence-based entry into the 21st century? *Acta Psychiatr Scand*, *120*(5), 363-372. https://doi.org/10.1111/j.1600-0447.2009.01456.x

Varchmin, L., Montag, C., Treusch, Y., Kaminski, J., & Heinz, A. (2021). Traumatic Events, Social Adversity and Discrimination as Risk Factors for Psychosis - An Umbrella Review. *Front Psychiatry*, *12*, 665957. https://doi.org/10.3389/fpsyt.2021.665957

Velthorst, E., Zinberg, J., Addington, J., Cadenhead, K. S., Cannon, T. D., Carrión, R. E., . . . Bearden, C. E. (2018). Potentially important periods of change in the development of social and role functioning in youth at clinical high risk for psychosis. *Dev Psychopathol*, *30*(1), 39-47. https://doi.org/10.1017/S0954579417000451

Ventura, J., Subotnik, K. L., Ered, A., Gretchen-Doorly, D., Hellemann, G. S., Vaskinn, A., & Nuechterlein, K. H. (2014). The relationship of attitudinal beliefs to negative symptoms, neurocognition, and daily functioning in recent-onset schizophrenia. *Schizophr Bull*, *40*(6), 1308-1318. https://doi.org/10.1093/schbul/sbu002

Ventura, J., Thames, A. D., Wood, R. C., Guzik, L. H., & Hellemann, G. S. (2010). Disorganization and reality distortion in schizophrenia: a meta-analysis of the relationship between positive symptoms and neurocognitive deficits. *Schizophr Res*, *121*(1-3), 1-14. https://doi.org/10.1016/j.schres.2010.05.033

Vesterager, L., Christensen, T. O., Olsen, B. B., Krarup, G., Melau, M., Forchhammer, H. B., & Nordentoft, M. (2012). Cognitive and clinical predictors of functional capacity in patients with first episode schizophrenia. *Schizophr Res*, *141*(2-3), 251-256. https://doi.org/10.1016/j.schres.2012.08.023

Vidarsdottir, O. G., Roberts, D. L., Twamley, E. W., Gudmundsdottir, B., Sigurdsson, E., & Magnusdottir, B. B. (2019). Integrative cognitive remediation for early psychosis: Results from a randomized controlled trial. *Psychiatry Res*, *273*, 690-698. https://doi.org/10.1016/j.psychres.2019.02.007

Vita, A., Barlati, S., Ceraso, A., Nibbio, G., Ariu, C., Deste, G., & Wykes, T. (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*(8), 848-858. https://doi.org/10.1001/jamapsychiatry.2021.0620

Vizzotto, A., Celestino, D., Buchain, P., Oliveira, A., Oliveira, G., Di Sarno, E., . . . Elkis, H. (2021). Occupational Goal Intervention Method for the Management of Executive Dysfunction in People With Treatment-Resistant Schizophrenia: A Randomized Controlled Trial. *Am J Occup Ther*, *75*(3). https://doi.org/10.5014/ajot.2021.043257

Vlagsma, T. T., Duits, A. A., Dijkstra, H. T., van Laar, T., & Spikman, J. M. (2020). Effectiveness of ReSET; a strategic executive treatment for executive dysfunctioning in patients with Parkinson's disease. *Neuropsychological Rehabilitation*, *30*(1), 67-84. https://doi.org/10.1080/09602011.2018.1452761

Wallwork, R. S., Fortgang, R., Hashimoto, R., Weinberger, D. R., & Dickinson, D. (2012). Searching for a consensus five-factor model of the Positive and Negative Syndrome Scale for schizophrenia. *Schizophr Res*, *137*(1-3), 246-250. https://doi.org/10.1016/j.schres.2012.01.031

Wechsler, D. (1999). *Wechsler Abbreviated Scale of Intelligence (WASI)*. NCS Pearson, Inc.

Wechsler, D. (2008). *Wechsler Adult Intelligence Scale - Fourth Edition (WAIS-IV)*. Pearson Assessment.

Westerhausen, R., Kompus, K., & Hugdahl, K. (2011). Impaired cognitive inhibition in schizophrenia: a meta-analysis of the Stroop interference effect. *Schizophr Res*, *133*(1-3), 172-181. https://doi.org/10.1016/j.schres.2011.08.025

World Medical Association. (2013). *Declaration of Helsinki: Ethical principles in research involving human subjects*. Brazil: 64th WMA General Assembly Retrieved from https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/

Wykes, T., Huddy, V., Cellard, C., McGurk, S. R., & Czobor, P. (2011). A meta-analysis of cognitive remediation for schizophrenia: Methodology and effect sizes. *Am J Psychiatry*, *168*(5), 472-485. https://doi.org/10.1176/appi.ajp.2010.10060855

Wykes, T., Joyce, E., Velikonja, T., Watson, A., Aarons, G., Birchwood, M., . . . Upthegrove, R. (2018). The CIRCuiTS study (Implementation of cognitive remediation in early intervention services): protocol for a randomised controlled trial. *Trials*, *19*(1), 183. https://doi.org/10.1186/s13063-018-2553-3

Wykes, T., & Reeder, C. (2005). *Cognitive remediation therapy for schizophrenia : theory and practice*. Routledge.

Wykes, T., & Spaulding, W. D. (2011). Thinking about the future cognitive remediation therapy--what works and could we do better? *Schizophr Bull*, *37 Suppl 2*, S80-90. https://doi.org/10.1093/schbul/sbr064

Yung, A. R., Phillips, L. J., McGorry, P. D., McFarlane, C. A., Francey, S., Harrigan, S., . . . Jackson, H. J. (1998). Prediction of psychosis: A step towards indicated prevention of

schizophrenia. *Br J Psychiatry Suppl*, *172*(33), 14-20. https://doi.org/10.1192/S0007125000297602

Zelazo, P. D. (2020). Executive Function and Psychopathology: A Neurodevelopmental Perspective. *Annu Rev Clin Psychol*, *16*, 431-454. https://doi.org/10.1146/annurev-clinpsy-072319-024242

Zhang, T., Cui, H., Wei, Y., Tang, X., Xu, L., Hu, Y., . . . Wang, J. (2022). Neurocognitive Assessments Are More Important Among Adolescents Than Adults for Predicting Psychosis in Clinical High Risk. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, *7*(1), 56-65. https://doi.org/10.1016/j.bpsc.2021.06.015

Zheng, W., Zhang, Q.-E., Cai, D.-B., Ng, C. H., Ungvari, G. S., Ning, Y.-P., & Xiang, Y.-T. (2018). *Neurocognitive dysfunction in subjects at clinical high risk for psychosis: A meta-analysis*. Journal of Psychiatric Research. Vol.103 2018, pp. 38-45. https://doi.org/10.1016/j.jpsychires.2018.05.001

Zhu, C., Kwok, N. T., Chan, T. C., Chan, G. H., & So, S. H. (2020). Inflexibility in Reasoning: Comparisons of Cognitive Flexibility, Explanatory Flexibility, and Belief Flexibility Between Schizophrenia and Major Depressive Disorder. *Front Psychiatry*, *11*, 609569. https://doi.org/10.3389/fpsyt.2020.609569

Zink, N., Lenartowicz, A., & Markett, S. (2021). A new era for executive function research: On the transition from centralized to distributed executive functioning. *Neurosci Biobehav Rev*, *124*, 235-244. https://doi.org/10.1016/j.neubiorev.2021.02.011

Øie, M. B. (2021). *Goal Management Training for Schizophrenia Spectrum Disorders: Effects on Self-Esteem, Self-Efficacy and Quality of Life* [Master Thesis, University of Oslo]. DUO Research Archive. https://www.duo.uio.no/handle/10852/90102

Åsbø, G., Ueland, T., Haatveit, B., Bjella, T., Flaaten, C. B., Wold, K. F., . . . Simonsen, C. (2022). The Time is Ripe for a Consensus Definition of Clinical Recovery in First-episode Psychosis: Suggestions Based on a 10-Year Follow-up Study. *Schizophr Bull*. https://doi.org/10.1093/schbul/sbac035

I

Papers I-III

Paper I
Executive Dysfunction in Schizophrenia:
Predictors of the Discrepancy Between
Subjective and Objective Measures

Schizophrenia Research: Cognition 26 (2021) 100201

Contents lists available at ScienceDirect

Schizophrenia Research: Cognition

journal homepage: www.elsevier.com/locate/scog

Research Paper

Executive dysfunction in schizophrenia: Predictors of the discrepancy between subjective and objective measures

Ingvild Haugen [a,b,*], Jan Stubberud [b,c], Torill Ueland [b,d], Elisabeth Haug [a], Merete Glenne Øie [a,b]

[a] Research Division, Innlandet Hospital Trust, P.O. Box 104, 2381 Brumunddal, Norway
[b] Department of Psychology, University of Oslo, P.O. Box 1094, 0317 Oslo, Norway
[c] Department of Research, Lovisenberg Diaconal Hospital, P.O. Box 4970, Nydalen, 0440 Oslo, Norway
[d] Norwegian Centre for Mental Disorders Research, Oslo University Hospital, Postboks 4956, Nydalen, 0424 Oslo, Norway

ARTICLE INFO

Keywords:
Executive function
Subjective assessment
Cognition
Cognitive impairment
Schizophrenia
Psychosis
Self-efficacy

ABSTRACT

This study aimed to investigate what characterizes individuals with schizophrenia who experience more or less subjective executive dysfunction in everyday life compared to objective executive performance on neuropsychological tests.

Sixty-six participants with broad schizophrenia spectrum disorders completed a comprehensive assessment of executive function. Discrepancies between performance on neuropsychological tests (objective) and an extensive self-report questionnaire (subjective) of central executive functions (inhibition, shifting and working memory) were calculated. Higher level of self-efficacy was the best predictor of experiencing fewer subjective cognitive complaints compared to objective performance, followed by higher levels of disorganized symptoms. Depressive symptoms did not predict discrepancy between subjective and objective executive function. Higher estimated IQ predicted greater subjective working memory difficulties in everyday life despite better objective performance.

Results may aid clinicians in the assessment and remediation of cognitive impairment. Low self-efficacy may identify individuals who are not able to utilize their potential executive functions in daily life. Interventions aimed at fostering self-efficacy ought to be included in cognitive remediation for these individuals. Disorganized symptoms could prove useful in identifying individuals who are in need of cognitive remediation for executive dysfunction, despite that they overestimate their skills. These individuals may benefit from efforts to increase insight into cognitive dysfunction.

1. Introduction

Executive functions are among the most severely impaired cognitive functions in schizophrenia (East-Richard et al., 2020; Snyder et al., 2015). Deficits on both objective and subjective measures of executive functions such as inhibition, shifting and working memory have been reported (Bulzacka et al., 2013; Forbes et al., 2009; Garlinghouse et al., 2010; Laere et al., 2018; Westerhausen et al., 2011). Executive functions are also important predictors of functional outcome (Green, 1996; McGurk and Mueser, 2006), underlining the need for assessment of these functions.

Executive functions are challenging to assess because they are considered separate, but interacting cognitive functions (Friedman and Miyake, 2017). Neuropsychological tests may therefore lack the specificity needed to isolate components of executive functions (Snyder et al., 2015). On the other hand, executive functions are especially required during novel, complex situations. As a consequence neuropsychological tests may also fail to generalize to everyday situations because of their structured nature (Sbordone, 2014).

One way of addressing these challenges may be to combine tasks aimed at central components of executive functions with subjective assessment of real-world functioning in domains thought to reflect the same underlying components. However, diverging scores have been observed on objective (neuropsychological tests) and subjective measures (self-report questionnaires) across both healthy samples and clinical samples with neurological or psychiatric disorders (Toplak et al., 2013). One explanation for this is that despite measuring the same underlying constructs, objective measures are thought to capture skills, while subjective measures capture the application of these skills in the real-world context (Gioia et al., 2010; McAuley et al., 2010). Subjective

* Corresponding author at: Research Division, Innlandet Hospital Trust, P.O. Box 104, 2381 Brumunddal, Norway.
E-mail address: Ingvild.Haugen@sykehuset-innlandet.no (I. Haugen).

https://doi.org/10.1016/j.scog.2021.100201
Received 2 March 2021; Received in revised form 19 May 2021; Accepted 20 May 2021
Available online 15 June 2021

measures on the other hand provide valuable information about everyday experience, but may be confounded by emotional states (Shwartz et al., 2020).

Research on the discrepancy between subjective and objective executive function in schizophrenia is limited, but studies on cognition in general have found the associations between subjective and objective measures to be weaker among individuals with schizophrenia than among healthy individuals (Medalia et al., 2008; Potvin et al., 2014). It has been suggested that co-morbid symptoms and lack of insight into cognitive impairment biases subjective cognitive assessment for a substantial portion of individuals with schizophrenia (Burton et al., 2016; Harvey and Pinkham, 2015; Raffard et al., 2020). Overestimation of cognition is problematic because it is associated with poorer functional outcomes (Gould et al., 2015). Similarly, overestimation of social cognition is related to poorer social function (Silberstein et al., 2018). Underestimation of skills is also problematic if lack of confidence leads to avoidance of activities (Silberstein and Harvey, 2019). Furthermore, subjective cognitive complaints are related to internalized stigma and poorer quality of life among persons with schizophrenia (Shin et al., 2016).

A novel method, the Stoicism-Sensitivity framework (Miskowiak et al., 2016) previously used in studies on bipolar and depressive disorders, may prove useful in quantifying the degree and direction of discrepancy between subjective and objective executive function. By comparing rankings on subjective and objective measures it is possible to view discrepancy as a bidirectional phenomenon ranging from ***stoicism*** (less subjective complaints relative to objective performance) to ***sensitivity*** (more subjective complaints relative to objective performance). Fig. 1 is an illustration of the framework where discrepancy scores fall along a scale ranging from −10 to +10.

Since discrepancy between subjective and objective measures have been observed in many aspects of cognition and function in schizophrenia, the Stoicism-Sensitivity framework may offer a standardized way to study discrepancy. One advantage of the Stoicism-Sensitivity framework is that it quantifies both under- and overestimation along the same dimension. By using continuous values, the framework avoids having to establish cut-off points for distinct categories. Instead, participants are assigned individual scores for degree of stoicism or sensitivity relative to the sample. In addition, the framework avoids simply using high levels of subjective complaints as a proxy for accurate self-assessment.

Positive and negative symptoms are the most researched predictors of the discrepancy between subjective and objective cognition in schizophrenia, but results have been mixed (Homayoun et al., 2011; Potvin et al., 2014). New insight into the predictive value of psychotic symptoms could perhaps be gained by looking at a broader spectrum of psychotic symptoms. Wallwork et al.'s (2012) five factor consensus model of the Positive and Negative Syndrome Scale (PANSS) could prove optimal for this purpose. The model distinguishes between excited, disorganized and depressive symptoms in addition to positive and negative symptoms. Disorganized symptoms are particularly interesting in this regard as they share a stronger relationship with cognition than positive symptoms (Rodriguez-Jimenez et al., 2013; Ventura et al., 2010). Furthermore, depressive symptoms have been associated with more subjective cognitive complaints among persons with schizophrenia (Burton et al., 2016; Raffard et al., 2020; Sellwood et al., 2013).

Less attention has been paid to psychological mechanisms as predictors of the relationship between subjective and objective cognition (Cella et al., 2014). One such psychological mechanism that may have predictive value for the subjective-objective cognition discrepancy is self-efficacy. Self-efficacy is beliefs in one's capability of the behaviors needed to produce a desired outcome (Bandura, 1977). Higher self-efficacy increases motivation for, and effort in, the application of skills. People high in self-efficacy tend to set goals that are more ambitious, exert more effort and be more persistent in the face of difficulty. In contrast, people low in self-efficacy make fewer attempts and give up more easily (Bandura, 1977; Bandura, 2011). Self-efficacy is increasingly being recognized as an important factor in the relationship between cognition, negative symptoms and real-world functioning in schizophrenia (Allott et al., 2020; Ventura et al., 2014). Because of self-efficacy's relationship with motivation and effort, it has potential as an explanatory variable for the gap between objectively measured capacities and subjectively reported functioning.

The aim of the current study was to investigate potential predictors of the discrepancy between subjective and objective executive dysfunction, in persons with schizophrenia. Using the abovementioned Stoicism-Sensitivity framework, the degree and direction of the discrepancy between subjective and objective executive dysfunction was quantified (Miskowiak et al., 2016; Petersen et al., 2019). We used self-efficacy and a five-factor model of psychotic symptoms as predictors. Because experience with being integrated into society has shown to improve correlations between self-assessment and function in schizophrenia, outcomes were checked against age, current participation in school or work and level of education completed (Harvey and Pinkham, 2015; Olsson et al., 2019). Other potential confounds that have been seen to influence self-assessment in other contexts were also controlled for including gender, estimated general intellectual ability, diagnosis and overall symptoms (Harvey and Pinkham, 2015; Olsson et al., 2015). We hypothesized that:

- Higher levels of self-efficacy predict *lower* subjective than objective dysfunction
- More disorganized symptoms predict *lower* subjective than objective dysfunction
- Greater depressive symptoms predict *higher* subjective than objective dysfunction

2. Methods

2.1. Participants

The sample ($n = 66$, 40 males and 26 females, aged 16–44 years, $M = 25.53$, $SD = 6.56$) consisted of individuals participating in a randomized controlled trial evaluating the effects of cognitive remediation targeting

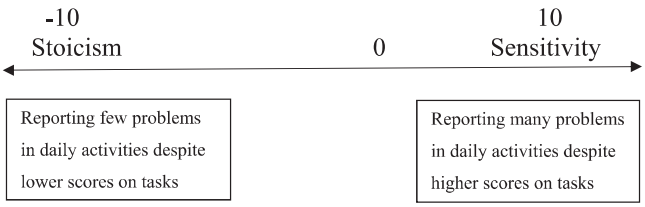


Fig. 1. The Stoicism-Sensitivity framework.

Table 1
Demographical and clinical characteristics ($n = 66$).

Participant characteristic	Frequency	*Mean*	*SD*	*SE*
Gender				
Female	26 (39.39%)			
Male	40 (60.61%)			
Age		25.53	6.55	0.81
Age females		25.38	5.99	1.17
Age males		25.62	6.96	1.10
Education in years		12.83	1.81	0.22
Estimated IQ[a]		99.43	13.29	1.81
Diagnosis (DSM-IV)[b]				
Schizophrenia	30 (45.50%)			
Schizoaffective disorder	14 (21.20%)			
Schizophreniform disorder	6 (9.10%)			
Psychotic disorder NOS[c]	15 (22.7%)			
Delusional disorder	1 (1.50%)			
Duration of untreated psychosis (weeks)		219.38	209.77	25.82
Hospitalizations		3.28	5.07	0.63
Months in hospital		5.75	8.15	1.01
Symptoms: Total scores[d]				
Psychosis – positive		11.97	3.37	0.42
Psychosis – negative		15.43	4.87	0.61
Psychosis – disorganized		7.15	1.85	0.23
Psychosis – depressive		10.38	2.83	0.35
Psychosis – excited		8.62	2.56	0.32
Summed		53.55	8.91	1.11
Positive, disorganized and excited		27.74	6.00	0.74
Depressive and negative		25.82	5.99	0.74
Symptoms: Mean scores				
Psychosis – positive		2.99	0.84	0.10
Psychosis – negative		2.57	0.81	0.10
Psychosis – disorganized		2.38	0.62	0.08
Psychosis – depressive		3.46	0.94	0.12
Psychosis – excited		2.15	0.64	0.08
Drug therapy	51 (77.30%)			
DDD[e] antipsychotics		0.672	0.75	0.09
DDD antidepressants		0.491	0.87	0.11
DDD mood stabilizers		0.143	0.47	0.06
DDD cns[f] stimulants		0.025	0.15	0.02
DDD anxiolytics AH[g]		0.015	0.09	0.01
DDD anxiolytics BZ[h]		0.073	0.28	0.03
DDD sedatives AH		0.045	0.24	0.03
DDD sedatives BZ		0.131	0.38	0.05

[a] IQ was estimated from two subtest of Wechsler Abbreviated Scale of Intelligence (WASI): Vocabulary and Matrix Reasoning. The normative mean of estimated IQ is 100 (*SD = 15*).
[b] According to the criteria in the Diagnostic and statistical manual of mental disorders, DSM-IV-TR (American Psychiatric Association, 2000).
[c] NOS = Not otherwise specified.
[d] Summed scores for the items considered part of the five-factor consensus model (Wallwork et al., 2012). Scores on the Positive and Negative Syndrome Scale (PANSS) range from 1 "missing" to 7 "extreme," 4 is considered psychotic threshold for delusions and hallucinations.
[e] DDD = Defined daily dose.
[f] cns = central nervous system.
[g] AH = antihistamines.
[h] BZ = benzodiazepines.

executive dysfunction (clinical.trials.gov: NCT03048695). The data presented are from the baseline assessment. Participants were recruited among patients referred for treatment of psychosis at Innlandet Hospital in Norway. The inclusion criteria were age 16 to 69 years, symptoms of broad schizophrenia spectrum disorder and self-reported executive dysfunction according to The Behavior Rating Inventory of Executive Function - Adult version, BRIEF-A (Roth and Gioia, 2005). In the Norwegian cultural context healthy participants score lower than U.S. norms, so a total score > *T*55 was considered clinically relevant (Løvstad et al., 2016). Exclusion criteria included comorbid neurological conditions, ongoing alcohol or substance abuse, intellectual impairment (IQ < 70) and treatment for psychosis for longer than five years. The study was approved by an ethics committee (The Regional Committee for Medical and Health Research Ethics of South-Eastern Norway, application no 2015/2118) and participants gave informed consent. See Table 1 for further description of participants.

2.2. Procedure

Diagnostic assessment was conducted by a clinical psychologist according to the criteria in the Diagnostic and Statistical Manual of Mental Disorders, DSM-IV-TR (American Psychiatric Association, 2000). Cognitive assessments and symptom ratings were undertaken by the same clinical psychologist or one of two trained psychiatric nurses. Training for the clinical assessment was provided by a specialist in psychiatry and for the cognitive assessment by a specialist in neuropsychology.

2.3. Objective cognitive measures

Inhibition was assessed using the age normed scaled score for time spent on Color-Word Interference Test condition three (Color-Word 3) from the Delis-Kaplan Executive Function System (D-KEFS) (Delis et al.,

2001). The age normed *T*-score for commission errors from Conners Continuous Performance Test 3rd edition (CPT3) was converted to the same numerical scale as the other objective tests and combined with Color-Word 3 to make an inhibition domain score (Conners, 2014). ***Shifting*** was measured by averaging the scaled scores for time spent on condition four of the Color-Word Interference Test (Color-Word 4) and condition four of the Trail Making Test from D-KEFS (Delis et al., 2001). ***Working memory*** was assessed by averaging the age normed scaled scores from the Digit Span and Letter-Number Sequencing subtests in the Wechsler Adult Intelligence Scale – 4th edition, WAIS-IV (Wechsler, 2008). The domain scores were combined to create a mean score for objective executive function in concordance with current models of separate, but interacting executive components (Friedman and Miyake, 2017).

2.4. Subjective cognitive measures

Subjective executive function was measured with the 75-item questionnaire Behavior Rating Inventory of Executive Function - Adult version, BRIEF-A, (Roth and Gioia, 2005). The subscales Inhibit, Working Memory and Shift were selected because of their theorized conceptual overlap with the corresponding neuropsychological tests. The subscales had adequate Cronbach's Alpha scores showing good internal consistency: Inhibit (α .79), Shift (α .71) and Working Memory (α .71). The *T*-scores on the three subscales were averaged to create a total subjective executive functioning measure.

