



King's Research Portal

DOI:

[10.1177/2043808719826846](https://doi.org/10.1177/2043808719826846)

Document Version

Peer reviewed version

[Link to publication record in King's Research Portal](#)

Citation for published version (APA):

Cella, M., Edwards, C., Swan, S., Elliot, K., Reeder, C., & Wykes, T. (2019). Exploring the effects of cognitive remediation on metacognition in people with schizophrenia. *Journal of Experimental Psychopathology*, 10(2). <https://doi.org/10.1177/2043808719826846>

Citing this paper

Please note that where the full-text provided on King's Research Portal is the Author Accepted Manuscript or Post-Print version this may differ from the final Published version. If citing, it is advised that you check and use the publisher's definitive version for pagination, volume/issue, and date of publication details. And where the final published version is provided on the Research Portal, if citing you are again advised to check the publisher's website for any subsequent corrections.

General rights

Copyright and moral rights for the publications made accessible in the Research Portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognize and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the Research Portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the Research Portal

Take down policy

If you believe that this document breaches copyright please contact librarypure@kcl.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.

Exploring the Effects of Cognitive Remediation on Metacognition in people with Schizophrenia

Matteo Cella^{1,2}, Clementine Edwards^{1,2}, Sarah Swan², Kay Elliot¹, Clare Reeder¹, Til Wykes^{1,2}

- 1- King's College London, Department of Psychology, Institute of Psychiatry, Psychology and Neuroscience, De Crespigny Park, London, SE5 8AF, London, United Kingdom.
- 2- South London and Maudsley NHS Foundation Trust, Bethlem Royal Hospital, Monks Orchard Road, Beckenham, Kent, BR3 3BX, United Kingdom.

Corresponding author:

Matteo Cella

Department of Psychology, Institute of Psychiatry, Psychology & Neuroscience,

King's College London,

De Crespigny Park,

SE5 8AF London, UK.

E-mail address: matteo.cella@kcl.ac.uk

Abstract

Background: Interventions targeting cognition in people with schizophrenia have shown moderate effects on improving functioning. Recent Cognitive Remediation (CR) approaches have begun to target metacognition to improve functioning outcomes. This study aims to develop a novel measure of metacognition and assess if metacognitive based CR (mCR) can improve metacognition.

Methods: We use data from a single-blinded randomised controlled trial comparing mCR plus Treatment as Usual (TAU) to TAU alone in people with schizophrenia. Participants were assessed with measures of cognition, functioning and a new measure of metacognition at three time points: week-0 (baseline), week-12 and week-24.

Results: The evaluation of the novel metacognition assessment suggests that it is a reliable and valid measure. The measure positively correlates with cognitive measures, in particular with executive function and IQ, but also with a measure of functioning. We found that a course of mCR was