2.5. Predictor variables

Self-efficacy was assessed with the ten-item questionnaire General Perceived Self-Efficacy Scale (Schwarzer and Jerusalem, 1995). The scale's unidimensional factor structure, test-retest reliability and correlations with theoretically related concepts have been confirmed across cultures (Luszczynska et al., 2005; Scholz et al., 2002). High test-retest reliability and good internal consistency has also been found when employing the scale in schizophrenia (Chiu and Tsang, 2004). In the current study, the Cronbach α coefficient for the scale was α .85, indicating good internal consistency.

Symptoms of psychosis at the time of testing were assessed with the Structured Clinical Interview for the Positive and Negative Syndrome Scale for Schizophrenia, the SCI-PANSS (Kay et al., 1987). We grouped the symptoms according to a five-factor consensus model yielding a total score for positive, negative, disorganized, depressive and expressive symptoms (Wallwork et al., 2012). In the current study, the Cronbach alpha coefficients were α .65 for the positive symptoms subscale, α .86 for the negative symptoms subscale, α .59 for the disorganized symptoms subscale, α .54 for the depressive symptoms subscale and α .68 for the expressive symptoms subscale.

2.6. Variables controlled for

Significant predictors were checked against the effects of gender and general intellectual ability (IQ). IQ was estimated with Vocabulary and Matrix Reasoning from Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999). To assess the influence of amount of life-experience with challenging situations we used the variables age, years of education, education level completed (0 - not completed elementary school, 1 - completed elementary school, 2 - started secondary school, 3 - completed secondary school, 4 - started higher education, 5 - completed higher education) and occupational status. Occupational status was scored using the same criteria as the Social Functioning Scale (Birchwood et al., 1990): ranging from 10 for full-time work or study, via part-time and supported work placements to 0 if the participant had not worked in more than two years, was not actively job seeking and considered that working would be impossible. To check for the influence of remission status we entered summed symptoms on all five symptom groups from PANSS, as well as summed scores for positive, disorganized and excited symptoms and summed scores for depressive and negative symptoms (Wallwork et al., 2012). The other clinical variables controlled for were diagnosis, duration of untreated psychosis, number of hospitalizations, months spent in hospital and antipsychotic drug treatment.

2.7. Data analysis

We applied the Stoicism-Sensitivity framework previously used in studies on affective disorders (Miskowiak et al., 2016; Petersen et al., 2019). Assuming that accurate assessment would lead to a similar ranking on both measures, the objective rank was subtracted from the subjective rank in the inhibition, shifting and working memory domains, as well as for the combined total executive functioning score. The differences in ranking were then transformed into a stoicism-sensitivity score by using the following formula:

$$\frac{(\mathrm{New}_{\max} - \mathrm{New}_{\min})}{(\mathrm{Old}_{\max} - \mathrm{Old}_{\min})} * (\mathrm{X} - \mathrm{Old}_{\max}) + \mathrm{New}_{\max}$$

The scores fell along a scale ranging from −10 (maximum ***stoicism***: least subjective complaints relative to objective performance) to 10 (maximum ***sensitivity***: most subjective complaints relative to objective performance).

Multiple linear regression analysis was used to investigate predictors of sensitivity and stoicism. Analyses were performed using SPSS Statistics, version 26. Data were assumed to be missing at random and dealt with in a pairwise fashion. The Kolmogorov-Smirnov test was significant for disorganized symptoms $D\ (65) = 0.149$, $p = .001$, depressive symptoms $D\ (65) = 0.147$, $p = .001$ and self-efficacy $D\ (56) = 0.152$, $p = .003$, indicating deviation from the normal distribution of scores. Bias-corrected and accelerated bootstrapping was performed to ensure a robust analysis. Significant predictors were retained and separate linear regressions were run with each control variable to check for potential influence.

Table 2
Scores on measures of executive function.

Variable	*Mean*	*SD*	*SE*	*r*	Sig.
Total objective executive functioning[a]	8.37	2.06	0.26		
Total subjective executive functioning[b]	62.27	9.37	1.22	−.10	.480
Objective inhibition					
Color-Word 3 inhibition	7.76	3.35	0.42		
CPT3 commissions	57.15	10.91	1.35		
Subjective inhibition				−.35	**.009**
BRIEF-A inhibit subscale	56.68	12.16	1.61		
Objective shifting	7.21	3.55	0.44		
Trail making test 4	6.53	3.98	0.52		
Color-Word 4 switching	7.60	3.74	0.47		
Subjective shifting				−.13	.337
BRIEF-A shift subscale	62.64	11.33	1.49		
Objective working memory	9.72	2.35	0.29		
Digit span	9.79	2.58	0.33		
Letter-number sequencing	9.69	2.75	0.35		
Subjective working memory				−.05	.724
BRIEF-A working memory subscale	67.14	10.64	1.40		

Note: Correlations are Pearson's correlations between objective and subjective domains. **Bold** values are significant at the $p < .05$ level in a two-tailed test. The only significant correlation detected was between greater subjective complaints of inhibition and lower scores on the tasks for objective inhibition, $r - .35$, p .009.

[a] Objective scores derived from normed scaled scores in the D-KEFS and WAIS-IV all have a mean of 10 ($SD = 3$). Higher scores indicate better performance. CPT3 *T*-scores have a mean of 50 ($SD = 10$). CPT3 scores were converted to the same scale as the other objective scores before combining them.

[b] Subjective scores are based on normed BRIEF-A *T*-scores with a mean of 50 ($SD = 10$). Higher scores indicate greater dysfunction.

Table 3
Correlations between variables.

	Subjective executive function				Objective executive function				Self-efficacy	Symptoms of psychosis				
	Total	Inhibition	Shifting	Working memory	Total	Inhibition	Shifting	Working memory		Positive symptoms	Negative symptoms	Disorganized symptoms	Depressive symptoms	Excited symptoms
Subjective EF														
Total														
Inhibition	.78**													
Shifting	.80**	.32**												
Working memory	.87**	.55**	.62**											
Objective EF														
Total	−.06	−.18	.08	−.04										
Inhibition	−.19	−.31*	−.01	−.14	.83**									
Shifting	.05	−.05	.13	.05	.88**	.69**								
Working memory	−.07	−.14	.03	−.05	.59**	.28*	.22							
Self-efficacy	−.41**	−.21	−.47**	−.36**	−.33*	−.14	−.37**	−.16						
Symptoms of psychosis														
Positive	−.13	−.12	−.08	−.13	.01	−.03	.03	.02	.15					
Negative	−.19	−.28*	−.05	−.10	−.03	.01	.01	−.10	−.03	.10				
Disorganized	−.19	−.23	−.04	−.17	−.27*	−.25*	−.24	−.13	.24	.38**	.16			
Depressive	.17	−.08	.40**	.15	.06	.08	.03	.04	−.20	.10	.14	−.04		
Excited	.14	−.07	.19	.05	.07	−.13	.12	.14	−.14	.49**	−.07	.17	.12	
Estimated IQ	−.20	−.30*	−.13	−.08	.48**	.36**	.21	.66**	.02	−.19	−.20	−.22	.00	−.08

EF = Executive Function.
* Correlation is significant at $< p$ .05.
** Correlation is significant at $< p$ .01.

Table 4
Linear model of predictors of stoicism and sensitivity in executive dysfunction with 95% bias corrected and accelerated confidence intervals reported in brackets. Confidence intervals and standard errors based on 1000 bootstrap samples.

Linear models	*B*	*SE B*	*β*	Sig.	r^2
Total executive function					
Model 1					.27
Constant	11.55	2.97			
Self-efficacy	−0.52 [−0.73, −0.27]	0.12	−0.52	**.001**	
Model 2					.38
Constant	14.73	5.06			
Self-efficacy	−0.46 [−0.70, −0.19]	0.13	−0.47	**.003**	
Disorganized symptoms	−0.79 [−1.38, −0.16]	0.31	−0.29	**.013**	
Depressive symptoms	0.11 [−0.33, 0.50]	0.21	0.06	.598	
Positive symptoms	0.10 [0.68, −0.34]	0.24	0.07	.679	
Negative symptoms	−0.14 [−0.39, −0.08]	0.13	−0.14	.274	
Excited symptoms	0.11 [−0.39, 0.59]	0.24	0.06	.642	
Inhibition					
Model 1					.08
Constant	6.19	2.78			
Self-efficacy	−0.26 [−0.46, −0.03]	0.11	−0.28	**.019**	
Model 2					.29
Constant	16.29	5.21			
Self-efficacy	−0.23 [−0.45, 0.01]	0.12	−0.24	.057	
Disorganized symptoms	−1.07 [−1.78, −0.50]	0.35	−0.42	**.007**	
Depressive symptoms	−0.07 [−0.56, 0.35]	0.21	−0.05	.745	
Positive symptoms	0.17 [−0.23, 0.64]	0.22	0.13	.429	
Negative symptoms	−0.16 [−0.38, 0.07]	0.13	−0.17	.198	
Excited symptoms	−0.23 [−0.76, 0.45]	0.26	−0.13	.351	
Shifting					
Model 1					.28
Constant	12.01	2.98			
Self-efficacy	−0.53 [−0.73, −0.31]	0.12	−0.53	**.001**	
Model 2					.36
Constant	9.45	5.99			
Self-efficacy	−0.45 [−0.68, −0.21]	0.14	−0.46	**.001**	
Disorganized symptoms	−0.49 [−1.05, 0.05]	0.28	−0.19	.086	
Depressive symptoms	0.29 [−0.15, 0.65]	0.23	0.17	.188	
Positive symptoms	0.07 [−0.37, 0.54]	0.21	0.05	.751	
Negative symptoms	−0.05 [−0.32, 0.21]	0.14	−0.05	.717	
Excited symptoms	0.14 [−0.37, 0.70]	0.23	0.08	.532	
Working memory					
Model 1					.17
Constant	8.46	2.74			
Self-efficacy	−0.37 [−0.56, − 0.17]	0.10	−0.43	**.001**	
Model 2					.24
Constant	13.45	5.03			
Self-efficacy	−0.33 [−0.57, −0.08]	0.11	−0.39	**.008**	
Disorganized symptoms	−0.67 [−1.19, −0.08]	0.29	−0.29	**.028**	
Depressive symptoms	−0.14 [−0.51, 0.25]	0.20	−0.10	.485	
Positive symptoms	−0.02 [−0.40, 0.32]	0.21	−0.01	.920	
Negative symptoms	−0.13 [−0.41, 0.16]	0.12	−0.16	.252	
Excited symptoms	0.33 [−0.10, 0.90]	0.23	0.21	.165	

Note: Significant predictors have *p*-values in **bold**. Model 1 was considered the better fit as there was no significant *F*-change for model 2 for Total Executive function *p* .182, Shifting, *p* .438 and Working Memory, *p* .110. Model 2 was considered the better fit for Inhibition.

3. Results

3.1. Executive function

Mean total objective executive function score in the sample was significantly lower than the normative mean scaled score of 10 in a one-sample *t*-test: *M* 8.27, *SD* 2.16, *SE* 0.27, $t\ (1, 64) = -6.439$, *p* .000. Also, total subjective complaints, *M* 62.03, *SD* 9.23, *SE* 1.21, were significantly higher than the normative mean *T*-score of 50, $t\ (1,57) = 9.93$, *p* .000. See Table 2 for scores on measures of executive function and Table 3 for correlations between variables.

3.2. Stoicism and sensitivity

The distribution of stoicism and sensitivity scores for total executive function, *M* −1.19, *SD* 5.05, *SE* 0.67, showed a slight overrepresentation of stoicism. Thirty-two participants, 48.5%, ranked lower on total subjective complaints than objective measures (stoicism) and 26 participants, 39.4%, ranked higher on total subjective complaints than objective measures (sensitivity). Eight participants, 12.1%, had missing scores on at least one measure.

3.3. Predictors of stoicism and sensitivity

For total executive functioning, the strongest predictor of greater stoicism (fewer subjective complaints relative to objective performance) was higher self-efficacy, accounting for 27% of the variation, $F\ (1, 51) = 19.21$, $p = .001$, $r^2 = .27$. See Table 4 for results of the regression analysis.

Separate analysis of the executive function domains found that greater self-efficacy was the strongest predictor of greater stoicism in shifting, Model 1: $F\ (1, 50) = 19.85$, *p* .000, $r^2 = .27$, and working

Table 5
Influence of demographic and clinical variables.

Linear regression controlling for:	Total executive function			Inhibition			Shifting			Working memory		
	F change	Sig.	Δr^2	*F* change	Sig.	Δr^2	*F* change	Sig	Δr^2	*F* change	Sig	Δr^2
Gender	0.05	.833	.00	0.22	.645	.00	0.02	.900	.02	0.11	.740	.00
Age	1.97	.167	.03	0.03	.866	.00	1.43	.238	.02	0.91	.346	.02
Estimated IQ[a]	1.44	.237	.02	0.79	.379	.01	0.42	.521	.00	12.03	**.001**	.15
Diagnosis	0.52	.476	.01	0.07	.796	.00	0.24	.628	.00	0.00	.972	.00
DUP[b]	1.66	.204	.02	1.91	.173	.03	1.15	.290	.02	0.21	.652	.00
Total symptoms	0.02	.894	.00	0.79	.378	.01	1.09	.302	.02	0.22	.642	.00
Positive, disorganized & excited symptoms	1.09	.301	.01	0.00	.971	.00	1.23	.274	.02	1.36	.250	.02
Negative and depressed symptoms	0.48	.492	.01	1.39	.245	.02	0.19	.994	.00	2.71	.106	.04
Drug therapy (yes/no)	0.43	.513	.01	0.40	.533	.01	0.76	.388	.01	0.35	.556	.01
DDD[c] antipsychotics	0.00	.991	.00	0.86	.357	.02	0.09	.761	.00	0.08	.775	.00
Hospitalizations	0.26	.611	.00	0.52	.474	.01	0.25	.622	.00	0.32	.572	.01
Months in hospital	2.23	.142	.03	0.39	.534	.01	2.16	.148	.03	0.10	.757	.00
Occupational status[d]	0.35	.558	.01	0.08	.778	.00	0.18	.676	.00	0.49	.487	.01
Years of education	0.15	.705	.00	0.54	.465	.01	0.13	.717	.00	0.39	.538	.01
Education completed[e]	0.06	.807	.00	1.20	.280	.02	0.15	.705	.00	0.37	.546	.01

Note: Significant predictors identified in the main analysis were retained (self-efficacy and disorganized symptoms) and controlling variables were added to the linear regression model one-by-one. Bootstrapping was performed ($n = 1000$) similar to main analysis. Values in **bold** are significant.

[a] IQ was estimated from two subtest of Wechsler Abbreviated Scale of Intelligence (WASI): Vocabulary and Matrix Reasoning.

[b] Duration of untreated psychosis.

[c] DDD = Defined daily dose.

[d] Occupational status was coded the same way as in the Social Functioning Scale (Birchwood et al., 1990).

[e] Level of education completed was coded 0 - not completed elementary school, 1 - completed elementary school, 2 - started secondary school, 3 - completed secondary school, 4 - started higher education, 5 - completed higher education.

memory, $F\ (1, 49) = 11.19$, p .002, $r^2 = .19$. However, in the inhibition domain more disorganized symptoms were a stronger predictor of stoicism than self-efficacy, Model 2: $F\ (6, 44) = 3.01$, p .015, $\Delta r^2 = .22$. Depressive, positive and negative symptoms were not significant predictors of stoicism and sensitivity in any domain.

3.4. Controlling for demography and clinical variables

Gender did not change the significance of the predictive value of self-efficacy and disorganized symptoms on stoicism-sensitivity. Nor did experience from daily life measured by age, occupational status, years of education, level of education completed or estimated IQ. However, higher estimated IQ independently predicted greater sensitivity (greater subjective complaints despite better performance on tests) in the working memory domain only, $F\ (3, 37) = 13.76$, p .000, $\Delta r^2 = .15$. The clinical variables, diagnosis, symptoms, duration of untreated psychosis and treatment had no significant bearing on the results. See Table 5 for details.

4. Discussion

The present study investigated potential predictors of discrepancy between subjective and objective executive function among persons with schizophrenia. The discrepancy was quantified using a novel framework creating a scale ranging from sensitivity (greater subjective complaints than objective dysfunction) to stoicism (fewer subjective complaints than objective dysfunction) (Miskowiak et al., 2016). We found that participants were characterized by both sensitivity and stoicism, which is in line with studies finding both over- and underestimation of cognition and social cognition (Burton et al., 2016; Silberstein et al., 2018). Stoicism and sensitivity scores were normally distributed, but there was slightly higher occurrence of stoicism in the sample in total executive function. This might seem surprising considering that subjective executive complaints were an inclusion criterion. However, this only shows that despite increased subjective complaints in the group as a whole compared to the normative mean in a healthy population, there are still individual variations in how well subjective complaints align with objective performance within the sample.

As expected, greater self-efficacy was associated with greater stoicism and lower self-efficacy was associated with greater sensitivity in all domains explaining a substantial amount of the variance in discrepancy in working memory, shifting and total executive function. This finding emphasizes the importance of exploring psychological factors as explanations for discrepancy between subjective and objective cognitive assessment (Cella et al., 2014). The effect of self-efficacy on stoicism-sensitivity was not better explained by gender, diagnosis, total symptoms, age, intellectual abilities, occupational status or having longer experience within the educational system. Nevertheless, we found that higher estimated IQ independent of self-efficacy, predicted greater sensitivity in the working memory domain alone. It is not clear whether this is due to an association between intellectual capacity and the ability to self-monitor working memory performance, or whether those who perform well on tasks measuring intellectual ability expect more from their working memory.

Our second hypothesis was partially supported. We expected higher levels of disorganized symptoms to predict greater stoicism, and found that it was the superior predictor of stoicism in the inhibition domain. The mechanism is not known, but perhaps disorganized symptoms interfere with attention so that subjective experiences of problems with inhibition to a greater degree go unnoticed. Disorganized symptoms appear to be fairly unexplored as a predictor of the subjective-objective cognition discrepancy, although one study found an association between a single item for disorientation and lower subjective cognitive complaints (Baliga et al., 2020).

Our third hypothesis was not supported. Higher levels of depressive symptoms did not predict greater sensitivity. Considering the consistent findings in other studies of a relationship between depressive symptoms and subjective cognitive complaints, it was surprising that depressive symptoms did not predict sensitivity in the current study (Burton et al., 2016; Durand et al., 2015; Raffard et al., 2020; Sellwood et al., 2013). One explanation for this might be that even though several participants had mild and moderate depressive symptoms, few had severe depressive symptoms. Studies with healthy individuals across cultures has shown that mild self-reported dysphoria is associated with more accurate self-assessment of capabilities - a phenomenon known as depressive realism. According to these studies, non-dysphoric individuals often overestimate their abilities (Moore and Fresco, 2012). Research on self-assessment of daily function in schizophrenia has also shown that

depression was associated with accuracy rather than underestimation (Harvey et al., 2017). In addition, we used a clinician rating for depressive symptoms, whereas some of the previous studies have used self-reported depression scales which may have resulted in lower scores (Moore and Fresco, 2012).

Much of the emerging research on discrepancies between subjective and objective cognition in schizophrenia has favored lack of insight into cognitive impairment as the primary explanation (Medalia et al., 2008). We may also interpret the most extreme stoicism and sensitivity scores among our participants as over- and underestimation of executive skills. However, some degree of discrepancy between subjective and objective measures of executive function was expected, and may at least partially also be explained by the problems inherent in measuring executive function. Previous research has pointed out that task measures specific enough to isolate components of executive function in the lab often have little in common with the novel, complex real-life situations where the interplay of executive functions are most required (Sbordone, 2014). When combining objective and subjective measures we must keep in mind that we are measuring theoretically assumed underlying brain functions, but at two different levels of measurement. Executive tasks in the lab aim to tap capacity, while the subjective measures aim to tap performance in real-life (Gioia et al., 2010).

There are several possible interpretations of the finding that self-efficacy predicts stoicism and sensitivity. The direction of relationships between cognition, negative symptoms, real-world function and self-efficacy or related psychological concepts has proven difficult to disentangle and are currently under debate (Beck et al., 2018; Chang et al., 2017). It is possible that adequate self-efficacy is a pre-requisite for attempting activities that lead to greater stoicism when successful (Cardenas et al., 2013). However, it is also possible that self-efficacy is better preserved among individuals who make few attempts at challenging activities due to avoidant coping strategies (Lysaker et al., 2001). In addition, since self-efficacy is a subjective measure, it is not possible to rule out that challenges to accurate self-assessment also affect this measure for some participants.

4.1. Implications

Although the number of studies exploring subjective cognition in schizophrenia is growing, there are few specifically focusing on executive functions, making conclusions tentative at this point. Still, the present study has several possible implications. The results indicate that disorganized symptoms can help identify stoic individuals. Stoic individuals may be more likely to turn down cognitive remediation (Balzan et al., 2014). When daily function indicates that stoic individuals may benefit from cognitive remediation or supportive services, interventions should include efforts to increase recognition of cognitive difficulties in everyday life (Medalia et al., 2008).

However, our results also raise ethical concerns over whether interventions aimed at increasing insight into cognitive impairment may harm self-efficacy (Cella et al., 2014; Rose et al., 2008). This could be counterproductive, considering the importance of self-efficacy to well-being in severe mental illness (Gleeson et al., 2020; Hansson, 2006). Sensitive participants may also have difficulty engaging during cognitive remediation due to low self-efficacy (Beck et al., 2018; Chang et al., 2017). To ensure that interventions are effective and ethically sound for sensitive individuals, they should be carried out in a manner that fosters self-efficacy (Allott et al., 2020; Cella and Wykes, 2019).

4.2. Strengths and limitations

The extensive test battery and questionnaire specifically tapping core components of executive function is a strength of this study. There are, however, also some limitations that warrant mentioning. Our selection of objective measures allow for comparison with previous research, although the specificity of these measures has been drawn into question (Barch et al., 2009; Miyake et al., 2000). We chose to focus on components of executive functions that aligned with the subscales of the BRIEF-A questionnaire. Tasks that are more complex may be subject to task impurity (Donohoe and Robertson, 2003; Roca et al., 2014). However, we acknowledge that the inclusion of more complex executive tasks such Wisconsin Card Sorting Test which has been shown to predict function (McGurk and Meltzer, 2000) may have been beneficial. Subjective executive complaints were part of the inclusion criteria, but we assume our sample to be representative of persons with schizophrenia in this regard since scores were similar to other studies (Bulzacka et al., 2013; Garlinghouse et al., 2010).

Importantly, the analyses were correlational and thus cannot establish causal relationships between the variables. Because the study is part of a cognitive remediation trial, we did not include a healthy control group and scores were instead standardized using norms. Precautions should be taken in the generalization of findings because the sample in the study is somewhat heterogeneous and small. Specifically, the sample has a young mean age and excluded anyone who had received treatment for longer than five years. Therefore, we do not know if the results will generalize to individuals who have been living with schizophrenia spectrum disorders for longer. A longer duration in stable remission from psychotic symptoms is related to higher correlations between self-assessment and daily function (Harvey et al., 2019; Olsson et al., 2015). For the youngest participants in the present study variables such as level of education and occupational status are likely to change since some are currently still in secondary school.

Not all potential predictors of discrepancy were accounted for. For example, the present study could have benefitted from the inclusion of more proximal measures of functioning in daily life. Experience with everyday situations has previously shown to be associated with more accurate assessment in other areas (Harvey and Pinkham, 2015). This could be interesting directions for future research, in addition to longitudinal studies of discrepancy over time.

CRediT authorship contribution statement

Ingvild Haugen: Investigation, formal analysis and writing – original draft, **Jan Stubberud:** Conceptualization, Supervision and writing – review and editing, **Torill Ueland:** Writing – review and editing, **Elisabeth Haug:** Conceptualization, supervision and writing – review and editing, **Merete Glenne Øie**: Conceptualization, funding acquisition, project administration, supervision and writing – review and editing.

Declaration of competing interest

The authors have no conflicting interests to declare.

Acknowledgements

The study was funded by the South-Eastern Norway Health Authority (grant number 2017012), Innlandet Hospital Trust (grant number 150602) and University of Oslo (grant number 353139). Sponsors had no involvement in the execution of the study.

References

Allott, K., Steele, P., Boyer, F., et al., 2020. Cognitive strengths-based assessment and intervention in first-episode psychosis: a complementary approach to addressing functional recovery? Clin. Psychol. Rev. 79 https://doi.org/10.1016/j.cpr.2020.101871.

American Psychiatric Association, 2000. Diagnostic and Statistical Manual of Mental Disorders: DSM-IV-TR, 4th ed. American Psychiatric Association, Washington, DC.

Baliga, S.P., Kamath, R.M., Kedare, J.S., 2020. Subjective cognitive complaints and its relation to objective cognitive performance, clinical profile, clinical insight, and social functioning in patients of schizophrenia: a cross-sectional study. Indian J. Psychiatry 62 (2), 178–185. https://doi.org/10.4103/psychiatry.IndianJPsychiatry_639_19.

Balzan, R.P., Neaves, A., Denson, L.A., Liu, D., Galletly, C., 2014. Cognitive deficit awareness in schizophrenia: absent, intact, or somewhere in-between? Cogn.

Neuropsychiatry 19 (6), 471–484. https://doi.org/10.1080/13546805.2014.909311.
Bandura, A., 1977. Self-efficacy: toward a unifying theory of behavioral change. Psychol. Rev. 84 (2), 191–215. https://doi.org/10.1037//0033-295X.84.2.191.
Bandura, A., 2011. On the functional properties of perceived self-efficacy revisited. J. Manag. 38 (1), 9–44. https://doi.org/10.1177/0149206311410606.
Barch, D.M., Braver, T.S., Carter, C.S., Poldrack, R.A., Robbins, T.W., 2009. CNTRICS final task selection: executive control. Schizophr. Bull. 35 (1), 115–135. https://doi.org/10.1093/schbul/sbn154.
Beck, A.T., Himelstein, R., Bredemeier, K., Silverstein, S.M., Grant, P., 2018. What accounts for poor functioning in people with schizophrenia: a re-evaluation of the contributions of neurocognitive v. attitudinal and motivational factors. Psychol. Med. 48 (16), 2776–2785. https://doi.org/10.1017/S0033291718000442.
Birchwood, M., Smith, J., Cochrane, R., Wetton, S., Copestake, S., 1990. The Social Functioning Scale. The development and validation of a new scale of social adjustment for use in family intervention programmes with schizophrenic patients. Br. J. Psychiatry 157 (12), 853–859. https://doi.org/10.1192/bjp.157.6.853.
Bulzacka, E., Vilain, J., Schurhoff, F., Meary, A., Leboyer, M., Szoke, A., 2013. A self-administered executive functions ecological questionnaire (the behavior rating inventory of executive function - adult version) shows impaired scores in a sample of patients with schizophrenia. Ment. Illn. 5 (1), e4. https://doi.org/10.4081/mi.2013.e4.
Burton, C.Z., Harvey, P.D., Patterson, T.L., Twamley, E.W., 2016. Neurocognitive insight and objective cognitive functioning in schizophrenia. Schizophr. Res. 171 (1–3), 131–136. https://doi.org/10.1016/j.schres.2016.01.021.
Cardenas, V., Abel, S., Bowie, C.R., et al., 2013. When functional capacity and real-world functioning converge: the role of self-efficacy. Schizophr. Bull. 39 (4), 908–916. https://doi.org/10.1093/schbul/sbs004.
Cella, M., Wykes, T., 2019. The nuts and bolts of Cognitive Remediation: exploring how different training components relate to cognitive and functional gains. Schizophr. Res. 203, 12–16. https://doi.org/10.1016/j.schres.2017.09.012.
Cella, M., Swan, S., Medin, E., Reeder, C., Wykes, T., 2014. Metacognitive awareness of cognitive problems in schizophrenia: exploring the role of symptoms and self-esteem. Psychol. Med. 44 (3), 469–476. https://doi.org/10.1017/S0033291713001189.
Chang, W.C., Kwong, V.W., Hui, C.L., Chan, S.K., Lee, E.H., Chen, E.Y., 2017. Relationship of amotivation to neurocognition, self-efficacy and functioning in first-episode psychosis: a structural equation modeling approach. Psychol. Med. 47 (4), 755–765. https://doi.org/10.1017/S0033291716003044.
Chiu, F.P.F., Tsang, H.W.H., 2004. Validation of the Chinese general self-efficacy scale among individuals with schizophrenia in Hong Kong. Int. J. Rehabil. Res. 27 (2), 159–161. https://doi.org/10.1097/01.mrr.0000127640.55118.6b.
Conners, K.C., 2014. Conners Continuous Performance Test, 3rd edn. Multi-Health Systems Inc, Toronto.
Delis, D.C., Kaplan, E., Kramer, J.H., 2001. Delis–Kaplan Executive Function System. NCS Pearson, Inc, Bloomington.
Donohoe, G., Robertson, I.H., 2003. Can specific deficits in executive functioning explain the negative symptoms of schizophrenia? A review. Neurocase 9 (2), 97–108. https://doi.org/10.1076/neur.9.2.97.15075.
Durand, D., Strassnig, M., Sabbag, S., et al., 2015. Factors influencing self-assessment of cognition and functioning in schizophrenia: implications for treatment studies. Eur. Neuropsychopharmacol. 25 (2), 185–191. https://doi.org/10.1016/j.euroneuro.2014.07.008.
East-Richard, C., R. -Mercier, A., Nadeau, D., Cellard, C., 2020. Transdiagnostic neurocognitive deficits in psychiatry: a review of meta-analyses. Can. Psychol. 61 (3), 190–214. https://doi.org/10.1037/cap0000196.
Forbes, N.F., Carrick, L.A., McIntosh, A.M., Lawrie, S.M., 2009. Working memory in schizophrenia: a meta-analysis. Psychol. Med. 39 (6), 889–905. https://doi.org/10.1017/S0033291708004558.
Friedman, N.P., Miyake, A., 2017. Unity and diversity of executive functions: individual differences as a window on cognitive structure. Cortex 86, 186–204. https://doi.org/10.1016/j.cortex.2016.04.023.
Garlinghouse, M.A., Roth, R.M., Isquith, P.K., Flashman, L.A., Saykin, A.J., 2010. Subjective rating of working memory is associated with frontal lobe volume in schizophrenia. Schizophr. Res. 120 (1–3), 71–75. https://doi.org/10.1016/j.schres.2010.02.1067.
Gioia, G.A., Kenworthy, L., Isquith, P.K., 2010. Executive function in the real world: BRIEF lessons from Mark Ylvisaker. J. Head Trauma Rehabil. 25 (6), 433–439. https://doi.org/10.1097/HTR.0b013e3181fbc272.
Gleeson, J.F.M., Eleftheriadis, D., Santesteban-Echarri, O., et al., 2020. Positive and meaningful lives: systematic review and meta-analysis of eudaimonic well-being in first-episode psychosis. Early Interv. Psychiatry. https://doi.org/10.1111/eip.13049.
Gould, F., McGuire, L.S., Durand, D., et al., 2015. Self-assessment in schizophrenia: accuracy of evaluation of cognition and everyday functioning. Neuropsychology 29 (5), 675–682. https://doi.org/10.1037/neu0000175.
Green, M.F., 1996. What are the functional consequences of neurocognitive deficits in schizophrenia? Am. J. Psychiatry 153 (3), 321–330. https://doi.org/10.1176/ajp.153.3.321.
Hansson, L., 2006. Determinants of quality of life in people with severe mental illness. Acta Psychiatr. Scand. (429), 46–50. https://doi.org/10.1111/j.1600-0447.2005.00717.x.
Harvey, P.D., Pinkham, A., 2015. Impaired self-assessment in schizophrenia: why patients misjudge their cognition and functioning. Curr. Psychiatr. Ther. 14 (4), 53–59. Available at: https://www.mdedge.com/psychiatry/article/98117/schizophrenia-other-psychotic-disorders/impaired-self-assessment?sso=true.
Harvey, P.D., Twamley, E.W., Pinkham, A.E., Depp, C.A., Patterson, T.L., 2017. Depression in schizophrenia: associations with cognition, functional capacity, everyday functioning, and self-assessment. Schizophr. Bull. 43 (3), 575–582. https://doi.org/10.1093/schbul/sbw103.
Harvey, P.D., Strassnig, M.T., Silberstein, J., 2019. Prediction of disability in schizophrenia: symptoms, cognition, and self-assessment. J. Exp. Psychopathol. 10 (3) https://doi.org/10.1177/2043808719865693 (pp. 204380871986569).
Homayoun, S., Nadeau-Marcotte, F., Luck, D., Stip, E., 2011. Subjective and objective cognitive dysfunction in schizophrenia - is there a link? Front. Psychol. 2, 148. https://doi.org/10.3389/fpsyg.2011.00148.
Kay, S.R., Fiszbein, A., Opler, L.A., 1987. The Positive and Negative Syndrome Scale (PANSS) for schizophrenia. Schizophr. Bull. 13 (2), 261–276. https://doi.org/10.1093/schbul/13.2.261.
Laere, E., Tee, S.F., Tang, P.Y., 2018. Assessment of cognition in schizophrenia using trail making test: a meta-analysis. Psychiatry Investig. 15 (10), 945–955. https://doi.org/10.30773/pi.2018.07.22.
Løvstad, M., Sigurdardottir, S., Andersson, S., et al., 2016. Behavior rating inventory of executive function adult version in patients with neurological and neuropsychiatric conditions: symptom levels and relationship to emotional distress. J. Int. Neuropsychol. Soc. 22 (6), 682–694. https://doi.org/10.1017/S135561771600031X.
Luszczynska, A., Scholz, U., Schwarzer, R., 2005. The general self-efficacy scale: multicultural validation studies. J. Psychol. 139 (5), 439–457. https://doi.org/10.3200/JRLP.139.5.439-457.
Lysaker, P.H., Clements, C.A., Wright, D.E., Evans, J., Marks, K.A., 2001. Neurocognitive correlates of helplessness, hopelessness, and well-being in schizophrenia. J. Nerv. Ment. Dis. 189 (7), 457–462. https://doi.org/10.1097/00005053-200107000-00007.
McAuley, T., Chen, S., Goos, L., Schachar, R., Crosbie, J., 2010. Is the behavior rating inventory of executive function more strongly associated with measures of impairment or executive function? J. Int. Neuropsychol. Soc. 16 (3), 495–505. https://doi.org/10.1017/S1355617710000093.
McGurk, S.R., Meltzer, H.Y., 2000. The role of cognition in vocational functioning in schizophrenia. Schizophr. Res. 45 (3), 175–184. https://doi.org/10.1016/S0920-9964(99)00198-X.
McGurk, S.R., Mueser, K.T., 2006. Cognitive and clinical predictors of work outcomes in clients with schizophrenia receiving supported employment services: 4-year follow-up. Adm. Policy Ment. Health Ment. Health Serv. Res. 33 (5), 598–606. https://doi.org/10.1007/s10488-006-0070-2.
Medalia, A., Thysen, J., Freilich, B., 2008. Do people with schizophrenia who have objective cognitive impairment identify cognitive deficits on a self report measure? Schizophr. Res. 105 (1–3), 156–164. https://doi.org/10.1016/j.schres.2008.07.007.
Miskowiak, K.W., Petersen, J.Z., Ott, C.V., et al., 2016. Predictors of the discrepancy between objective and subjective cognition in bipolar disorder: a novel methodology. Acta Psychiatr. Scand. 134 (6), 511–521. https://doi.org/10.1111/acps.12649.
Miyake, A., Friedman, N.P., Emerson, M.J., Witzki, A.H., Howerter, A., Wager, T.D., 2000. The unity and diversity of executive functions and their contributions to complex "Frontal Lobe" tasks: a latent variable analysis. Cogn. Psychol. 41 (1), 49–100. https://doi.org/10.1006/cogp.1999.0734.
Moore, M.T., Fresco, D.M., 2012. Depressive realism: a meta-analytic review. Clin. Psychol. Rev. 32 (6), 496–509. https://doi.org/10.1016/j.cpr.2012.05.004.
Olsson, M., Carlström, E., Marklund, B., Helldin, L., Hjärthag, F., 2015. Assessment of distress and quality of life: a comparison of self-assessments by outpatients with a schizopsychotic illness and the clinical judgment of nurses. Arch. Psychiatr. Nurs. 29 (5), 284–289. https://doi.org/10.1016/j.apnu.2015.05.001.
Olsson, A.-K., Hjärthag, F., Helldin, L., 2019. Overestimated function in patients with schizophrenia: a possible risk factor for inadequate support? Schizophr. Res. 206, 194–199. https://doi.org/10.1016/j.schres.2018.11.027.
Petersen, J.Z., Porter, R.J., Miskowiak, K.W., 2019. Clinical characteristics associated with the discrepancy between subjective and objective cognitive impairment in depression. J. Affect. Disord. 246, 763–774. https://doi.org/10.1016/j.jad.2018.12.105.
Potvin, S., Pelletier, J., Stip, E., 2014. Neurocognitive insight in schizophrenia: a meta-analysis. Sante Ment. Que. 39 (2), 183. https://doi.org/10.7202/1027839ar.
Raffard, S., Lebrun, C., Bayard, S., Macgregor, A., Capdevielle, D., 2020. Self-awareness deficits of cognitive impairment in individuals with schizophrenia. Really? Front. Psych. 11, 731. https://doi.org/10.3389/fpsyt.2020.00731.
Roca, M., Manes, F., Cetkovich, M., et al., 2014. The relationship between executive functions and fluid intelligence in schizophrenia. Front. Behav. Neurosci. 8, 46. https://doi.org/10.3389/fnbeh.2014.00046.
Rodriguez-Jimenez, R., Bagney, A., Mezquita, L., et al., 2013. Cognition and the five-factor model of the positive and negative syndrome scale in schizophrenia. Schizophr. Res. 143 (1), 77–83. https://doi.org/10.1016/j.schres.2012.10.020.
Rose, D., Farrier, D., Doran, A.-M., Sporle, T., Bogner, D., 2008. What do clients think of cognitive remediation therapy? A consumer-led investigation of satisfaction and side-effects. Am. J. Psychiatr. Rehabil. 11 (2), 181–204. https://doi.org/10.1080/15487760801963694.
Roth, R.M., Gioia, G.A., 2005. Behavior Rating Inventory of Executive Function - Adult Version. Psychological Assessment Resources, Lutz, Florida.
Sbordone, R.J., 2014. The hazards of strict reliance on neuropsychological tests. Appl. Neuropsychol. Adult 21 (2), 98–107. https://doi.org/10.1080/09084282.2012.762630.
Scholz, U., Gutiérrez Doña, B., Sud, S., Schwarzer, R., 2002. Is general self-efficacy a universal construct? Psychometric findings from 25 countries. Eur. J. Psychol. Assess. 18 (3), 242–251. https://doi.org/10.1027//1015-5759.18.3.242.

Schwarzer, R., Jerusalem, M., 1995. Generalized self-efficacy scale. In: Weinman, J., Wright, S., Johnston, M. (Eds.), Measures in Health Psychology: A User's Portfolio. NFER-NELSON, Windsor, England, pp. 35–37.

Sellwood, W., Morrison, A.P., Beck, R., Heffernan, S., Law, H., Bentall, R.P., 2013. Subjective cognitive complaints in schizophrenia: relation to antipsychotic medication dose, actual cognitive performance, insight and symptoms. PLoS One 8 (12), e83774. https://doi.org/10.1371/journal.pone.0083774.

Shin, Y.J., Joo, Y.H., Kim, J.H., 2016. Self-perceived cognitive deficits and their relationship with internalized stigma and quality of life in patients with schizophrenia. Neuropsychiatr. Dis. Treat. 12, 1411–1417. https://doi.org/10.2147/NDT.S108537.

Shwartz, S.K., Roper, B.L., Arentsen, T.J., Crouse, E.M., Adler, M.C., 2020. The Behavior Rating Inventory of Executive Function®-Adult Version is related to emotional distress, not executive dysfunction, in a veteran sample. Arch. Clin. Neuropsychol. 35 (6), 701–716. https://doi.org/10.1093/arclin/acaa024.

Silberstein, J., Harvey, P.D., 2019. Cognition, social cognition, and self-assessment in schizophrenia: prediction of different elements of everyday functional outcomes. CNS Spectr. 24 (1), 88–93. https://doi.org/10.1017/S1092852918001414.

Silberstein, J.M., Pinkham, A.E., Penn, D.L., Harvey, P.D., 2018. Self-assessment of social cognitive ability in schizophrenia: association with social cognitive test performance, informant assessments of social cognitive ability, and everyday outcomes. Schizophr. Res. 199, 75–82. https://doi.org/10.1016/j.schres.2018.04.015.

Snyder, H.R., Miyake, A., Hankin, B.L., 2015. Advancing understanding of executive function impairments and psychopathology: bridging the gap between clinical and cognitive approaches. Front. Psychol. 6, 328. https://doi.org/10.3389/fpsyg.2015.00328.

Toplak, M.E., West, R.F., Stanovich, K.E., 2013. Practitioner review: do performance-based measures and ratings of executive function assess the same construct? J. Child Psychol. Psychiatry 54 (2), 131–143. https://doi.org/10.1111/jcpp.12001.

Ventura, J., Thames, A.D., Wood, R.C., Guzik, L.H., Hellemann, G.S., 2010. Disorganization and reality distortion in schizophrenia: a meta-analysis of the relationship between positive symptoms and neurocognitive deficits. Schizophr. Res. 121 (1–3), 1–14. https://doi.org/10.1016/j.schres.2010.05.033.

Ventura, J., Subotnik, K.L., Ered, A., et al., 2014. The relationship of attitudinal beliefs to negative symptoms, neurocognition, and daily functioning in recent-onset schizophrenia. Schizophr. Bull. 40 (6), 1308–1318. https://doi.org/10.1093/schbul/sbu002.

Wallwork, R.S., Fortgang, R., Hashimoto, R., Weinberger, D.R., Dickinson, D., 2012. Searching for a consensus five-factor model of the Positive and Negative Syndrome Scale for schizophrenia. Schizophr. Res. 137 (1–3), 246–250. https://doi.org/10.1016/j.schres.2012.01.031.

Wechsler, D., 1999. Wechsler Abbreviated Scale of Intelligence (WASI). NCS Pearson, Inc, San Antonio, Texas.

Wechsler, D., 2008. Wechsler Adult Intelligence Scale - Fourth Edition (WAIS-IV). Pearson Assessment, San Antonio, Texas.

Westerhausen, R., Kompus, K., Hugdahl, K., 2011. Impaired cognitive inhibition in schizophrenia: a meta-analysis of the Stroop interference effect. Schizophr. Res. 133 (1–3), 172–181. https://doi.org/10.1016/j.schres.2011.08.025.

Paper II

A Randomized Controlled trial of Goal Management Training for Executive Functioning in Schizophrenia Spectrum Disorders or Psychosis Risk Syndromes

II

Haugen *et al. BMC Psychiatry* (2022) 22:575
https://doi.org/10.1186/s12888-022-04197-3

BMC Psychiatry

RESEARCH

Open Access

A randomized controlled trial of Goal Management Training for executive functioning in schizophrenia spectrum disorders or psychosis risk syndromes

Ingvild Haugen[1,2*], Jan Stubberud[2,3], Elisabeth Haug[1], Susan R. McGurk[4], Kjell Tore Hovik[1,5], Torill Ueland[2,6] and Merete Glenne Øie[2,7]

Abstract

Background: Executive functioning is essential to daily life and severely impaired in schizophrenia and psychosis risk syndromes. Goal Management Training (GMT) is a theoretically founded, empirically supported, metacognitive strategy training program designed to improve executive functioning.

Methods: A randomized controlled parallel group trial compared GMT with treatment as usual among 81 participants (GMT, $n = 39$ versus Wait List Controls, $n = 42$) recruited from an early intervention for psychosis setting. Computer generated random allocation was performed by someone independent from the study team and raters post-intervention were unaware of allocation. The primary objective was to assess the impact of GMT administered in small groups for 5 weeks on executive functioning. The secondary objective was to explore the potential of the intervention in influencing daily life functioning and clinical symptoms.

Results: GMT improved self-reported executive functioning, measured with the Behavior Rating Inventory of Executive Function – Adult version (BRIEF-A), significantly more than treatment as usual. A linear mixed model for repeated measures, including all partial data according to the principle of intention to treat, showed a significant group x time interaction effect assessed immediately after intervention (post-test) and 6 months after intervention (follow-up), $F = 8.40$, p .005, r .37. Improvement occurred in both groups in objective executive functioning as measured by neuropsychological tests, functional capacity, daily life functioning and symptoms of psychosis rated by clinicians. Self-reported clinical symptoms measured with the Symptoms Check List (SCL-10) improved significantly more after GMT than after treatment as usual, $F = 5.78$, p .019, r .29. Two participants withdrew due to strenuous testing and one due to adverse effects.

Conclusions: GMT had clinically reliable and lasting effects on subjective executive function. The intervention is a valuable addition to available treatment with considerable gains at low cost.

Trial registration: Registered at clinicaltrials.gov NCT03048695 09/02/2017.

*Correspondence: ingvild.haugen@sykehuset-innlandet.no

[1] Division of Mental Health Care, Innlandet Hospital Trust, P. O. Box 104, 2381 Brumunddal, Norway
Full list of author information is available at the end of the article

Keywords: Early intervention, Psychosis, Executive function, Cognitive remediation, Cognitive impairment, Real-world function

Introduction

Executive functioning (EF) is important for education, work and social functioning [1]. EF is a set of interrelated higher-order mental processes involving top-down control of cognition, emotion and behavior necessary for successful navigation of complex everyday situations [2]. Definitions of EF include the core components of inhibition, shifting (also known as set-switching or mental flexibility) and updating of working memory, as well as more complex processes such as planning and problem solving [3, 4].

Executive functioning is among the most consistently impaired cognitive domains in schizophrenia spectrum disorders on tests of inhibition, shifting and planning, as well as manipulation and maintenance of working memory [5]. Compared to healthy controls, persons with schizophrenia also report significantly more complaints of EF difficulties in everyday life on the Behavior Rating Inventory of Executive Function – Adult version (BRIEF-A) [6, 7].

EF impairments are also found among persons with psychosis risk [8]. Psychosis risk syndromes include attenuated positive symptoms, brief intermittent psychotic symptoms and genetic risk combined with deteriorated functioning [9, 10]. Emerging evidence suggests that cognitive remediation in early intervention for psychosis could potentially have a preventative effect on the burden of illness through preserving cognition and everyday functioning [11–14]. However, there is a lack of evidence for the efficacy of cognitive remediation in psychosis risk syndromes at present [15].

Lower scores on objective measures of EF (neuropsychological tests) predict poorer everyday functioning, greater need for vocational support and poorer life satisfaction in schizophrenia spectrum disorders and psychosis risk syndromes [16–20]. Fewer subjective EF complaints on the BRIEF-A is associated with greater personal recovery in schizophrenia spectrum disorders [21].

Goal Management Training (GMT) is a metacognitive strategy training program that aims to improve EF [22, 23]. Metacognitive strategy training is a mode of cognitive remediation that involves top-down learning of a mental strategy, rather than bottom-up learning through repetition of tasks. The strategy training promotes awareness of cognitive deficits, and facilitates increased self-monitoring and control over mental processes [24]. Metacognitive strategy training should not be confused with metacognitive training, which targets bias in thought content, or metacognitive therapy which targets rumination and worry [25]. Due to the complexity of interacting executive functions, metacognitive strategy interventions are recommended for EF impairments [26]. GMT has proved effective in people with different neurological and mental disorders [24]. The theory behind GMT posits that failures in goal-directed behavior often are due to lapses in sustained attention [27]. For example, one of our participants complained that if she were interrupted by the sight of a bill while vacuuming, she would forget to finish vacuuming. Instead, she would pay the bill, get caught up watching videos on the computer, and return later to find the vacuum cleaner in the middle of the room. Such distracted behavior with sudden bursts of activity is a hallmark of executive dysfunction and is often a sign that goal-directed behavior has been replaced by habits *("When I am on the computer, I watch videos"*) or reliance on cues in the surroundings (seeing the bill or the vacuum cleaner) [27]. GMT teaches participants to replace automatic, distracted behavior and instead set, prioritize, maintain and perform goals through verbal self-instructions (Table 1).

Several cognitive remediation studies for individuals with schizophrenia spectrum disorders include training in metacognitive strategies in combination with drill and practice or vocational training [28–32]. However, few studies appear to have assessed the effect of a stand-alone metacognitive strategy training on EF in schizophrenia spectrum disorders and none in psychosis risk syndromes [15, 33]. Studies of stand-alone interventions are important to understanding mechanisms behind change in cognitive remediation. Furthermore, most studies have focused on mental strategies tailored to specific individuals or situations. GMT, in contrast, offers

Table 1 Functions of the steps in the GMT strategy

1. Stop	Interrupting automatic behavior
2. Focus on your breath	Adjusting arousal, present-mindedness
3. Define your goal	Forming and prioritizing task goals
4. Check the mental blackboard	Updating of working memory
5. Divide the goal into subgoals	Chunking of information
6. Check what you are doing	Task- and self-monitoring

guiding principles that can be applied across any number of everyday activities [22, 34]. In addition, GMT is a manualized group intervention that can be administered in only nine sessions. Therefore, GMT could potentially prove to be an easy to implement, cost-effective intervention with a broad impact on everyday functioning [34]. GMT has been introduced for people with schizophrenia with promising results in one case-study and a recent randomized controlled trial (RCT) that combined GMT with occupational therapy [35, 36]. The individual from the case study showed better performance of familiar and novel real-life tasks after intervention. The effects remained after 2 years and he also reported increased self-confidence in performing activities of daily living [36]. The RCT that combined GMT with occupational therapy was aimed at adults with treatment resistant schizophrenia. The participants in the treatment group showed greater improvements in activities of daily living scored by observers [35].

The aim of the present RCT is to determine the effectiveness of GMT on executive functioning in a sample of young participants with early schizophrenia or psychosis risk. The potential of GMT for improving daily life functioning, symptoms of psychosis and well-being is also explored. A recent master thesis investigated the effects of GMT on measures of wellbeing among participants with a diagnosis in the schizophrenia spectrum in the sample and found that GMT significantly improved self-efficacy, but not self-esteem or quality of life [37]. The present study reports the effect of GMT on subjective EF (self-reported) and objective EF (neuropsychological tasks), symptoms of psychosis, functional capacity and daily life function.

Based on previous GMT research, we hypothesized improved subjective and objective EF following GMT [24]. As GMT is a metacognitive strategy training program, it might be expected to have the largest impact on EF in real-world situations [22]. Thus the trial was powered to detect meaningful differences on the primary subjective outcome measure, the BRIEF-A questionnaire. A computerized test of inattentiveness, Connors Continuous Performance Test (CPT3) [38] was chosen as a primary outcome measure for objective EF because it has been sensitive to change in previous GMT studies [39]. Given the close link between EF and everyday functioning in schizophrenia and psychosis risk syndromes, we further hypothesized improved functional capacity and independent living [40–42]. Even though cognitive remediation for schizophrenia does not target psychotic symptoms, small reductions in symptoms have been seen across previous studies [43]. Cognitive remediation appears to be especially beneficial for the reduction of negative symptoms [44]. Moreover, associations have been found between poor objective EF performance and negative and disorganized symptoms, but not positive symptoms [45, 46]. Thus, we hypothesized a reduction in negative and disorganized symptoms following GMT.

Methods

Participants

Eighty-one participants, 49 males (60%) and 32 females (40%), were recruited among patients referred for treatment of psychosis at a regional, public hospital, Innlandet Hospital, in Norway 2017–2020. The majority of participants were recruited through the hospital's specialized early detection and intervention for psychosis clinics, resulting in a young sample between the ages of 16 and 44. Mean age was 25 years (SD 6.35), and 94% of participants were between 16 and 35 years old. Sixteen individuals, aged between 18 and 40 with a mean age of 23 years, were diagnosed with psychosis risk syndromes. The remainder of the sample were diagnosed with a disorder in the schizophrenia spectrum. See Table 5 for further details of participant characteristics.

The inclusion criteria were age (16 to 69 years), diagnosis (schizophrenia spectrum disorder according to the criteria in the Diagnostic and Statistical Manual of Mental Disorders, DSM-IV [47] or psychosis risk syndrome [9, 10]) and self-reported executive dysfunction (Total *T*-score above 55 on the BRIEF-A, considered clinically relevant in the Norwegian context [6, 48]). Exclusion criteria included comorbid neurological conditions, ongoing alcohol or substance abuse, intellectual impairment (IQ < 70) and treatment for psychosis for more than 5 years.

The study was preregistered at clinicaltrials.gov (NCT03048695 09/02/2017). Due to time consuming and strenuous assessment days, the assessment protocol was reduced after pre-registration so that some measures were only collected at baseline including the Iowa Gambling Task [49] and Letter Number Sequencing Test from WAIS-IV [50]. Goal Attainment Scale [51] was used only in the intervention group as it was integrated into the GMT-manual. The everyday functioning questions were simplified. The Cognitive Failures Questionnaire [52] was left out of the protocol due to an administration error.

The study was approved by the Regional Committee for Medical and Health Research Ethics Norway (2015/2118), and conducted in accordance with the Helsinki declaration. Informed consent was obtained for all participants. Advisers with service-user experience employed by the hospital were consulted during the planning and execution of the study. For instance, they advised on recruitment procedures and adaption of the intervention for a new patient population. An adviser

also observed one of the first GMT-sessions gathering feedback from participants.

Procedure

Participants were assessed for diagnostic eligibility by a trained psychologist using the Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV) Axis I disorders, SCID-I and Structured Interview for Prodromal Symptoms [9, 53]. Symptoms of psychosis were assessed with the Structured Clinical Interview for the Positive and Negative Syndrome Scale for Schizophrenia, the SCI-PANSS [54]. Symptoms were grouped according to a five-factor consensus model with positive, negative, disorganized, depressed and excited symptoms [55].

Figure 1 is a flow chart of participation [56].

Participants were randomly assigned in a parallel group trial design to either GMT ($n=39$) or a Wait-List Control condition (WLC; $n=42$) by a person independent from the study team using computer-generated random assignment from https://www.randomizer.org. Trained clinicians undertook baseline assessments (T1), post-treatment assessments immediately following GMT completion (T2 at 5 weeks) and follow-up assessments 6 months after GMT completion (T3 at 30 weeks). Conditions were masked from the raters gathering post-intervention and follow-up assessments. The raters were ordinarily employed in a ward separate from the intervention sites both in terms of organization and geography. To our knowledge, no instances of unmasking occurred. Participants received GMT in addition to treatment at usual for psychosis according to Norwegian national guidelines [57]. Treatment frequently involved a combination of medication and psychotherapy. Participants with psychosis risk syndromes received treatment for sub-threshold psychotic or general symptoms where indicated, but did not receive antipsychotics [57]. The control group members were offered GMT after

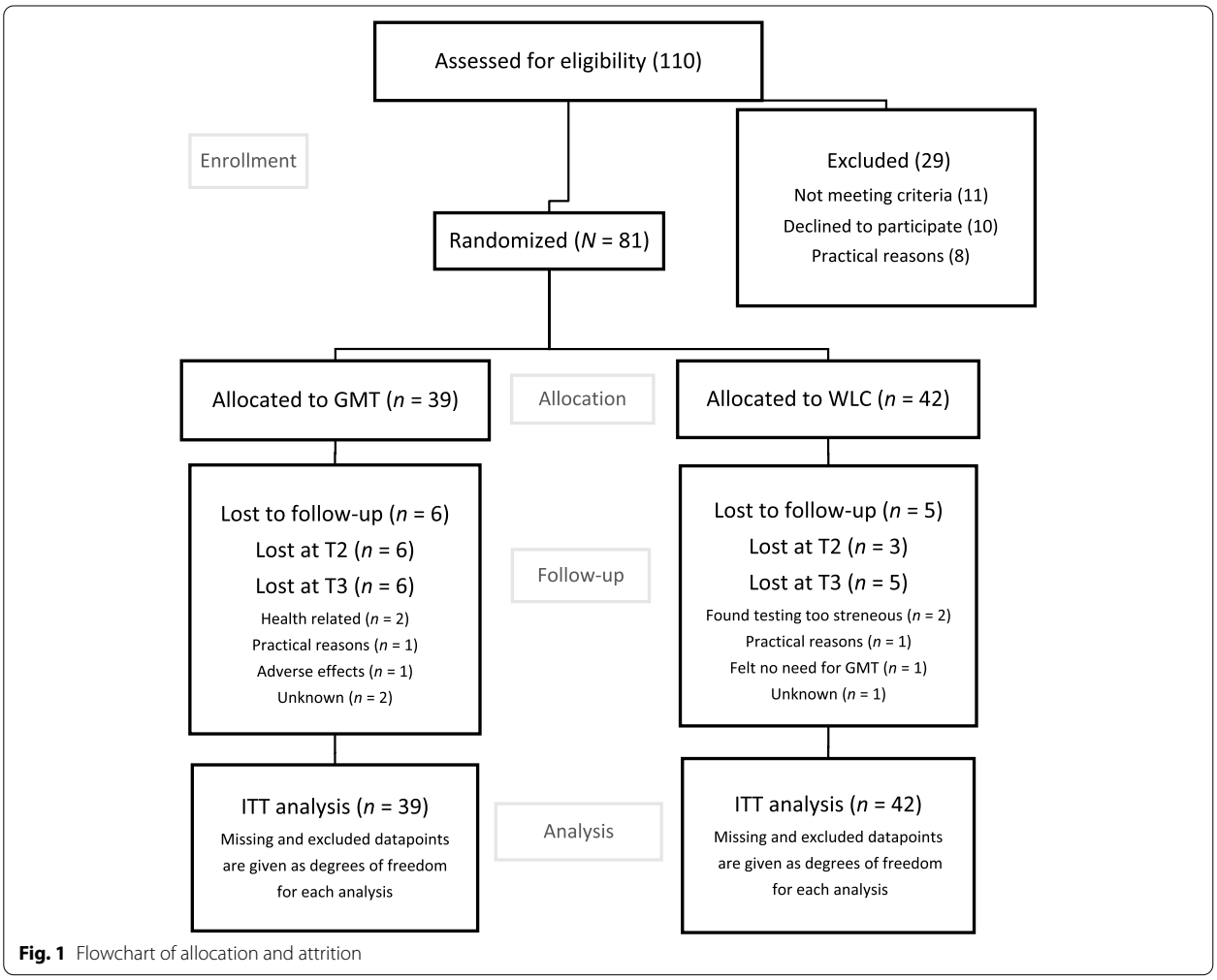


Fig. 1 Flowchart of allocation and attrition

follow-up assessment. The trial ended when a sufficient number of participants had been recruited.

Intervention: Goal Management Training

Goal Management Training was administered to small groups of participants in nine, 2-h sessions (twice weekly). All sessions were held by the same clinical psychologist trained in GMT by a specialist in neuropsychology and GMT methodology, together with a local co-therapist. Co-therapists were given basic training in GMT and were doctors, psychologists, psychiatric nurses or occupational therapists. The training followed a script with accompanying PowerPoint slides and participant workbooks. Participants received a daily text message prompting strategy use between sessions four and nine [58, 59]. The current GMT-manual includes mindfulness breathing exercises to encourage adequate arousal and further improve the focus on goals in the present situation [27, 60]. The Norwegian translation of the GMT-manual [39] used in previous studies was revised by removing a mindfulness exercise involving sensory scanning of the body to reduce discomfort in case of tactile hallucinations or anmalous self-experiences. An exercise was added where participants developed one individual long-term goal according to the procedures in goal attainment scaling, because a review of GMT studies showed that personal goals increased effect of the intervention [51, 61]. Between-session assignments were reduced from three to two exercises due to the frequency of sessions (twice a week). Examples of assignments between sessions were collecting personal examples of inattentive slips, practicing mindful breathing or rehearsing the strategy for 30 min per day. See Table 2 for content of GMT.

Because the metacognitive strategy is gradually taught by adding steps from session four to nine, all sessions should be attended in order. Therefore, individual sessions were offered in cases of absence. The 33 participants in the intervention group who completed all three assessments points attended all nine sessions. Five participants completed the last three sessions via videoconference due to the outbreak of the Covid-19 pandemic.

Measures

An overview of all measures reported in this study is provided in Table 3. The pre-registered primary outcome measures were BRIEF-A (subjective EF), CPT3 (objective EF) and SCI-PANSS (symptoms of psychosis).

Subjective EF in everyday situations was measured using the 75-item questionnaire BRIEF-A [6]. The instrument has shown good test-retest reliability ranging from *r* .82 to .93 across nine subscales [6]. The scale showed good internal consistency in the present study at baseline with an adequate Cronbach's Alpha score of α .95 for the total score.

Objective EF was assessed with the following tests: Inattentiveness was measured with the Conners Continuous Performance Test - 3rd edition (CPT3) [38]. The raw score for detectability (d') analyzed is a signal-to-noise ratio that captures ability to correctly respond to targets

Table 2 Content of Goal Management Training

Module	Content	Demonstrations	Assignments at home
1. Present- and absentmindedness	Absentmindedness is normal. Present mindedness can be practiced.	Clapping task demonstrating inattention Mindful eating of a raisin	Record absentmindedness, practice present mindedness
2. Slip-ups	Absentmindedness can lead to slip-ups	Clapping task Set personal goal	Record slip-ups, practice present mindedness
3. The autopilot	Acting on autopilot can lead to slip-ups	Sorting cards Breathing exercise	Record slip-ups, practice breathing exercise
4. STOP the autopilot	Saying STOP interrupts the autopilot and allows refocus	Sorting cards with STOP Short breathing exercise	Practice STOP 30 min daily, practice breathing exercise
5. The mental blackboard	Update working memory using the STOP-FOCUS-CHECK sequence	Sorting cards with distraction Short breathing exercise	Practice strategy 30 min daily, practice breathing exercise
6. State the goal	Stating goals aloud before and during tasks helps goal-attainment	Complex exercise that requires switching between 5 tasks	Practice strategy 30 min daily
7. Decision making	Recognize stress as a signal to use strategy to overcome indecision	Complex decision making task	Practice strategy when needed, internet shopping task
8. Dividing goal into subgoals	Large tasks are often made up of smaller tasks. Use subgoals when overwhelmed.	Define the subgoals in moving house and plan a wedding	Practice strategy when needed, internet shopping task
9. Check if goal is met	Checking if current actions are helpful in reaching the goal	Revisit clapping task Summary of the training	

Table 3 Measures

Instrument	Outcome variables	Time points
SCID-I: Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV) Axis I [53]		Inclusion
SIPS: Structured Interview for Prodromal Symptoms [9]		Inclusion
SCI-PANSS: Structured Clinical Interview for the Positive and Negative Syndrome Scale for Schizophrenia [54]	Positive, negative, disorganized, depressive and excited symptoms	T1, T2, T3
SCL-10: Symptoms Check List [62]	Total score	T1, T2, T3
WASI: Wechsler Abbreviated Scale of Intelligence [63]	Estimated IQ from Matrix Reasoning and Vocabulary	T1
WAIS-IV: Wechsler's Adult Intelligence Scale, 4th edition [50]	or Estimated IQ from General Ability Index (GAI)	T1
BRIEF-A: Behavior Rating Inventory of Executive Function - Adult version [6]	Total raw score 9 subscale scores	T1, T2, T3
CPT3: Conners Continuous Performance Test 3rd edition [38]	Detectability (d') raw score	T1, T2, T3
Digit Span from the Wechsler Adult Intelligence Scale – 4th edition, WAIS-IV [50]	Total number of correct trials from the forward, backwards and sequential conditions	T1, T2, T3
CWIT: Color-Word Interference Test from the Delis-Kaplan Executive Function System (D-KEFS) [64]	Time – raw scores in seconds Raw contrasts between conditions 4 versus 3 (switching) and between condition 3 versus 1 and 2 (inhibition)	T1, T2, T3
Tower task from D-KEFS [64]	Total achievement score	T1, T2, T3
UPSA-B: University of California San Diego Performance-based Skills Assessment, brief version [65, 66]	Total score on the finance and communication modules	T1, T2, T3
Hotel Task [59]	Time expressed in number of seconds deviating from optimal time distribution between five tasks	T1, T2, T3
SFS: Social Functioning Scale [67]	The scores from the subscales Independence Competence and Independence Performance	T1, T2, T3
GAF: Global Assessment of Functioning-Split Version [47]	GAF-F global function score	T1, T2, T3

Abbreviations: *T1* Time one, baseline assessment (0 weeks), *T2* Time two, post-intervention assessment (5 weeks), *T3* Time three, follow-up assessment 6 months after intervention (30 weeks)

while inhibiting responses to non-targets. Higher scores indicate poorer performance. The measures are reported to have adequate split-half reliability in a normative sample *r* .92 (*r* .95 for those under 18 years) and test-retest reliability, *r* .74 [38].

Total score on the Digit Span task (forwards, backwards and sequential conditions) from the Wechsler Adult Intelligence Scale – 4th edition, WAIS-IV [50] was used to assess working memory. The test has adequate internal consistency in normative samples with Cronbach Alpha scores of α .84 in the forwards condition, α .78 in the backwards condition and α .89 in the sequential condition [50]. Test-retest reliability ranges from *r* .71–.77 across the three conditions [50].

Inhibition and shifting were assessed with the Color-Word Interference Test (CWIT) from the Delis-Kaplan Executive Function System (D-KEFS) [64]. The test-retest reliability correlations for the four conditions in a normative sample were CWIT1 Color naming, *r* .86, CWIT2 Word reading *r* .49, CWIT3 Inhibition *r* .71 and CWIT4 Inhibition/Switching *r* .52 in the age group 20–49. Among those under 19 years the correlations ranged from *r*. 77 to *r* .90 [64]. In the present study, two raw contrast scores for inhibition and shifting were used as outcome measures to separate out the confounding effects of processing speed [68, 69]. A contrast measure of inhibition was created by subtracting the average amount of seconds spent on CWIT1 and CWIT2 from CWIT3. A contrast measure of shifting was created by subtracting time spent on CWIT3 from time spent on CWIT4. Higher contrast scores indicate greater difficulties with inhibition and shifting.

Strategic planning was measured with the total achievement score from the Tower task from D-KEFS [64]. The total achievement score reflects the building of correct towers with as few moves as possible, requiring the ability to plan more than one step ahead. Higher scores indicate better performance. Test-retest reliability in a normative sample was *r* .41 (*r*. 51 for those under 18) [64].

Raw scores on the above neuropsychological tests were converted to *z*-scores, reversed where appropriate and averaged for a total mean score of objective EF. Positive mean scores indicated better performance.

Symptoms of psychosis were measured using SCI-PANSS [54]. The instrument was scored by a trained clinician and included a structured interview with participants, input from someone who knew the participant well and saw them regularly (e.g., a family member or treating clinician) and observations made during the interview. Thirty items were scored on a scale ranging

from 1 (absent) to 7 (extreme). Items referring to hallucinations and delusions with a score higher than 4 (moderate) indicate psychosis. The instrument has shown adequate reliability in both in- and outpatient settings [70]. In the present study, items were grouped according to a five-factor consensus model [55]. The total scores for positive, negative, disorganized, depressed and excited symptoms were used as outcome measures.

A brief, ten-item version of the Symptom Check List, SCL-10, was used to assess self-reported psychological distress [62]. The SCL-10 has shown adequate psychometric qualities equivalent to longer versions of the instrument and it has been validated in the Norwegian population [71]. The questionnaire reflects subjectively experienced anxiety and depressed mood. Items are scored on a scale ranging from 1 (a little bothered) and 4 (very bothered). The total score from the questionnaire was used as an outcome measure.

Functional capacity measures included the brief version of the University of California San Diego Performance-based Skills Assessment, UPSA-B [65, 66] and the Hotel Task [59]. From the UPSA, the total score out of 100 for the Finance and Communication modules was used. The UPSA is a role-playing task imitating activities of daily life including paying a bill and making a telephone call. Higher scores indicate better performance. During the Hotel Task participants are instructed to divide their time equally between five different tasks: Sorting coins, proof reading, creating invoices, using a telephone directory and sorting names alphabetically. The number of seconds deviating from optimal time distribution between the five tasks was used as the outcome measure.

Activities of daily living was assessed with two subscales from the self-reported Social Functioning Scale, SFS [67]. The Norwegian translation of the scale has been shown to be reliable and valid among people with schizophrenia [72]. The two subscales Independence Competence and Independence Performance were considered the most relevant outcome measures [73]. The internal consistency of the Independence Performance subscale, α .81, and Independence Competence subscale, α .65, was adequate. Furthermore, global function was assessed with clinician ratings of the Global Assessment of Functioning - Split version, GAF-F [47]. The scale ranges from 0 to 100 and higher scores indicate better functioning across important areas of life such as school or work, socially and at home. Ratings have been shown to be consistent among experienced raters [74].

Data analysis

Analyses were performed using SPSS, version 26. In order to describe EF at baseline, one-sample *t*-tests were run comparing normed scores from the sample to standardized normative means gathered from the test manuals of EF instruments. Main outcome analyses were run using raw scores to retain variance. Outliers more than three standard deviations from the mean or with extreme residuals were excluded. The scores for CWIT Inhibition and SFS Independence Competence were log transformed to account for skewed distributions of scores. Group comparisons at baseline between GMT and WLC, and between completers and non-completers, were done using the Mann-Whitney Test for continuous variables and Pearson Chi Square for categorical variables.

A-priori power calculations based on existing GMT-studies indicated that to detect an effect size on the primary outcome measure of *r*. 30 (*d* 0.65), a sample size of $n=60$ would be sufficient to render power of 80% with the alpha level set to p .05. Based on the principle of intention-to-treat (ITT), available data for all 81 participants were entered into a linear mixed model analysis for repeated measures [75]. Missing data were assumed to be missing at random. Group, time and group by time interactions were assessed as fixed effects and *p*-values < .05 were considered statistically significant. A first-order autoregressive covariance matrix was chosen for the repeated measures. Random subject intercepts were allowed for. Post-hoc explorations of change within treatment groups were done by running the models separately for each group.

As a precaution, age, sex, years of education, diagnosis, symptoms and treatment content in TAU (drug therapy and psychotherapy) were added one-by-one as co-variates in the mixed model analysis to control for potential influence on significant group x time interactions.

Effect sizes were expressed as Pearson's *r* for the group x time interaction effects:

$$r = \sqrt{\frac{F_{(time\ x\ group)}}{F_{(time\ x\ group)} + Df}}$$

Reliable Change Index (RCI) was calculated for the primary outcome measure that showed a significant interaction effect, BRIEF-A, to identify individuals with clinically reliable improvement from baseline (T1) to follow-up (T3) [76].

Results

Baseline characteristics of the sample

At baseline, the sample showed significantly more subjective complaints of EF with a mean total *T*-score of 68 on BRIEF-A when compared to normative samples [6]. The sample showed comparable performance to normative samples on the Digit Span test. All conditions of the CWIT were performed slower than the normative

average, but there was no additional speed reduction on the conditions requiring shifting and inhibition, similar to previous studies [69]. The sample did, however, have more difficulty differentiating between targets and non-targets on the CPT3. Table 4 shows the executive functioning in the sample compared to the standardized means derived from large norming samples with healthy participants listed in the test manuals of the instruments [6, 38, 50, 64].

Group comparisons at baseline

Any baseline differences between the groups were considered incidental due to randomization [77]. The GMT-group reported more subjective EF complaints at baseline, $F(1,72) = 6.66$, p .012. The GMT-group also showed a significantly lower level of negative symptoms compared to the WLC-group, $F(1, 79) = 17.34$, p .008. The groups were otherwise comparable, see Table 5.

Attrition

Nine subjects did not complete testing at T2, and this number increased to 11 at T3 making attrition 13.58% at the end of the study. There were no significant differences between completers and non-completers in demographical or clinical variables.

GMT outcomes

A linear mixed model analysis showed a significant decrease in self-reported symptoms of executive dysfunction in everyday life in the GMT-group only, BRIEF-A Total score, $F(1, 51.94) = 8.40$, p .005, r .37. Results for subjective EF can be seen in Table 6. The result remained unchanged when controlling for age, sex, diagnosis, years of education, treatment and severity of psychotic symptoms. In particular, there was no main effect of negative symptoms on subjective EF, and adding the variable did not change the significant interaction effect between group and time on subjective EF. Of note, significantly more participants in the GMT-group (10 of 19, 52.60%) experienced reliable clinical change from baseline to follow-up on this measure compared to the WLC-group (2 of 18, 11.10%), $\chi 2(1) = 7.27$, p .007, ϕc .44 according to the RCI [76].

The results show no difference in effectiveness between the two groups measured with neuropsychological tasks. However, both groups improved significantly over time on the Tower task and in mean objective EF.

There were no significant differences between treatments in functional capacity, self-reported independent living or clinician ratings of global functioning.

Table 4 Executive functioning at baseline ($N = 81$)

	Study Sample		*Standardized norms*			
	M	***SD***	***M***	***SD***	***t*[a]**	***p***
BRIEF-A: Total *T*-score	68.08	10.59	50	10	14.68	**< .001**
Inhibit *T*	58.43	11.72	50	10	6.19	**< .001**
Shift *T*	62.82	11.30	50	10	9.76	**< .001**
Emotional Control *T*	58.01	11.73	50	10	5.88	**.003**
Self-Monitor *T*	53.95	10.97	50	10	3.10	**< .001**
Initiate *T*	68.92	12.01	50	10	13.55	**< .001**
Working Memory *T*	67.73	10.38	50	10	14.70	**< .001**
Plan/ Organize *T*	62.53	9.83	50	10	10.96	**< .001**
Task Monitor *T*	61.01	11.01	50	10	8.61	**< .001**
Organization of Materials *T*	54.78	12.58	50	10	3.27	**.002**
Digit Span total Scaled Score	9.88	2.60	10	3	−0.39	.697
CWIT1: Color Naming SS	6.86	2.91	10	3	−9.57	**< .001**
CWIT2: Reading SS	8.05	3.20	10	3	−5.42	**< .001**
CWIT3: Inhibition SS	8.27	3.45	10	3	−4.46	**< .001**
CWIT4: Inhibition & switching SS	7.95	3.85	10	3	−4.46	**< .001**
CWIT Contrast Inhibition SS	11.41[b]	2.66	10	3	4.69	**< .001**
CWIT Contrast Shifting SS	9.73	2.97	10	3	−0.80	.429
Tower total achievement SS	10.50	2.36	10	3	1.90	.062
CPT3 d' *T*-score	54.87	10.38	50	10	4.23	**< .001**

Bold values are statistically significant

[a] Results of one-sample t-tests compared to standardized means of normative samples from the manuals of the instruments [6, 38, 50, 64]

[b] Note that the scaled score for CWIT Inhibition is higher than the normative mean

Table 5 Baseline characteristics of the randomized sample ($N=81$)

	GMT ($n=39$)				WLC ($n=42$)				
	Frequency	***M***	***SD***	***SE***	**Frequency**	***M***	***SD***	***SE***	***P***
Sex									.102
Female	19 (49%)				13 (31%)				
Male	20 (51%)				29 (69%)				
Age		25.46	6.68	1.07		24.38	6.07	.94	.504
Years of Education		13.00	2.00	.32		12.81	1.67	.26	.814
Estimated IQ[a]		98.65	15.11	2.48		98.97	13.17	2.11	.670
Diagnosis									.869
Schizophrenia spectrum disorder[b]	31 (80%)				34 (81%)				
Psychosis risk syndrome[c]	8 (20%)				8 (19%)				
DUP[d] (weeks)		205.44	266.77	42.72		185.93	210.11	32.42	.924
Hospitalizations		2.62	5.13	.82		2.88	4.27	.66	.463
Months in hospital		4.46	8.67	1.39		5.23	6.56	1.01	.287
Drug therapy	30 (77%)				30 (71%)				.573
Antipsychotics	23 (59%)				27 (64%)				.623

[a] Estimated IQ: General intellectual ability was estimated at baseline with Vocabulary and Matrix Reasoning subtests from the Wechsler Abbreviated Scale of Intelligence (WASI) [63]. A few participants had GAI (General Ability Index) scores from Wechsler's Adult Intelligence Scale, 4th edition (WAIS-IV) in place of WASI scores [50]

[b] Classifications were schizophrenia (GMT $n=12$, WLC $n=17$), schizoaffective disorder (GMT $n=6$, WLC $n=8$), schizophreniform episode (GMT $n=4$, WLC $n=2$), delusional disorder (WLC $n=1$) and psychosis not otherwise specified (GMT $n=9$, WLC $n=6$) [47]

[c] Classifications were positive symptoms syndrome (GMT $n=6$, WLC $n=3$), brief intermittent psychotic symptoms (GMT $n=2$, WLC $n=3$) and genetic risk combined with fall in function (GMT $n=0$, WLC $n=2$) [9]

[d] *DUP*: Duration of untreated psychosis defined as weeks from onset of psychotic symptoms until start of adequate treatment with antipsychotic medication or hospitalization in a specialized ward [78]

Table 6 Linear mixed model analysis (ITT $N=81$): subjective executive functioning

	GMT Mean scores			WLC Mean Scores			Group x Time interaction					
	T1[a]	**T2**	**T3**	**T1**	**T2**	**T3**	***df***	***b* (GMT)**	***b SE***	***95% CI***	***P***	***r***
BRIEF-A total	149.34	140.30	132.55	136.60[b]	132.48	135.05	51.94	−7.62	2.63	−12.90, −2.35	**.005**	.37
Inhibit	15.29	15.35	14.73	13.54[b]	13.48	13.52	51.81	−0.72	0.37	−1.45, 0.02	**.056**	.26
Shift	11.97	12.45	11.41	11.33	11.79	12.57	44.16	−0.73	0.32	−1.38, −0.07	**.030**	.32
Emotional Control	20.09	19.50	19.14	17.62[b]	17.38	18.00	47.36	−0.39	0.53	−1.46, 0.67	.463	.11
Self-Monitor	10.35	10.17	10.00	9.37	9.93	10.48	50.02	−0.66	0.25	−1.16, −0.16	**.011**	.35
Initiate	18.49	17.90	16.45	17.35	18.22	18.11	51.82	−1.43	0.36	−2.15, −0.72	**< .001**	.49
Working Memory	17.12	17.21	16.38	15.67	16.00	16.38	53.14	−0.74	0.37	−1,49, 0.00	.051	.26
Plan/ Organize	19.89	20.25	18.09[c]	18.08[b]	19.76	19.90	63.41	−1.78	0.52	−2,83, −0.74	**.001**	.39
Task-Monitor	11.43	11.50	10.95	11.37	11.39	11.45	36.34	−0.35	0.33	−1.01, 0.31	.293	.17
Organization of Materials	15.21	15.90	15.05	13.95	14.34	14.48	48.12	−0.72	0.44	−1.59, 0.17	.109	.23

Bold values are statistically significant

[a] The time variable was coded 0 for baseline, 1 for post-intervention testing and 2 for follow-up

[b] The GMT-group had a higher mean score at baseline on the BRIEF-A total raw score and the subscales for Inhibit, Emotional Control and Plan/Organize

[c] Significant main effect of time

Both functional capacity and clinician rated function improved significantly over time in both groups.

Both treatment groups showed a reduction in positive, disorganized and excited symptoms over time, but no significant treatment effect of GMT were registered in psychotic symptoms assessed by a trained clinician with SCI-PANSS. The GMT-group experienced a significantly greater reduction in self-reported symptoms of anxiety and depressed mood measured by the

Table 7 Linear mixed model analysis (ITT $N = 81$): objective executive functioning

	GMT *Mean scores*			WLC Mean Scores			Group x Time interaction					
	T1[a]	T2	T3	T1	T2	T3	*df*	*b* (GMT)	*b SE*	*95% CI*	*P*	*r*
Objective EF mean	−0.02[c]	0.18	0.22	0.02	0.21	0.38	70.43	−0.05	0.05	−0.15, 0.05	.331	.12
CPT3 d'	−2.79	−2.81	−2.78	−2.55	−2.79	−2.82	70.45	−0.07	0.10	−0.27, 0.12	.463	.09
Digit Span	26.00	27.58	25.97	25.18	25.59	26.20	65.47	−0.54	0.49	−1.52, 0.44	.278	.13
CWIT Inhibition	29.36	30.81	29.15	26.49	27.07	25.53	48.53	0.03	0.05	−0.08, 0.13	.623	.07
CWIT Switching	6.68	5.68	6.48	6.95	7.89	6.14	58.65	0.03[d]	0.04	−0.04, 0.11	.391	.11
Tower	17.72[c]	18.21	19.58	18.21	20.10	20.68	84.07	−0.30	0.51	−1.33, 0.72	.558	.06
UPSA	78.03[c]	80.47	82.13	74.69	79.16	82.31	74.71	−1.66	1.16	−3.97, 0.65	.157	.16
Hotel Task	287.60[c]	321.79	263.48	389.32[b]	314.87	289.79	65.71	28.50	20.75	−12.93, 69.93	.174	.17

[a] The time variable was coded 0 for baseline, 1 for post-intervention testing and 2 for follow-up

[b] The GMT-group performed the Hotel Task significantly better than the WLC-group at baseline

[c] Significant main effect of time

[d] Variable was log transformed to correct skewed distribution of scores

Table 8 Linear mixed model analysis (ITT $N = 81$): self- and clinician rated functioning

	GMT Mean scores			WLC Mean Scores			Group x Time interaction					
	T1[a]	T2	T3	T1	T2	T3	*df*	*b* (GMT)	*b SE*	*95% CI*	*P*	*r*
GAF-F	43.87[c]	47.31	48.82	42.66	43.97	46.92	82.96	0.33	1.33	−2.31, 2.98	.802	.00
SFS:												
Withdrawal	8.07	8.85	9.75	7.97	7.39	7.80	49.97	0.44	0.35	−0.26, 1.14	.210	.18
Interpersonal behavior	6.85	6.05	6.70	5.67[b]	5.79	5.55	57.54	−0.15	0.30	−0.74, 0.44	.618	.07
Pro-social activities	12.71	11.58	14.32	10.36	9.89	8.68	34.94	0.84	0.81	−0.80, 2.48	.307	.17
Recreation	17.58	17.00	19.55	15.03	15.50	15.65	52.81	0.80	0.73	−0.67, 2.26	.280	.15
Independence Competence	33.21	34.26	34.84	31.55	31.56	31.21	54.35	0.17[d]	0.10	−0.03, 0.36	.097	.22
Independence Performance	24.59	25.16	26.75	23.18	23.46	24.15	48.73	0.91	0.74	−0.58, 2.40	.227	.17
Employment	6.16	5.55	6.75	5.54	4.43	4.80	51.60	0.47	0.45	−0.44, 1.38	.305	.14

[a] The time variable was coded 0 for baseline, 1 for post-intervention testing and 2 for follow-up

[b] The GMT-group scored significantly higher on the subscales Interpersonal behavior than the WLC-group at baseline

[c] Main effect of time

[d] Variable was log transformed to correct skewed distribution of scores

Table 9 Linear mixed model analysis (ITT $N = 81$): clinical symptoms

	GMT Mean scores			WLC Mean Scores			Group x Time interaction					
	T1[a]	T2	T3	T1	T2	T3	*df*	*b* (GMT)	*b SE*	*95% CI*	*P*	*r*
SCI-PANSS:												
Positive	12.21[c]	9.09	9.58	11.26	9.26	8.57	80.43	0.05	0.46	−0.85, 0.96	.910	.01
Negative	13.85	11.76	12.94	16.69[b]	15.87	15.00	78.36	0.35	0.60	−0.84, 1.54	.562	.07
Disorganized	6.87[c]	6.15	6.88	7.17	6.69	6.35	82.27	0.41	0.29	−0.17, 0.99	.165	.15
Depressed	10.38	8.52	8.61	10.36	9.97	9.54	75.45	−0.50	0.32	−1.13, 0.14	.123	.18
Excited	8.95[c]	7.67	8.18	8.38	7.08	6.92	85.37	0.34	0.35	−0.35, 1.03	.327	.11
SCL-10	24.87	20.45	22.00	23.44	23.59	24.25	64.05	−2.32	0.97	−4,25, −0.39	**.019**	.29

Bold values are statistically significant

[a] The time variable was coded 0 for baseline, 1 for post-intervention testing and 2 for follow-up

[b] The WLC-group had significantly higher mean levels of negative symptoms at baseline than the GMT-group

[c] Significant main effect of time

SCL-10, $F(1, 64.05) = 5.78$, p .019, r .29. See Tables 7, 8 and 9 for results of the mixed model analyses.

Post-hoc explorations of change within each group showed that the GMT-group demonstrated significant improvement on the primary outcome measure for objective EF, the CPT3, over time, $F(34.18) = 4.33$, p .045, r .33, while the WLC-group did not demonstrate statistically significant improvement, $F(35.75) = 1.58$, p .216, r .20. The GMT-group also showed significant improvement over time in self-reported performance (SFS Performance GMT $F(21.07) = 5.17$, p .034, r .44 versus WLC $F(29.70) = 0.19$, p .666, r .08) and competence in independent activities of daily living (SFS Performance GMT $F(32.68) = 4.79$, p .036, r .36 versus WLC $F(22.73) = 1.39$, p .251, r .24). However, improvement was significant in both groups for the Tower task, mean objective EF, GAF-F and the UPSA. None of the groups experienced improvement on the CWIT and, in fact, the WLC-group showed greater improvement on the Digit Span and the Hotel Task, $F(40.40) = 9.82$, p .003, r .44 compared to the GMT-group, $F(25.02) = 1.92$, p .176, r .26.

Post-hoc explorations of change within each group showed that the GMT-group demonstrated significant reduction in depressive symptoms, $F(37.01) = 12.97$, $p < .001$, r .51, while the WLC-group did not demonstrate statistically significant improvement, $F(38.38) = 2.67$, p .111, r .26. The opposite was found for excited symptoms. The WLC-group demonstrated a significant reduction in excited symptoms, $F(41.80) = 12.01$, p .001, r .47, while the reduction in the GMT-group did not reach statistical significance, $F(44.51) = 1.78$, p .189, r .20.

Discussion

This study examined the efficacy of GMT in improving EF among people with schizophrenia spectrum disorders or psychosis risk syndromes. To our knowledge this is the first RCT of stand-alone GMT as an early intervention for this patient group. GMT led to a significant and clinically reliable reduction of dysexecutive problems in daily life 6 months after the intervention. The largest effects of GMT on self-reported EF were in initiating activities, planning/ organizing, self-monitoring and shifting focus between activities as assessed with the BRIEF-A subscales. The effect GMT had on increased initiation of activity is especially compelling as this has been reported to be the most impaired domain both in our sample and in a previous schizophrenia study [7]. Difficulty initiating activity is also a challenging symptom to treat in schizophrenia [79].

We did not find significantly greater improvement on objective EF measures in the GMT-group compared to the WLC-group. Since the post-hoc analysis showed improved scores on overall objective EF and the Tower task in both groups, this likely reflects practice effects due to repetition of measures similar to previous studies in schizophrenia [64, 80]. There could be several possible reasons why GMT changed subjective EF more consistently than objective EF. It may be that GMT primarily had a compensatory, rather than restorative, mechanism within the follow-up period of the present study [33, 81]. A restorative mechanism supposes an improvement in specific cognitive functions (for example through frequent task repetition) leading to improved performance on objective measures [82]. A compensatory mechanism supposes learning to use other, better functioning areas of cognition to work around specific challenges. Metacognitive strategy training programs such as GMT, could potentially have both a compensatory and a restorative effect [83]. The earliest effects of GMT might be expected at the behavioral level as a result of compensatory strategy use in real-world situations. However, there might also be a restorative effect of GMT on specific executive functions over time when the strategy becomes automatized through repetition. Current evidence implies that GMT leads to improved performance on neuropsychological tasks across study populations, especially in a working memory task [24]. It is not certain why the present study failed to show similar effects of GMT on objective EF. The study may have lacked sufficient power to detect small treatment effects, especially considering that our study sample performed as well as normative samples on some of the objective tasks at baseline [84]. It is also possible that people with psychosis require more support outside sessions in order to internalize GMT-strategies. Nonetheless, since GMT is a metacognitive strategy training rehearsed in real-world situations, neuropsychological tests may not have been the most suitable outcome measures in the present study. The end goal for GMT is improving goal-directed behavior in real life. The use of systematic observation of familiar and novel real-life tasks might hold the key to unlocking the real potential of GMT [22, 36].

Furthermore, subjective and objective measures of EF are rarely strongly correlated in neither healthy nor clinical samples [85, 86]. One of the main strengths of objective measures is limiting the influence of confounding factors through control over the test situation. As a consequence, the objective test setting provides too much structure to assess the complexity of interacting components of executive function required in real-life [87]. Subjective measures, on the other hand, are better at capturing complex everyday situations, but are more easily influenced by confounding emotional states [88]. Since the discrepancy between subjective and objective measures of cognition is often larger among persons with schizophrenia than in healthy samples, caution should

be exercised in the interpretation of the mechanisms of change in subjective EF in the present study [89–92]. That is not to say that self-reported executive functioning is not of clinical importance as it has been shown to predict important life outcomes, for example academic performance in college [93], and impulse control in younger people [94]. In addition, fewer subjective cognitive complaints in schizophrenia are associated with better physical and psychological well-being [95]. Lower scores on the BRIEF-A in particular is associated with greater personal recovery among people with schizophrenia spectrum disorders [21]. Furthermore, it is possible that a reduction in executive difficulties in real-world situations leads to attempting more challenging tasks [21, 96, 97]. Over time this can build increased confidence in the mastery of activities of daily living, similar to what was observed in the first case study of GMT in schizophrenia [36].

There was no effect of GMT as a stand-alone intervention in functional capacity (UPSA and Hotel Task), self-reported activities of independent living (SFS) or clinician rated global functioning (GAF-F). Some of this may be due to methodological issues. For example, the UPSA may have lacked the sensitivity required to detect meaningful treatment effects, as it has shown ceiling effects in previous studies among younger individuals with a first episode of psychosis [98–100]. The Hotel task may have been subject to an inverse treatment effect due to similarities to a practical multi-tasking exercise during GMT. In a demonstration during session six, GMT-participants are instructed to shift quickly between tasks, but not divide their time equally as in the Hotel task. An inverse effect where GMT-participants perform more poorly on the Hotel task after GMT has been observed previously in a GMT study [27].

The post-hoc analysis of the SFS indicated that change did occur in self-reported performance and competence in activities of independent living in the GMT-group and not the WLC-group, but that the analysis lacked sufficient statistical power to reveal this in the main analysis. The clinician ratings of global function, however, showed that both groups improved their functioning over time showing that GMT did not outperform treatment as usual. Global function as defined in GAF-F is a very broad construct including areas of life not necessarily expected to change in the time span of the present study. Thus, using Goal Attainment Scale as an outcome measure of progress on individual goals of everyday functioning, as originally intended, would likely have been a more appropriate measure [101].

It is possible the interval of 6 months between intervention and follow-up measurements was not long enough to detect an effect of GMT on daily life function, since the GMT-strategy is internalized through repetition over time. Unfortunately, the present study did not assess the amount of strategy rehearsal each participant engaged in, and therefore it is not known to what degree the strategy was internalized. Nonetheless, our finding is in line with existing evidence indicating that cognitive remediation should be integrated into psychosocial rehabilitation programs in order to improve real-world functioning [11, 102, 103]. Combining GMT with restorative drill training and vocational rehabilitation may offer the most promise for achieving functional gains among people with psychosis and EF impairments [33, 102–104]. In a study by Vizzotto and colleagues GMT was combined with occupational therapy where participants with treatment-resistant schizophrenia practiced real-life tasks during sessions lasting a total of 45 h [35]. In that context, GMT improved performance on observed real-life tasks and informant reports of independent living. The aim of the present study was to assess stand-alone metacognitive strategy training as this has rarely been done in schizophrenia [15, 33]. However, the end goal of research on cognitive remediation in schizophrenia is to develop rehabilitation that maximizes the improvement in function, including participation in education and work [105, 106]. Future studies might consider comparing the effects of GMT to other forms cognitive training. Investigating GMT in combination with drill and practice training of executive functions might also further elucidate mechanisms and assist in the search for optimal treatments.

GMT led to improvement in self-reported, but not clinician rated, clinical symptoms. Since clinician rated symptoms were reduced over time in both groups, the reduction was most likely due to treatment as usual. It is possible that an improvement in EF would be associated with better self-regulation and a reduction in stressful experiences in daily life. A bidirectional interplay between EF and psychopathology has been suggested [107, 108]. Executive difficulties among adolescents and young adults with psychosis may exacerbate challenges in meeting the increased expectations of self-organization at home, in school, or in social situations. Failing to meet expectations from parents, peers, or teachers could cause stress and raise the risk of clinical symptoms [109, 110]. Accordingly, the reduction on self-rated symptoms of anxiety after GMT may be an expression of improved self-regulation and fewer stressful encounters. Perhaps it reflects those participants felt less overwhelmed in everyday situations when using the GMT strategies.

Converging evidence of reduced depressive symptoms after GMT from both self-reports and clinician ratings indicate that GMT had a positive effect on depression, as well. However, the change assessed by the clinicians was small and could only be detected in

the post-hoc analysis. In addition, excited symptoms were only reduced in the control group, indicating that symptoms fluctuated in the sample over time and that the significant changes could be spurious findings.

The sample in the present study included both persons recently diagnosed with a schizophrenia spectrum disorder and persons with psychosis risk syndromes. Studies on cognitive remediation for psychosis risk are scarce and have not previously investigated metacognitive strategy training [15]. Some have argued that improved EF in everyday life could potentially protect against a worse prognosis by preserving role function during an important phase of life when work, social and family life begins to be established [11, 111]. In our sample, there were not enough participants with psychosis risk syndrome to analyze this subgroup alone. However, effects of GMT were similar in analyses with and without psychosis risk participants. Even though the current study cannot conclude that GMT has a preventative effect on prognosis, improvements in subjective EF among at-risk participants are important nonetheless because it may indicate a reduction of friction in everyday situations [112]. Everyday stressors tends to increase intensity of psychotic symptoms [113]. The relationship between cognition and stress in psychosis is in need of further elucidation [114]. However, improved self-reports of executive problems such as inattentiveness, impulsive behavior or challenges initiating activities may potentially have a protective effect early in psychotic illness [14, 21].

Implications

GMT is a valuable addition to early intervention in the schizophrenia spectrum disorders and psychosis risk syndromes, because EF is important in everyday situations and frequently severely impaired in these patient groups [5, 7, 8]. Aside from the associations subjective EF has with personal recovery, experiencing that you are better able to plan, start and organize everyday tasks, monitor yourself and shift focus when required, could have a positive impact on the participants' everyday life and adherence to treatment for psychosis. GMT proved to have clinically reliable and lasting effects after being administered in groups over a brief period of 5 weeks. Participants also reported less anxiety and depressed mood after intervention. Thus, this suggests that GMT can provide considerable gains at low cost in clinical settings. The standardized manual ensures fidelity and allows for efficient training of clinicians. Future studies should assess maintenance of strategies learnt during GMT [115].

Strengths and limitations

The robust randomized design featuring masking of conditions and follow-up over 6 months with low attrition rates are important strengths of this study. The sample size ensured sufficient statistical power to detect moderate effects. The extensive assessment protocol with a multimodal approach to the measurement of EF is also a strength of the study. However, the protocol lacked observational measures of real-life situations and community functioning and was a missed opportunity of capturing potential beneficial effects of GMT on functioning [35, 36, 116]. The primary outcome measure that showed the largest treatment effect of GMT was self-reported EF, which may be vulnerable to cognitive deficits in self-evaluation, demand characteristics and social desirability bias [117]. The neuropsychological tests were the same at all assessment points. It would have been preferable to use tests with alternative versions to avoid practice effects.

An important question is whether the study has sufficient generalizability beyond this sample. The sample was young and had received treatment for psychosis for a maximum of 5 years or had psychosis risk syndromes. It is therefore somewhat uncertain if the results may be generalized to older adults who have been living with schizophrenia for a longer period of time. However, a recent study using the GMT protocol in combination with occupational therapy among adults with treatment-resistant schizophrenia and a higher mean age found similar results [35].

Treatment as usual at the time of participating in the present study varied somewhat since not all patients received both psychotherapy and drug treatment. This heterogeneity may have interfered with treatment effects of GMT. For example, attending psychotherapy may increase metacognitive capacity [96]. However, there were no significant difference between the GMT-group and WLC-group in concomitant treatment after randomization. Also, we did not find that other concomitant treatment moderated the effect of GMT when controlling for this statistically. Another caveat is that the GMT-group had fewer negative symptoms than the WLC-group. Since negative symptoms mediate the relationship between cognition and functional outcome, findings need to be replicated to ensure that the efficacy of GMT also applies to individuals with higher levels of negative symptoms [118]. Nonetheless, we did control for negative symptoms in the statistical analysis in the present study and negative symptoms did not influence the outcome of GMT on subjective EF.

Our sample was selected on the basis of EF complaints. In addition, the GMT-group reported greater difficulties with EF in everyday situations at baseline than the WLC-group, which may have inflated the effect size of the main

finding, but the effect of GMT remained significant when controlling for this baseline difference by removing the main effect of treatment group [119].

Conclusions

To our knowledge, this is the first high-quality RCT of stand-alone metacognitive strategy training in people with schizophrenia spectrum disorders and psychosis risk syndromes. Our main findings demonstrated that a five-week, group-based GMT program was effective in reducing self-assessed, daily-life executive dysfunction. Finally, the study had a low attrition rate, suggesting high participant acceptance of the intervention.

Abbreviations

GMT: Goal Management Training; EF: Executive functioning; RCT: Randomized controlled trial; WLC: Wait-List Control; T1: Time one, baseline assessment at 0 weeks; T2: Time two, post-intervention assessment after 5 weeks; T3: Time three, follow-up assessment 6 months after intervention (30 weeks); BRIEF-A: Behavior Rating Inventory of Executive Function – Adult version; CWIT: Color Word Interference Test; CPT3: Conners Performance Test, 3rd edition; UPSA: University of California San Diego Performance-based Skills Assessment; SFS: Social Functioning Scale; GAF-F: Global Assessment of Function, Split version (Function).

Acknowledgements

The Authors thank Evelyn Robsahm, Kari Veisten and Tina Sveum Engh for data collection and entry.

Authors' contributions

MGØ, JS, EH and TU planned the study. IH analyzed the data. All authors wrote and edited the manuscript. The author(s) read and approved the final manuscript.

Funding

The work was supported by the South-Eastern Norway Health Authority (grant number 2017012); Innlandet Hospital Trust (grant number 150602) and University of Oslo (grant number 353139).

Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available due to limitations of ethical approval involving the patient data and anonymity, but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Participants gave informed consent. The study was conducted in accordance with the Helsinki declaration and approved by the Regional Committee for Medical and Health Research Ethics Norway (2015/2118).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author details

[1]Division of Mental Health Care, Innlandet Hospital Trust, P. O. Box 104, 2381 Brumunddal, Norway. [2]Department of Psychology, University of Oslo, P.O. Box 1094, 0317 Oslo, Norway. [3]Department of Research, Lovisenberg Diaconal Hospital, P.O. Box 4970, Nydalen, 0440 Oslo, Norway. [4]Departments of Occupational Therapy and Psychological and Brain Sciences, Boston University, 930 Commonwealth Avenue, Boston, MA 02215, USA. [5]Department of Psychology, Inland Norway University of Applied Sciences, P.O.Box 400, Elverum, Norway. [6]Norwegian Centre for Mental Disorders Research, Oslo University Hospital, Postboks 4956, Nydalen, 0424 Oslo, Norway. [7]Research Division, Innlandet Hospital Trust, P.O. Box 104, 2381 Brumunddal, Norway.

Received: 12 January 2022 Accepted: 9 August 2022
Published online: 28 August 2022

References

1. Diamond A. Executive functions. Annu Rev Psychol. 2013;64(1):135–68.
2. Burgess PW, Alderman N, Forbes C, Costello A, Coates LM, Dawson DR, et al. The case for the development and use of "ecologically valid" measures of executive function in experimental and clinical neuropsychology. J Int Neuropsychol Soc. 2006;12(2):194–209.
3. Miyake A, Friedman NP, Emerson MJ, Witzki AH, Howerter A, Wager TD. The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: a latent variable analysis. Cogn Psychol. 2000;41(1):49–100.
4. Friedman NP, Miyake A. Unity and diversity of executive functions: individual differences as a window on cognitive structure. Cortex. 2017;86:186–204.
5. East-Richard C, R-Mercier A, Nadeau D, Cellard C. Transdiagnostic neurocognitive deficits in psychiatry: a review of meta-analyses. Can Psychol. 2020;61(3):190–214.
6. Roth RM, Gioia GA. Behavior rating inventory of executive function-adult version. Lutz: Psychological Assessment Resources; 2005.
7. Bulzacka E, Vilain J, Schurhoff F, Meary A, Leboyer M, Szoke A. A self administered executive functions ecological questionnaire (the behavior rating inventory of executive function - adult version) shows impaired scores in a sample of patients with schizophrenia. Ment Illn. 2013;5(1):e4.
8. Catalan A, Salazar de Pablo G, Aymerich C, Damiani S, Sordi V, Radua J, et al. Neurocognitive functioning in individuals at clinical high risk for psychosis: a systematic review and meta-analysis. JAMA Psychiatry. 2021;78(8):859–67.
9. Miller T, McGlashan T, Woods S, Stein K, Driesen N, Corcoran C, et al. Symptom assessment in schizophrenic prodromal states. Psychiatr Q. 1999;70(4):273–87.
10. Yung AR, Phillips LJ, McGorry PD, McFarlane CA, Francey S, Harrigan S, et al. Prediction of psychosis: a step towards indicated prevention of schizophrenia. Br J Psychiatry Suppl. 1998;172(33):14–20.
11. Barlati S, Deste G, De Peri L, Ariu C, Vita A. Cognitive remediation in schizophrenia: current status and future perspectives. Schizophr Res Treatment. 2013;2013:156084.
12. Carrión RE, McLaughlin D, Auther AM, Olsen R, Correll CU, Cornblatt BA. The impact of psychosis on the course of cognition: a prospective, nested case-control study in individuals at clinical high-risk for psychosis. Psychol Med. 2015;45(15):3341–54.
13. Oliver D, Reilly TJ, Baccaredda Boy O, Petros N, Davies C, Borgwardt S, et al. What causes the onset of psychosis in individuals at clinical high risk? A meta-analysis of risk and protective factors. Schizophr Bull. 2020;46(1):110–20.
14. Bechdolf A, Wagner M, Ruhrmann S, Harrigan S, Putzfeld V, Pukrop R, et al. Preventing progression to first-episode psychosis in early initial prodromal states. Br J Psychiatry. 2012;200(1):22–9.
15. Glenthøj LB, Hjorthøj C, Kristensen TD, Davidson CA, Nordentoft M. The effect of cognitive remediation in individuals at ultra-high risk for psychosis: a systematic review. NPJ Schizophr. 2017;3:20.
16. Cowman M, Holleran L, Lonergan E, O'Connor K, Birchwood M, Donohoe G. Cognitive predictors of social and occupational functioning in early psychosis: a systematic review and meta-analysis of cross-sectional and longitudinal data. Schizophr Bull. 2021;47(5):1243–53.
17. McGurk SR, Mueser KT. Cognitive and clinical predictors of work outcomes in clients with schizophrenia receiving supported employment services: 4-year follow-up. Adm Policy Ment Health Ment Health Serv Res. 2006;33(5):598–606.
18. Squarcina L, Kambeitz-Ilankovic L, Bonivento C, Prunas C, Oldani L, Wenzel J, et al. Relationships between global functioning and

neuropsychological predictors in subjects at high risk of psychosis or with a recent onset of depression. World J Biol Psychiatry. 2022:1–9. Online ahead of print.
19. Fujii DE, Wylie AM, Nathan JH. Neurocognition and long-term prediction of quality of life in outpatients with severe and persistent mental illness. Schizophr Res. 2004;69(1):67–73.
20. Eslami A, Jahshan C, Cadenhead KS. Disorganized symptoms and executive functioning predict impaired social functioning in subjects at risk for psychosis. J Neuropsychiatry Clin Neurosci. 2011;23(4):457–60.
21. Van Aken B, Wierdsma AI, Voskes Y, Pijnenborg G, Weeghel J, Mulder C. The association between executive functioning and personal recovery in people with psychotic disorders. Schizophr Bull Open. 2022;3(1):sgac023.
22. Levine B, Robertson IH, Clare L, Carter G, Hong J, Wilson BA, et al. Rehabilitation of executive functioning: an experimental-clinical validation of goal management training. J Int Neuropsychol Soc. 2000;6(3):299.
23. Robertson IH. Goal management training: a clinical manual. Cambridge: PsyConsult; 1996.
24. Stamenova V, Levine B. Effectiveness of goal management training® in improving executive functions: a meta-analysis. Neuropsychol Rehabil. 2018;29(10):1–31.
25. Capobianco L, Wells A. Letter to the editor: metacognitive therapy or metacognitive training: what's in a name? J Behav Ther Exp Psychiatry. 2018;59:161.
26. Cicerone KD, Goldin Y, Ganci K, Rosenbaum A, Wethe JV, Langenbahn DM, et al. Evidence-based cognitive rehabilitation: systematic review of the literature from 2009 through 2014. Arch Phys Med Rehabil. 2019;100(8):1515–33.
27. Levine B, Schweizer TA, O'Connor C, Turner G, Gillingham S, Stuss DT, et al. Rehabilitation of executive functioning in patients with frontal lobe brain damage with goal management training. Front Hum Neurosci. 2011;5:9.
28. McGurk SR, Mueser KT, Pascaris A. Cognitive training and supported employment for persons with severe mental illness: one-year results from a randomized controlled trial. Schizophr Bull. 2005;31(4):898–909.
29. Twamley EW, Vella L, Burton CZ, Heaton RK, Jeste DV. Compensatory cognitive training for psychosis: effects in a randomized controlled trial. J Clin Psychiatry. 2012;73(9):1212–9.
30. Vauth R, Corrigan PW, Clauss M, Dietl M, Dreher-Rudolph M, Stieglitz RD, et al. Cognitive strategies versus self-management skills as adjunct to vocational rehabilitation. Schizophr Bull. 2005;31(1):55–66.
31. Farreny A, Aguado J, Ochoa S, Huerta-Ramos E, Marsa F, Lopez-Carrilero R, et al. REPYFLEC cognitive remediation group training in schizophrenia looking for an integrative approach. Schizophr Res. 2012;142(1–3):137–44.
32. Reeder C, Huddy V, Cella M, Taylor R, Greenwood K, Landau S, et al. A new generation computerised metacognitive cognitive remediation programme for schizophrenia (CIRCuiTS): A randomised controlled trial. Psychol Med. 2017;47(15):2720–30.
33. Allott K, van-der-El K, Bryce S, Parrish EM, McGurk SR, Hetrick S, et al. Compensatory interventions for cognitive impairments in psychosis: a systematic review and meta-analysis. Schizophr Bull. 2020;46(4):869–83.
34. Connor LT, Maeir A. Putting executive performance in a theoretical context. OTJR (Thorofare N J). 2011;31(1):3–7.
35. Vizzotto A, Celestino D, Buchain P, Oliveira A, Oliveira G, Di Sarno E, et al. Occupational goal intervention method for the management of executive dysfunction in people with treatment-resistant schizophrenia: a randomized controlled trial. Am J Occup Ther. 2021;75(3).
36. Levaux MN, Laroi F, Malmedier M, Offerlin-Meyer I, Danion JM, Van Der Linden M. Rehabilitation of executive functions in a real-life setting: goal management training applied to a person with schizophrenia. Case Rep Psychiatry. 2012;2012:1–15.
37. Øie MB. Goal management training for schizophrenia spectrum disorders: effects on self-esteem, self-efficacy and quality of life [Master Thesis]. Oslo: University of Oslo; 2021.
38. Conners KC. Conners continuous performance test. 3rd ed. Toronto: Multi-Health Systems Inc.; 2014.
39. Stubberud J, Langenbahn D, Levine B, Stanghelle J, Schanke A-K. Goal management training of executive functions in patients with spina bifida: a randomized controlled trial. J Int Neuropsychol Soc. 2013;19(6):672–85.
40. McGurk SR, Meltzer HY. The role of cognition in vocational functioning in schizophrenia. Schizophr Res. 2000;45(3):175–84.
41. Bora E, Lin A, Wood SJ, Yung AR, McGorry PD, Pantelis C. Cognitive deficits in youth with familial and clinical high risk to psychosis: a systematic review and meta-analysis. Acta Psychiatr Scand. 2014;130(1):1–15.
42. Penadés R, Catalán R, Puig O, Masana G, Pujol N, Navarro V, et al. Executive function needs to be targeted to improve social functioning with cognitive remediation therapy (CRT) in schizophrenia. Psychiatry Res. 2009;177(1):41–5.
43. Vita A, Barlati S, Ceraso A, Nibbio G, Ariu C, Deste G, et al. Effectiveness, core elements, and moderators of response of cognitive remediation for schizophrenia: a systematic review and meta-analysis of randomized clinical trials. JAMA Psychiatry. 2021;78(8):848–58.
44. Cella M, Preti A, Edwards C, Dow T, Wykes T. Cognitive remediation for negative symptoms of schizophrenia: a network meta-analysis. Clin Psychol Rev. 2017;52:43–51.
45. Pijnenborg GHM, Van Beilen M, Arends J, Holthausen EAE, Withaar FK. Disturbed cognitive functioning and clinical symptoms: two independent problem areas in schizophrenia. Acta Neuropsychiatr. 2003;15(5):280–3.
46. Dibben CR, Rice C, Laws K, McKenna PJ. Is executive impairment associated with schizophrenic syndromes? A meta-analysis. Psychol Med. 2009;39(3):381–92.
47. American Psychiatric Association. Diagnostic and statistical manual of mental disorders: DSM-IV-TR. 4th ed., text revision. ed. Washington, DC: American Psychiatric Association; 2000.
48. Løvstad M, Sigurdardottir S, Andersson S, Grane VA, Moberget T, Stubberud J, et al. Behavior rating inventory of executive function adult version in patients with neurological and neuropsychiatric conditions: symptom levels and relationship to emotional distress. J Int Neuropsychol Soc. 2016;22(6):682–94.
49. Bechara A, Damasio AR, Damasio H, Anderson SW. Insensitivity to future consequences following damage to human prefrontal cortex. Cognition. 1994;50(1–3):7–15.
50. Wechsler D. Wechsler adult intelligence scale - fourth edition (WAIS-IV). San Antonio: Pearson Assessment; 2008.
51. Ashford S, Turner-Stokes L. Goal attainment for spasticity management using botulinum toxin. Physiother Res Int. 2006;11(1):24–34.
52. Broadbent DE, Cooper PF, FitzGerald P, Parkes KR. The cognitive failures questionnaire (CFQ) and its correlates. Br J Clin Psychol. 1982;21(1):1–16.
53. First MB, Spitzer RL, Gibbon M, Williams JB. Structured clinical interview for DSM-IV-TR Axis I disorders: patient edition. New York: Biometrics Research Department, Columbia University New York; 2005.
54. Kay SR, Fiszbein A, Opler LA. The positive and negative syndrome scale (PANSS) for schizophrenia. Schizophr Bull. 1987;13(2):261–76.
55. Wallwork RS, Fortgang R, Hashimoto R, Weinberger DR, Dickinson D. Searching for a consensus five-factor model of the positive and negative syndrome scale for schizophrenia. Schizophr Res. 2012;137(1–3):246–50.
56. Schulz KF, Altman DG, Moher D. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. BMJ. 2010;340:c332.
57. Norwegian Health Authority. National guideline for assessment, treatment and follow-up care of persons with psychotic illness. Oslo: Norwegian Health Authority; 2013.
58. Fish J, Evans JJ, Nimmo M, Martin E, Kersel D, Bateman A, et al. Rehabilitation of executive dysfunction following brain injury: "content-free" cueing improves everyday prospective memory performance. Neuropsychologia. 2007;45(6):1318–30.
59. Manly T, Hawkins K, Evans J, Woldt K, Robertson IH. Rehabilitation of executive function: facilitation of effective goal management on complex tasks using periodic auditory alerts. Neuropsychologia. 2002;40(3):271.
60. Kabat-Zinn J. Full catastrophe living: using the wisdom of your body and mind to face stress, pain and illness. 15th anniversary ed. New York: Delta Trade; 1990.
61. Krasny-Pacini A, Evans J, Chevignard M. Goal management training for rehabilitation of executive functions: a systematic review of effectiveness in patients with acquired brain injury. Ann Phys Rehabil Med. 2014;57:67.

62. Derogatis LR, Lipman RS, Rickels K, Uhlenhuth EH, Covi L. The Hopkins symptom checklist (HSCL): a self-report symptom inventory. Behav Sci. 1974;19(1):1–15.
63. Wechsler D. Wechsler abbreviated scale of intelligence (WASI). San Antonio: NCS Pearson, Inc; 1999.
64. Delis DC, Kaplan E, Kramer JH. Delis–Kaplan executive function system. Bloomington: NCS Pearson, Inc.; 2001.
65. Patterson TL, Goldman S, McKibbin CL, Hughs T, Jeste DV. UCSD performance-based skills assessment: development of a new measure of everyday functioning for severely mentally ill adults. Schizophr Bull. 2001;27(2):235–45.
66. Patterson TL, Mausbach B. UCSD performance-based skills assessement-brief (UPSA-B). San Diego: University of California; 2006.
67. Birchwood M, Smith J, Cochrane R, Wetton S, Copestake S. The social functioning scale. The development and validation of a new scale of social adjustment for use in family intervention programmes with schizophrenic patients. Br J Psychiatry. 1990;157(12):853–9.
68. Neill E, Rossell SL. Executive functioning in schizophrenia: the result of impairments in lower order cognitive skills? Schizophr Res. 2013;150(1):76–80.
69. Savla GN, Twamley EW, Thompson WK, Delis DC, Jeste DV, Palmer BW. Evaluation of specific executive functioning skills and the processes underlying executive control in schizophrenia. J Int Neuropsychol Soc. 2010;17(1):14–23.
70. Kay SR, Fiszbein A, Lindenmayer J-P, Opler LA. Positive and negative syndromes in schizophrenia as a function of chronicity. Acta Psychiatr Scand. 1986;74(5):507–18.
71. Strand BH, Dalgard OS, Tambs K, Rognerud M. Measuring the mental health status of the Norwegian population: a comparison of the instruments SCL-25, SCL-10, SCL-5 and MHI-5 (SF-36). Nord J Psychiatry. 2003;57(2):113–8.
72. Hellvin T, Sundet K, Vaskinn A, Simonsen C, Ueland T, Andreassen OA, et al. Validation of the Norwegian version of the social functioning scale (SFS) for schizophrenia and bipolar disorder. Scand J Psychol. 2010;51(6):525–33.
73. Horan WP, Harvey P-O, Kern RS, Green MF. Neurocognition, social cognition and functional outcome in schizophrenia. In: Gaebel W, editor. Schizophrenia: current science and clinical practice. Chichester: Wiley-Blackwell; 2011. p. 67–107.
74. Pedersen G, Hagtvet KA, Karterud S. Generalizability studies of the global assessment of functioning-split version. Compr Psychiatry. 2007;48(1):88–94.
75. Gupta SK. Intention-to-treat concept: a review. Perspect Clin Res. 2011;2(3):109–12.
76. Jacobson NS, Truax P. Clinical significance: a statistical approach to defining meaningful change in psychotherapy research. J Consult Clin Psychol. 1991;59(1):12–9.
77. Moher D, Hopewell S, Schulz KF, Montori V, Gotzsche PC, Devereaux PJ, et al. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. J Clin Epidemiol. 2010;63(8):e1–37.
78. Melle I, Larsen TK, Haahr U, Friis S, Johannesen JO, Opjordsmoen S, et al. Prevention of negative symptom psychopathologies in first-episode schizophrenia: two-year effects of reducing the duration of untreated psychosis. Arch Gen Psychiatry. 2008;65(6):634–40.
79. Aleman A, Lincoln TM, Bruggeman R, Melle I, Arends J, Arango C, et al. Treatment of negative symptoms: where do we stand, and where do we go? Schizophr Res. 2017;186:55–62.
80. McCaffrey RJ, Westervelt HJ. Issues associated with repeated neuropsychological assessments. Neuropsychol Rev. 1995;5(3):203–21.
81. Kidd SA, Herman Y, Virdee G, Bowie CR, Velligan D, Plagiannakos C, et al. A comparison of compensatory and restorative cognitive interventions in early psychosis. Schizophr Res Cogn. 2020;19:100157.
82. Kaneko Y, Keshavan M. Cognitive remediation in schizophrenia. Clin Psychopharmacol Neurosci. 2012;10(3):125–35.
83. Chung CS, Pollock A, Campbell T, Durward BR, Hagen S. Cognitive rehabilitation for executive dysfunction in adults with stroke or other adult non-progressive acquired brain damage. Cochrane Database Syst Rev. 2013;(4):CD008391.
84. Fett AJ, Reichenberg A, Velthorst E. Lifespan evolution of neurocognitive impairment in schizophrenia - a narrative review. Schizophr Res Cogn. 2022;28:100237.
85. Toplak ME, West RF, Stanovich KE. Practitioner review: do performance-based measures and ratings of executive function assess the same construct? J Child Psychol Psychiatry. 2013;54(2):131–43.
86. Haugen I, Stubberud J, Ueland T, Haug E, Øie MG. Executive dysfunction in schizophrenia: predictors of the discrepancy between subjective and objective measures. Schizophr Res Cogn. 2021;26:100201.
87. Sbordone RJ. The hazards of strict reliance on neuropsychological tests. Appl Neuropsychol Adult. 2014;21(2):98–107.
88. Shwartz SK, Roper BL, Arentsen TJ, Crouse EM, Adler MC. The behavior rating inventory of executive function®-adult version is related to emotional distress, not executive dysfunction, in a veteran sample. Arch Clin Neuropsychol. 2020;35(6):701–16.
89. Medalia A, Thysen J, Freilich B. Do people with schizophrenia who have objective cognitive impairment identify cognitive deficits on a self report measure? Schizophr Res. 2008;105(1–3):156–64.
90. Potvin S, Pelletier J, Stip E. Neurocognitive insight in schizophrenia: a meta-analysis. Sante Ment Que. 2014;39(2):183.
91. Raudeberg R, Karr JE, Iverson GL, Hammar Å. Examining the repeatable battery for the assessment of neuropsychological status validity indices in people with schizophrenia spectrum disorders. Clin Neuropsychol. 2021:1–18. Online ahead of print.
92. Glenthøj LB, Mariegaard L, Kristensen TD, Wenneberg C, Medalia A, Nordentoft M. Self-perceived cognitive impairments in psychosis ultra-high risk individuals: associations with objective cognitive deficits and functioning. NPJ Schizophr. 2020;6(1):31.
93. Baars MAE, Nije Bijvank M, Tonnaer GH, Jolles J. Self-report measures of executive functioning are a determinant of academic performance in first-year students at a university of applied sciences. Front Psychol. 2015;6:1131.
94. Piche J, Kaylegian J, Smith D, Hunter SJ. The relationship between self-reported executive functioning and risk-taking behavior in urban homeless youth. Behav Sci (Basel). 2018;8(1):6.
95. Paudel S, Coman D, Freudenreich O. Subjective experience of cognitive difficulties as an important attribute of quality of life among individuals with schizophrenia spectrum disorders. Schizophr Res. 2020;215:476–8.
96. Lysaker PH, Glynn SM, Wilkniss SM, Silverstein SM. Psychotherapy and recovery from schizophrenia: a review of potential applications and need for future study. Psychol Serv. 2010;7(2):75–91.
97. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. Psychol Rev. 1977;84(2):191–215.
98. Heinrichs RW, Statucka M, Goldberg J, McDermid Vaz S. The University of California Performance Skills Assessment (UPSA) in schizophrenia. Schizophr Res. 2006;88(1–3):135–41.
99. Vesterager L, Christensen TO, Olsen BB, Krarup G, Melau M, Forchhammer HB, et al. Cognitive and clinical predictors of functional capacity in patients with first episode schizophrenia. Schizophr Res. 2012;141(2–3):251–6.
100. Ostergaard Christensen T, Vesterager L, Krarup G, Olsen BB, Melau M, Gluud C, et al. Cognitive remediation combined with an early intervention service in first episode psychosis. Acta Psychiatr Scand. 2014;130(4):300–10.
101. Wykes T, Joyce E, Velikonja T, Watson A, Aarons G, Birchwood M, et al. The CIRCuiTS study (Implementation of cognitive remediation in early intervention services): protocol for a randomised controlled trial. Trials. 2018;19(1):183.
102. Wykes T, Huddy V, Cellard C, McGurk SR, Czobor P. A meta-analysis of cognitive remediation for schizophrenia: methodology and effect sizes. Am J Psychiatry. 2011;168(5):472–85.
103. McGurk SR, Twamley EW, Sitzer DI, McHugo GJ, Mueser KT. A meta-analysis of cognitive remediation in schizophrenia. Am J Psychiatry. 2007;164(12):1791–802.
104. Medalia A, Saperstein AM. Does cognitive remediation for schizophrenia improve functional outcomes? Curr Opin Psychiatry. 2013;26(2):151–7.
105. McGurk SR, Xie H, Bond GR, Mueser KT. Impact of cognitive remediation on the prediction of employment outcomes in severe mental illness. Schizophr Res. 2022;241:149–55.

106. Kharawala S, Hastedt C, Podhorna J, Shukla H, Kappelhoff B, Harvey PD. The relationship between cognition and functioning in schizophrenia: a semi-systematic review. Schizophr Res Cogn. 2022;27:100217.
107. Zelazo PD. Executive function and psychopathology: a neurodevelopmental perspective. Annu Rev Clin Psychol. 2020;16:431–54.
108. Romer AL, Pizzagalli DA. Is executive dysfunction a risk marker or consequence of psychopathology? A test of executive function as a prospective predictor and outcome of general psychopathology in the adolescent brain cognitive development study(R). Dev Cogn Neurosci. 2021;51:100994.
109. Shakoor S, Zavos HM, Haworth CM, McGuire P, Cardno AG, Freeman D, et al. Association between stressful life events and psychotic experiences in adolescence: evidence for gene-environment correlations. Br J Psychiatry. 2016;208(6):532–8.
110. Freedman D, Brown AS. The developmental course of executive functioning in schizophrenia. Int J Dev Neurosci. 2011;29(3):237–43.
111. Cornblatt BA, Lencz T, Smith CW, Correll CU, Auther AM, Nakayama E. The schizophrenia prodrome revisited: a neurodevelopmental perspective. Schizophr Bull. 2003;29(4):633–51.
112. Hakansson U, Watten RG, Soderstrom K, Oie MG. The association between executive functioning and parental stress and psychological distress is mediated by parental reflective functioning in mothers with substance use disorder. Stress Health. 2019;35(4):407–20.
113. Nuechterlein KH, Dawson ME. A heuristic vulnerability/stress model of schizophrenic episodes. Schizophr Bull. 1984;10(2):300–12.
114. Aas M, Dazzan P, Mondelli V, Melle I, Murray RM, Pariante CM. A systematic review of cognitive function in first-episode psychosis, including a discussion on childhood trauma, stress, and inflammation. Front Psychiatry. 2014;4:182.
115. Tornas S, Lovstad M, Solbakk AK, Schanke AK, Stubberud J. Use it or lose it? A 5-year follow-up study of goal management training in patients with acquired brain injury. J Int Neuropsychol Soc. 2019;25(10):1082–7.
116. Bellack AS, Green MF, Cook JA, Fenton W, Harvey PD, Heaton RK, et al. Assessment of community functioning in people with schizophrenia and other severe mental illnesses: a white paper based on an NIMH-sponsored workshop. Schizophr Bull. 2007;33(3):805–22.
117. McCambridge J, de Bruin M, Witton J. The effects of demand characteristics on research participant behaviours in non-laboratory settings: a systematic review. PLoS One. 2012;7(6):e39116.
118. Ventura J, Hellemann GS, Thames AD, Koellner V, Nuechterlein KH. Symptoms as mediators of the relationship between neurocognition and functional outcome in schizophrenia: a meta-analysis. Schizophr Res. 2009;113(2):189–99.
119. Twisk J, Bosman L, Hoekstra T, Rijnhart J, Welten M, Heymans M. Different ways to estimate treatment effects in randomised controlled trials. Contemp Clin Trials Commun. 2018;10:80–5.

Publisher's Note

Paper III

Moderators of Metacognitive Strategy Training for Executive Functioning in Early Schizophrenia and Psychosis Risk

III

MODERATORS OF METACOGNITIVE STRATEGY TRAINING FOR EXECUTIVE FUNCTIONING IN EARLY SCHIZOPHRENIA AND PSYCHOSIS RISK

Ingvild Haugen[a,b], Torill Ueland[b,c], Jan Stubberud [b,d] , Cathrine Brunborg[e], Til Wykes[f], Merete Glenne Øie[a,b] & Elisabeth Haug[a]

[a] Research Division, Innlandet Hospital Trust, P.O. Box 104, 2381 Brumunddal, Norway

[b] Department of Psychology, University of Oslo, P.O. Box 1094, 0317 Oslo, Norway

[c] Norwegian Centre for Mental Disorders Research, Oslo University Hospital, Postboks 4956 Nydalen, 0424 Oslo, Norway

[d] Department of Research, Lovisenberg Diaconal Hospital, P.O. Box 4970 Nydalen, 0440 Oslo, Norway

[e] Oslo Centre for Biostatistics and Epidemiology, Research Support Services, Oslo University Hospital, P.O. Box 4950 Nydalen, 0424 Oslo, Norway.

[f] Institute of Psychiatry, Psychology and Neuroscience, King's College London, De Crespigny Park, London SE5 8AF, The U.K.

Abstract

Goal Management Training (GMT) improved self-reported executive functioning in a recent randomized controlled trial in early intervention for psychosis participants. Little is known about the mechanism for this benefit, so this study investigates objectively measured executive function, and the difference between subjective and objective executive function as potential moderators of efficacy of GMT.

Baseline scores from 81 participants (GMT n = 39 vs Treatment-as-usual; TAU n = 42) were analyzed in a linear mixed model analysis for repeated measures as predictors of improvement on the self-reported Behavior Rating Inventory of Executive Function – Adult version (BRIEF-A) immediately and 30 weeks after GMT. Potential moderators were scores from objective measures of executive functioning and discrepancy between subjective and objective measures. Discrepancy was assessed by comparing four clusters of participants with differing patterns of scores.

The effect of GMT remained significant regardless of initial objective executive functioning at baseline. Those with higher subjective complaints at baseline in two clusters with (*i*) *both objective and subjective executive dysfunction,* and (*ii*) *mostly subjective executive dysfunction* experienced greater change after treatment.

Poor performance on neuropsychological tasks is not an obstacle to making use of GMT, but further knowledge is needed about the benefits of strategy training for individuals with a combination of poor performance with few subjective complaints.

Introduction

Executive functions are vital to everyday functioning in people with schizophrenia and psychosis risk (Kim et al., 2019; McGurk & Mueser, 2006; Santesteban-Echarri et al., 2017). Executive dysfunction is already noticeable prior to the onset of psychotic illness (Catalan et al., 2021). Goal Management Training (GMT; Levine et al., 2000), a meta-cognitive strategy training, is effective in improving self-reported executive functioning in young people with early schizophrenia spectrum disorders or psychosis risk syndromes (Haugen et al., in press). The improvement was a clinically reliable change for most participants and remained significant when clinical symptoms were controlled for. GMT was not superior to treatment as usual in improving objective executive function, except for attentional control. Nonetheless, improvement of subjective executive function has clinical importance as it is associated with better physical and psychological well-being and greater personal recovery from psychotic illness (Paudel et al., 2020; Van Aken et al., 2022). The present study explores potential predictors of change in subjective executive functioning following GMT

The efficacy of cognitive remediation in schizophrenia is well documented (Allott et al., 2020b; Lejeune et al., 2021; Vita et al., 2021), but the identification of reliably replicated moderators is challenging due to heterogeneity across studies in sample characteristics and type of intervention (Seccomandi et al., 2020). There are currently few studies on the predictors of treatment outcome in therapies aimed at young people or that specify executive functioning as the key outcome. Since the recent trial was the first study of stand-alone GMT in early schizophrenia, the mechanisms of change are important to identify in order to develop more targeted and personalized rehabilitation (Bowie et al., 2020; Cella et al., 2015; Wykes & Spaulding, 2011).

Although people with more severe impairments seem to gain the most from cognitive remediation in schizophrenia (DeTore et al., 2019; Vita et al., 2021), we chose to investigate baseline objective executive function as severe impairment could potentially prevent participants from learning and using the GMT-strategies (Collins et al., 2014; Emmanouel et al., 2018).

Another potential moderator of treatment effect of GMT is the discrepancy between subjectively and objectively assessed executive function. A substantial portion of people with schizophrenia report fewer subjective cognitive complaints relative to their objectively measured difficulties (Harvey & Pinkham, 2015; Haugen et al., 2021; Potvin et al., 2014). Individuals with psychosis risk syndromes, on the other hand, are more likely to report greater subjective complaints compared to objective test performance (Glenthøj et al., 2020). Discrepancy in either direction could be an obstacle for GMT. Greater subjective complaints could prevent making use of the strategies taught, if the participants do not recognize their potential ability due to negative thought patterns (Allott et al., 2020a; Beck et al., 2018; Cella et al., 2014). Few subjective complaints combined with poorer test results could make it difficult to recognize situations where the GMT-strategies might be effective. This pattern of scores may reflect inaccurate self-assessment or lack of insight into cognitive difficulties (Harvey & Pinkham, 2015; Olsson et al., 2019). Subjective cognition has rarely been investigated as a moderator of cognitive remediation in schizophrenia and results are contradictory (Seccomandi et al., 2020). One study found that more subjective cognitive complaints were associated with larger benefits in objective cognition (Twamley et al., 2011). In two other remediation trials subjective complaints was not a prerequisite for gains in objective cognition, but was associated with better attendance (Burton & Twamley, 2015; Saperstein et al., 2020). A study in psychosis risk found that subjective cognition did not moderate outcome (Glenthøj et al., 2020).

In this study we will test: first that poor baseline objective executive function will

reduce GMT benefits, and second that a larger discrepancy between subjective and objective measures of executive function in either direction at baseline will reduce benefit from GMT.

Methods

Design and procedure

This is a moderation analysis using data from an RCT with measures collected at 0, 5 weeks (post-intervention) and 30 weeks (follow-up). Participants were independently randomized to GMT (n = 39) or Treatment-As-Usual (TAU; n = 42). See Haugen et al. (in press) for details on assessments and therapy. Assessments were collected by a clinical psychologist or psychiatric nurse under supervision from specialists in neuropsychology and psychiatry. All participants gave written informed consent (Trial registration: clinicaltrials.gov, NCT03048695, Ethical Approval: Regional Committee for Medical and Health Research Ethics, 2015/2118, Norway).

Participants

Participants (n = 81, approximately 60% males and 40% females with a mean age of 25 years), were recruited from an early-intervention service at Innlandet Hospital in Norway. Table 1 shows sample characteristics. The inclusion criteria were: age 16 to 67 years, symptoms of broad schizophrenia spectrum disorder according to the criteria in the Diagnostic and Statistical Manual of Mental Disorders, DSM-IV-TR (American Psychiatric Association, 2000) or one of three psychosis risk syndromes (attenuated positive symptoms, brief intermittent psychotic symptoms, genetic risk combined with deteriorated functioning; Miller et al., 1999; Yung et al., 1998) and subjective complaints of executive dysfunction expressed as a total score above T55 on the Behavior Rating Inventory of Executive Function – Adult version, BRIEF-A (Roth & Gioia, 2005) – a cut off considered to be clinically relevant in the Norwegian cultural context (Løvstad et al., 2016). Participants were excluded if they had comorbid neurological conditions, ongoing substance abuse, intellectual impairment (estimated IQ < 70) or psychosis treatment for longer than five years.

Interventions

Goal Management Training (GMT) (Levine et al., 2000; Robertson, 1996) is a manualized meta-cognitive strategy training aimed at improving executive functioning. Eighteen hours (nine modules of approximately two hours duration) of GMT was administered by a clinical psychologist to groups of three to eight participants twice a week. The main ingredient of training is verbalization techniques (STOP – FOCUS on the present – STATE your goal – SPLIT goal into subtasks – CHECK progress) for goal achievement in everyday situations. Sessions included group discussions and practical exercises in present mindedness. Home assignments included rehearsing strategies for half an hour each day between sessions. GMT was provided in addition to usual care. Treatment-as-usual (TAU) group continued in their usual care according to national Norwegian guidelines, which often consist of a combination of psychotherapy, medication and family interventions (Norwegian Health Authority, 2013).

Table 1. *Demographical and clinical characteristics (n = 81)*

Sample characteristics	*Frequency*	*Mean*	*SD*	*SE*
Age		24.90	6.35	0.71
Gender				
Female	32 (39.50%)			
Male	49 (60.50%)			
Education in years		12.90	1.83	0.20
Diagnosis (DSM-IV):				
Schizophrenia spectrum disorder	*65 (80.20%)*			
Schizophrenia	29 (35.80%)			
Schizoaffective disorder	14 (17.30%)			
Schizophreniform disorder	6 (7.40%)			
Psychotic disorder not otherwise specified	15 (18.50%)			
Delusional disorder	1 (1.20%)			
Psychosis risk syndrome	*16 (19.80%)*			
Positive attenuated symptoms	9 (11.10%)			
Brief limited intermittent symptoms	5 (6.20%)			
Genetic risk with deteriorated function	2 (2.50%)			
Duration of untreated psychosis (weeks)		195.32	237.75	26.42
Hospitalizations		2.75	4.68	0.52
Months in hospital		4.86	7.61	0.85
Drug therapy	60 (74.10%)			
Antipsychotics	50 (61.70%)			

Measures

The outcome variable in this moderation analysis is ***subjective executive functioning -*** reported as total raw score on ***Behavior Rating Inventory of Executive Function – Adult version, BRIEF-A*** (Roth & Gioia, 2005). This is a 75-item questionnaire with nine subscales covering inhibition, shifting, emotional control, self-monitoring, initiating, working memory, planning/organizing, task-monitoring and organization of materials. It is reliable and valid in healthy and clinical populations, including people with schizophrenia (Bulzacka et al., 2013; Roth & Gioia, 2005; Van Aken et al., 2022).

Three normed *T*-scores for the Inhibit, Shift and Working Memory subscales were chosen as measures of subjective executive function that theoretically overlap with the objective measures (Friedman & Miyake, 2017; Roth & Gioia, 2005) and used in the calculation of the discrepancy score (see below).

Objective executive functioning

The first potential moderator is the mean z-score for baseline ***objective executive functioning,*** created from normed scores on several neuropsychological tests of inhibition, shifting and working memory according to contemporary theories of executive function (Friedman & Miyake, 2017). A central criticism of previous studies has been the use of a single test to draw conclusions about global executive functioning. The mean score across tests is considered more robust against the influence of measurement error (Hwang et al., 2019).

The tests used were

1. Color Word Interference Test

The age normed scaled score for time spent on Color-Word Interference Test condition three (CW3) from Delis-Kaplan Executive Function System (D-KEFS) (Delis et al., 2001), was used as a measure of inhibition and condition four (CW4) was used as a measure of shifting.

2. Trail Making Test

The aged normed scaled score for time spent on condition four, Letter Number Switching, from the Trail Making Test (TMT4) in D-KEFS (Delis et al., 2001) was used as a measure of shifting.

3. Conners Continuous Performance Test

The age normed *T*-score for commission errors from Conners Continuous Performance Test 3rd edition (CPT3) (Conners, 2014) was used as a measure of inhibition.

4. Working memory: Digit Span and Letter-Number Sequencing

Working memory was assessed by averaging the age normed scaled scores from the Digit Span and Letter-Number Sequencing (LNS) subtests in the Wechsler Adult Intelligence Scale – 4th edition, WAIS-IV (Wechsler, 2008).

All measures have shown adequate test-retest reliability in normative samples (Conners, 2014; Delis et al., 2001; Wechsler, 2008).

Data analysis

Variables

The primary outcome in the analyses was the total raw score of the BRIEF-A (Roth & Gioia, 2005).

Two potential moderators were tested: ***Baseline objective executive functioning score*** (described above), and ***Discrepancy between baseline subjective and objective executive functioning***. This second moderator was created by dividing participants into clusters based on the normed scores from three subscales of BRIEF, the Inhibit, Shift and Working Memory subscales, and normed scores from six neuropsychological tasks: CW3, CW4, TMT4, CPT3 commission errors, Digit Span and LNS. A two-step cluster analysis specified four clusters based on Schwartz's Bayesian criterion. The cluster solution was judged to be fair with adequate cohesion and separation. Eight participants were not assigned clusters due to missing scores.

The participants in Cluster A had poor scores on objective executive function but an average level of subjective complaints. The cluster was labelled ***Mostly objective executive dysfunction***. Cluster B had high levels of subjective complaints but average performance on objective tests and was labelled ***Mostly subjective executive dysfunction*** Cluster C had high levels of subjective complaints and poor performance on objective measures and was labelled ***Both objective and subjective executive dysfunction***. The participants in Cluster D had

average performance on objective measures combined with relatively lower levels of cognitive complaints and was labelled ***Neither objective, nor subjective executive dysfunction***. Table 2 shows the scores of the four clusters on subjective and objective measures.

Moderator analysis

Linear mixed effect models for repeated measures (baseline, 5 weeks, and 30 weeks) were fitted, with subjective cognitive complaints as the outcome (total BRIEF-A score). Random intercept and first-order autoregressive covariance matrix was used. Moderator variables were entered separately to test their influence independently, resulting in three different models described below. Maximum likelihood estimation was used since the goal was to compare nested models. Better model fit was defined as a significant reduction in minus twice the log likelihood (-2LL) for the nested model, exceeding the critical values in a chi-square distribution, $p. < .05$.

Model 0: The null model without moderators included fixed effects of time and the treatment x time interaction as predictors. The main effect of treatment group was removed from the model to adjust for potential baseline differences (Twisk et al., 2018).

Model 1a: Included objective executive functioning as a main effect and an interaction effect with treatment and time (treatment × time × objective executive function).

Model 1b: The discrepancy between subjective and objective measures of executive functioning was added to Model 0 as a main effect and an interaction effect with treatment and time (treatment × time × discrepancy). Discrepancy clusters were added as categorical variables. ***C: Both objective and subjective executive dysfunction*** was the reference category.

All *p*-values were two-sided and a 5% significance level was used. Statistical analyses were conducted using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA).

Statistical power

According to the principle of intention to treat, all partial data from the 81 participants who entered into the study were analyzed (Gupta, 2011). There was some missing questionnaire data for the outcome variable with completed questionnaires from 74 participants at baseline, 49 post-intervention and 43 at follow-up. All participants responded at least once. All 81 participants had scores for the predictor variable objective executive functioning at baseline and 73 had discrepancy cluster membership. To evaluate the representativeness of the available data, we compared baseline characteristics in those who completed one, two or three questionnaires. We found no statistically significant differences in treatment condition, cluster membership, demography (gender, age and education), clinical characteristics (diagnosis, symptoms, global function and treatment) or cognitive characteristics (estimated IQ, subjective and objective executive function). Missing data was assumed to be missing at random. Thus, imputation of missing outcome values was not performed as the linear mixed effect models provides unbiased estimates under the assumption of missing at random (Krueger & Tian, 2004; Muth et al., 2016). Degrees of freedom are listed for each effect in Table 3. Sample size was calculated for the primary endpoint of the RCT, which was to estimate the efficacy of GMT compared to treatment as usual (Haugen et al., in press). Because of the exploratory nature of this study, no power calculations were performed for the measures in this study.

Table 2. *Scores on subjective and objective executive function in the four clusters*

Clusters	Inhibition *Mean* (*SD*)			Shifting *Mean* (*SD*)			Working Memory *Mean* (*SD*)		
	BRIEF-A Inhibit *T*	CW3 *SS*	CPT-3 *T*	BRIEF-A Shift *T*	CW4 *SS*	TMT4 *SS*	BRIEF-A WM *T*	LNS *SS*	Digit Span *SS*
Cluster A (*n*16): *Mostly objective executive dysfunction*	48.56 (9.04)	6.25 (1.77)	55.25 (10.36)	53.81 (7.71)	6.06 (3.36)	5.06 (3.23)	54.50 (7.40)	8.88 (0.89)	8.80 (2.27)
Cluster B (*n*23): *Mostly subjective executive dysfunction*	62.13 (10.88)	9.36 (2.40)	57.30 (10.81)	72.22 (10.72)	9.95 (2.82)	8.30 (2.86)	77.35 (4.43)	8.64 (2.63)	9.86 (2.82)
Cluster C (*n*13): *Both objective and subjective dysfunction*	67.00 (11.39)	4.15 (3.93)	62.77 (9.88)	64.54 (7.85)	2.69 (2.39)	1.75 (1.54)	72.62 (5.58)	8.55 (1.69)	8.85 (2.73)
Cluster D (*n*21): *Neither objective, nor subjective dysfunction*	56.52 (11.80)	8.20 (3.54)	50.38 (8.73)	58.48 (8.33)	10.00 (2.32)	9.50 (2.40)	64.00 (5.82)	11.91 (3.45)	11.24 (2.36)
Average across clusters (*n*73)	58.41 (11.80)	8.21 (3.54)	55.84 (10.66)	62.86 (11.37)	7.79 (3.94)	6.74 (3.85)	67.66 (10.43)	9.66 (2.89)	9.86 (2.70)

Note: The normative mean of BRIEF-A is *T*50 (*SD* 10). The normative mean for the task measures is scaled score 10 (*SD* 3.

Results

Figure 1 is an illustration of the mean values of BRIEF-A total raw score for each cluster in the GMT-group. In the GMT condition, participants in cluster C experienced the greatest reduction in executive complaints after intervention, followed by participants in cluster B. Participants in cluster D experienced a reduction in subjective complaints immediately after GMT that had increased somewhat again at follow-up. Participants in cluster A experienced little to no change in self-reported executive function in real-world situations.

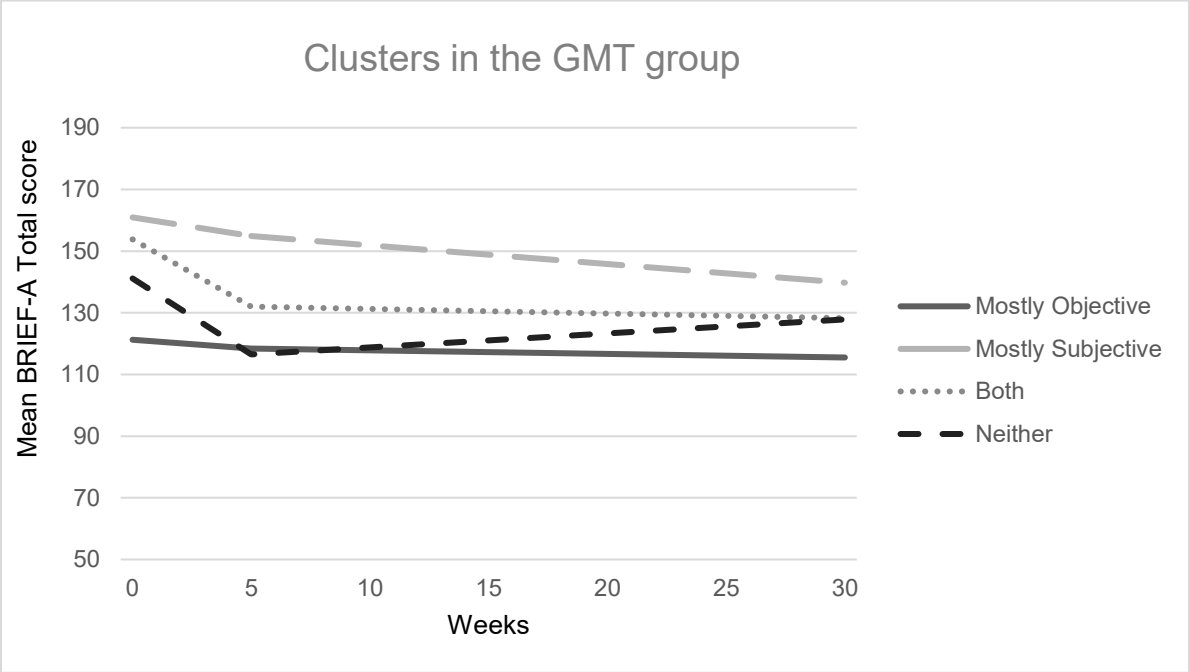


Figure 1: BRIEF-A outcome after intervention in clusters with different discrepancy between subjective and objective executive function

Mean values of BRIEF-A raw score over time in four clusters based on discrepancy between subjective and objective measures at baseline in the treatment group.

Table 3 displays the results of the linear mixed effect models analyses.

Model 1a shows that objective impairment did not moderate the effect of GMT since the interaction effect between treatment x time x objective executive functioning was not significant, *F* 0.65, *p* .526, and the treatment effect of GMT (group x time) remained of similar size as in the previous model, *F* 4.62, *p* .035. Model 1a did not show a significant improvement in statistical fit compared to Model 0.

Model 1b shows that the treatment effect of GMT remained significant when taking discrepancy cluster membership into account, *F* 6.41, *p* .031. There was a significant main effect of discrepancy, *F* 25.64, *p* <.001, but the interaction effect between discrepancy and treatment effect was not significant, *F* 1.37, *p* .241. Model 1b was superior in describing the data with significantly increased model fit compared to Model 0. The cluster with *Mostly Objective Executive Dysfunction* improved significantly less than the cluster with *Both Objective and Subjective Executive Dysfunction*, *p* .036.

Table 3. *Linear mixed model analysis of repeated measures (ITT n=81): Predictors of improved executive functioning following GMT*

	Estimated Coefficients					*Information criteria*			
	b (est)	*b SE*	*95% CI*	*Df*	*Sig.*	*-2LL*	*Sig. of -2LL*	*AIC*	*BIC*
Model 0:						1441.24		1453.24	1471.91
6 parameters									
Intercept	142.63	2.59	137.48, 147.77	100.54	<.001				
Time	-2.67	1.78	-6.23, 0.88	63.05	.137				
GMT x Time interaction	-5.14	2.43	-9.99, -0.28	67.42	**.038**				
Model 1a: Objective Executive Function						1439.95	.616	1457.95	1485.96
8 parameters									
Intercept	142.66	2.59	137.52, 147.79	100.38	<.001				
Time	-7.86	1.80	-11.46, -4.26	53.41	<.001				
Objective Executive Function	-0.59	2.59	-5.73, 4.55	99.50	.820				
GMT x Time interaction	-5.24	2.44	-10.11, -0.37	66.71	**.035**				
GMT x Time x Objective Executive Function	1.64	1.72	-1.80, 5.08	55.71	.343				
Model 1b: Discrepancy						1285.93	**<.001**	1315.93	1361.68
15 parameters									
Intercept	151.60	4.46	142.74, 160.45	103.68	<.001				
Time	-13.18	3.44	-20.06, -6.31	65.61	<.001				
Discrepancy									
A: Mostly Objective Dysfunction (in GMT)	-33.69	5.57	-45.62, -21.77	103.97	.115				
B: Mostly Subjective Dysfunction (in GMT)	8.86	6.01	-2.19, 19.90	101.68	**<.001**				
GMT x Time interaction	-19.13	7.62	-34.32, 3.95	70.72	**.014**				
GMT x Time x Discrepancy									
A: More Objective Dysfunction (in GMT)	13.13	4.30	-6.11, 11.07	62.17	**.036**				
B: More Subjective Dysfunction (in GMT)	2.48	6.11	0.92, 25.33	64.97	.566				

Note: The outcome variable was total raw score from the Behavior Rating Inventory of Executive Function – Adult version (BRIEF-A) (Roth & Gioia, 2005). Higher scores indicate greater executive difficulties in real-world situations. Coefficients for discrepancy clusters are comparisons with scores for the cluster with *Both objective and subjective executive dysfunction* in the GMT-group.

Discussion

We did not find support for our hypothesis that pronounced executive dysfunction measured with objective tasks could interfere with learning in the GMT-groups and prevent participants from making use of the strategies taught (Cicerone et al., 2019; Emmanouel et al., 2018). GMT was equally effective irrespective of performance on tasks of executive function. These results mirror a recent meta-analysis of moderators of cognitive training in schizophrenia that found that even people with severe cognitive dysfunction benefit from cognitive remediation (Vita et al., 2021).

We found partial support for our hypothesis that a larger discrepancy between subjective and objective executive function at baseline in either direction would be an obstacle to successful strategy training with GMT (Allott et al., 2020a; Beck et al., 2018; Harvey & Pinkham, 2015). Treatment effect of GMT remained significant when considering discrepancy, but participants with mostly objective executive dysfunction unaccompanied by pronounced subjective complaints experienced less benefit from GMT compared to participants with both subjective and objective dysfunction. This finding is in contrast to studies where objective cognition was the outcome (Burton & Twamley, 2015; Saperstein et al., 2020). Note, however, that in our study participants in the *Mostly objective executive dysfunction* cluster reported few subjective complaints to start with, so the lack of change could be due to a floor effect. Having mostly subjective complaints without accompanying poor task performance did not serve as an obstacle to benefiting from strategy training with GMT.

Clinical implications

Clinicians may recommend GMT to people with schizophrenia spectrum disorders or psychosis risk syndromes with self-reported executive dysfunction. Poor performance on neuropsychological tests is not an obstacle to benefiting from GMT. However, individuals with more severe objective dysfunction unaccompanied by subjective complaints might not benefit. Measuring both subjective and objective cognition in clinical assessment is important because discrepancy issues may be discovered and discussed with patients. Assisting patients in recognizing relevant everyday examples of cognitive difficulties should be carried out while also supporting self-efficacy and self-esteem (Cella et al., 2014; Haugen et al., 2021; Saperstein et al., 2020).

Implications for future research

Future research on cognitive remediation in schizophrenia may benefit from exploring the significance of discrepancy between subjective and objective cognition. So far the evidence that unawareness of cognitive difficulties is an obstacle for successful remediation is sparse and contradictory (Seccomandi et al., 2020).

Strengths and limitations

A strength of the study is the extensive assessment battery tapping different aspects of executive function. However, questionnaire data was missing at follow-up and may raise a concern about bias, except that we were unable to detect significant differences between the participants who completed all questionnaires and those who did not. This reduces the likelihood of bias. We also used mixed model analysis because it can accommodate missing data points and provide unbiased estimates under the assumption of missing at random (Krueger & Tian, 2004; Muth et al., 2016; Schielzeth et al., 2020).

Conclusions
Goal Management Training does not seem to be affected by levels of objective executive functioning. The relevance of differences between subjective and objective assessments as a barrier to successful intervention should be further explored.

Conflict of interest statement
The authors have no conflicting interests to declare.

Acknowledgements
The study was funded by the South-Eastern Norway Health Authority (grant number 2017012), Innlandet Hospital Trust (grant number 150602) and University of Oslo (grant number 353139). Funders had no involvement in the execution of the study.

References

Allott, K., Steele, P., Boyer, F. et al. (2020a) Cognitive strengths-based assessment and intervention in first-episode psychosis: A complementary approach to addressing functional recovery?, *Clin Psychol Rev*, 79. doi: 10.1016/j.cpr.2020.101871.

Allott, K., van-der-El, K., Bryce, S. et al. (2020b) Compensatory Interventions for Cognitive Impairments in Psychosis: A Systematic Review and Meta-Analysis, *Schizophr Bull*, 46(4), pp. 869-883. doi: 10.1093/schbul/sbz134.

American Psychiatric Association (2000) *Diagnostic and statistical manual of mental disorders : DSM-IV-TR*. 4th ed., text revision. edn. Washington, DC: American Psychiatric Association.

Beck, A. T., Himelstein, R., Bredemeier, K., Silverstein, S. M.& Grant, P. (2018) What accounts for poor functioning in people with schizophrenia: a re-evaluation of the contributions of neurocognitive v. attitudinal and motivational factors, *Psychol Med*, 48(16), pp. 2776-2785. doi: 10.1017/S0033291718000442.

Bowie, C. R., Bell, M. D., Fiszdon, J. M. et al. (2020) Cognitive remediation for schizophrenia: An expert working group white paper on core techniques, *Schizophr Res*, 215, pp. 49-53. doi: 10.1016/j.schres.2019.10.047.

Bulzacka, E., Vilain, J., Schurhoff, F., Meary, A., Leboyer, M.& Szoke, A. (2013) A self administered executive functions ecological questionnaire (the behavior rating inventory of executive function - adult version) shows impaired scores in a sample of patients with schizophrenia, *Ment Illn*, 5(1), pp. e4. doi: 10.4081/mi.2013.e4.

Burton, C. Z.& Twamley, E. W. (2015) Neurocognitive insight, treatment utilization, and cognitive training outcomes in schizophrenia, *Schizophr Res*, 161(2-3), pp. 399-402. doi: 10.1016/j.schres.2014.12.002.

Catalan, A., Salazar de Pablo, G., Aymerich, C. et al. (2021) Neurocognitive Functioning in Individuals at Clinical High Risk for Psychosis: A Systematic Review and Meta-analysis, *JAMA Psychiatry*. doi: 10.1001/jamapsychiatry.2021.1290.

Cella, M., Swan, S., Medin, E., Reeder, C.& Wykes, T. (2014) Metacognitive awareness of cognitive problems in schizophrenia: exploring the role of symptoms and self-esteem, *Psychol Med*, 44(3), pp. 469-476. doi: 10.1017/S0033291713001189.

Cella, M., Reeder, C.& Wykes, T. (2015) Cognitive remediation in schizophrenia—now it is really getting personal, *Current opinion in behavioral sciences*, 4, pp. 147-151. doi: 10.1016/j.cobeha.2015.05.005.

Cicerone, K. D., Goldin, Y., Ganci, K. et al. (2019) Evidence-Based Cognitive Rehabilitation: Systematic Review of the Literature From 2009 Through 2014, *Arch Phys Med Rehabil*, 100(8), pp. 1515-1533. doi: 10.1016/j.apmr.2019.02.011.

Collins, A. G., Brown, J. K., Gold, J. M., Waltz, J. A.& Frank, M. J. (2014) Working memory contributions to reinforcement learning impairments in schizophrenia, *J Neurosci*, 34(41), pp. 13747-13756. doi: 10.1523/JNEUROSCI.0989-14.2014.

Conners, K. C. (2014) *Conners Continuous Performance Test*. 3rd edn. Toronto: Multi-Health Systems Inc.

Delis, D. C., Kaplan, E.& Kramer, J. H. (2001) *Delis–Kaplan Executive Function System*. Bloomington: NCS Pearson, Inc.

DeTore, N. R., Mueser, K. T., Byrd, J. A.& McGurk, S. R. (2019) Cognitive functioning as a predictor of response to comprehensive cognitive remediation, *J Psychiatr Res*, 113, pp. 117-124. doi: 10.1016/j.jpsychires.2019.03.012.

Emmanouel, A., Kontrafouri, E., Nikolaos, P., Kessels, R. P. C.& Fasotti, L. (2018) Incorporation of a working memory strategy in GMT to facilitate serial-order behaviour in brain-injured patients, *Neuropsychol Rehabil*, pp. 1-27. doi: 10.1080/09602011.2018.1517369.

Friedman, N. P.& Miyake, A. (2017) Unity and diversity of executive functions: Individual differences as a window on cognitive structure, *Cortex*, 86, pp. 186-204. doi: 10.1016/j.cortex.2016.04.023.

Glenthøj, L. B., Mariegaard, L., Kristensen, T. D., Wenneberg, C., Medalia, A.& Nordentoft, M. (2020) Self-perceived cognitive impairments in psychosis ultra-high risk individuals: associations with objective cognitive deficits and functioning, *NPJ Schizophr*, 6(1), pp. 31. doi: 10.1038/s41537-020-00124-1.

Gupta, S. K. (2011) Intention-to-treat concept: A review, *Perspect Clin Res*, 2(3), pp. 109-112. doi: 10.4103/2229-3485.83221.

Harvey, P. D.& Pinkham, A. (2015) Impaired self-assessment in schizophrenia: Why patients misjudge their cognition and functioning, *Curr Psychiatr*, 14(4), pp. 53-59. Available at: https://www.mdedge.com/psychiatry/article/98117/schizophrenia-other-psychotic-disorders/impaired-self-assessment?sso=true.

Haugen, I., Stubberud, J., Ueland, T., Haug, E.& Øie, M. G. (2021) Executive dysfunction in schizophrenia: Predictors of the discrepancy between subjective and objective measures, *Schizophr Res Cogn*, 26. doi: 10.1016/j.scog.2021.100201.

Haugen, I., Stubberud, J., Haug, E. et al. (in press) Goal Management Training for executive functioning in schizophrenia spectrum disorders or psychosis risk syndromes: A randomized controlled trial, *BMC Psychiatry*.

Hwang, W. J., Lee, T. Y., Shin, W. G. et al. (2019) Global and Specific Profiles of Executive Functioning in Prodromal and Early Psychosis, *Front Psychiatry*, 10, pp. 356. doi: 10.3389/fpsyt.2019.00356.

Kim, H. K., Park, H. Y., Seo, E. et al. (2019) Factors Associated With Psychosocial Functioning and Outcome of Individuals With Recent-Onset Schizophrenia and at Ultra-High Risk for Psychosis, *Front Psychiatry*, 10, pp. 459. doi: 10.3389/fpsyt.2019.00459.

Krueger, C.& Tian, L. (2004) A comparison of the general linear mixed model and repeated measures ANOVA using a dataset with multiple missing data points, *Biol Res Nurs*, 6(2), pp. 151-157. doi: 10.1177/1099800404267682.

Lejeune, J. A., Northrop, A.& Kurtz, M. M. (2021) A Meta-analysis of Cognitive Remediation for Schizophrenia: Efficacy and the Role of Participant and Treatment Factors, *Schizophrenia Bulletin*, 47(4), pp. 997-1006. doi: 10.1093/schbul/sbab022.

Levine, B., Robertson, I. H., Clare, L. et al. (2000) Rehabilitation of executive functioning: an experimental-clinical validation of goal management training, *J Int Neuropsychol Soc*, 6(3), pp. 299. doi: 10.1017/S1355617700633052.

Løvstad, M., Sigurdardottir, S., Andersson, S. et al. (2016) Behavior Rating Inventory of Executive Function Adult Version in Patients with Neurological and Neuropsychiatric Conditions: Symptom Levels and Relationship to Emotional Distress, *J Int Neuropsychol Soc*, 22(6), pp. 682-694. doi: 10.1017/S135561771600031X.

McGurk, S. R.& Mueser, K. T. (2006) Cognitive and clinical predictors of work outcomes in clients with schizophrenia receiving supported employment services: 4-year follow-up, *Adm Policy Ment Health & Ment Health Serv Res*, 33(5), pp. 598-606. doi: 10.1007/s10488-006-0070-2.

Miller, T., McGlashan, T., Woods, S. et al. (1999) Symptom Assessment in Schizophrenic Prodromal States, *Psychiatr Q*, 70(4), pp. 273-287. doi: 10.1023/A:1022034115078.

Muth, C., Bales, K. L., Hinde, K., Maninger, N., Mendoza, S. P.& Ferrer, E. (2016) Alternative Models for Small Samples in Psychological Research: Applying Linear Mixed Effects Models and Generalized Estimating Equations to Repeated Measures Data, *Educ Psychol Meas*, 76(1), pp. 64-87. doi: 10.1177/0013164415580432.

Norwegian Health Authority (2013) National guideline for assessment, treatment and follow-up care of persons with psychotic illness. Oslo. Available at: https://www.helsedirektoratet.no.

Olsson, A.-K., Hjärthag, F.& Helldin, L. (2019) Overestimated function in patients with schizophrenia: A possible risk factor for inadequate support?, *Schizophr Res*, 206, pp. 194-199. doi: 10.1016/j.schres.2018.11.027.

Paudel, S., Coman, D.& Freudenreich, O. (2020) Subjective experience of cognitive difficulties as an important attribute of quality of life among individuals with schizophrenia spectrum disorders, *Schizophr Res*, 215, pp. 476-478. doi: 10.1016/j.schres.2019.09.008.

Potvin, S., Pelletier, J.& Stip, E. (2014) Neurocognitive insight in schizophrenia: a meta-analysis, *Sante Ment Que*, 39(2), pp. 183. doi: 10.7202/1027839ar.

Robertson, I. H. (1996) *Goal Management Training: A Clinical Manual*. Cambridge: PsyConsult.

Roth, R. M.& Gioia, G. A. (2005) *Behavior rating inventory of executive function- Adult version*. Lutz, Florida: Psychological Assessment Resources.

Santesteban-Echarri, O., Paino, M., Rice, S. et al. (2017) Predictors of functional recovery in first-episode psychosis: A systematic review and meta-analysis of longitudinal studies, *Clin Psychol Rev*, 58, pp. 59-75. doi: 10.1016/j.cpr.2017.09.007.

Saperstein, A. M., Lynch, D. A., Qian, M.& Medalia, A. (2020) How does awareness of cognitive impairment impact motivation and treatment outcomes during cognitive remediation for schizophrenia?, *Schizophr Res*, 218, pp. 70-75. doi: 10.1016/j.schres.2020.02.014.

Schielzeth, H., Dingemanse, N. J., Nakagawa, S. et al. (2020) Robustness of linear mixed-effects models to violations of distributional assumptions, *Methods Ecol Evol*, 11(9), pp. 1141-1152. doi: 10.1111/2041-210x.13434.

Seccomandi, B., Tsapekos, D., Newbery, K., Wykes, T.& Cella, M. (2020) A systematic review of moderators of cognitive remediation response for people with schizophrenia, *Schizophr Res Cogn*, 19, pp. 100160. doi: 10.1016/j.scog.2019.100160.

Twamley, E. W., Burton, C. Z.& Vella, L. (2011) Compensatory cognitive training for psychosis: who benefits? Who stays in treatment?, *Schizophr Bull*, 37 Suppl 2, pp. S55-62. doi: 10.1093/schbul/sbr059.

Twisk, J., Bosman, L., Hoekstra, T., Rijnhart, J.& Welten, M. H., M. (2018) Different ways to estimate treatment effects in randomised controlled trials, *Contemp Clin Trials Commun*, 10, pp. 80-85. doi: 10.1016/j.conctc.2018.03.008.

Van Aken, B., Wierdsma, A. I., Voskes, Y., Pijnenborg, G., Weeghel, J.& Mulder, C. (2022) The association between executive functioning and personal recovery in people with psychotic disorders, *Schizophrenia Bulletin Open*. doi: 10.1093/schizbullopen/sgac023.

Vita, A., Barlati, S., Ceraso, A. 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(8), pp. 848-858. doi: 10.1001/jamapsychiatry.2021.0620.

Wechsler, D. (2008) *Wechsler Adult Intelligence Scale - Fourth Edition (WAIS-IV)*. San Antonio, Texas: Pearson Assessment.

Wykes, T.& Spaulding, W. D. (2011) Thinking about the future cognitive remediation therapy--what works and could we do better?, *Schizophr Bull*, 37 Suppl 2, pp. S80-90. doi: 10.1093/schbul/sbr064.

Yung, A. R., Phillips, L. J., McGorry, P. D. et al. (1998) Prediction of psychosis: A step towards indicated prevention of schizophrenia, *Br J Psychiatry Suppl*, 172(33), pp. 14-20. doi: 10.1192/S0007125000297602.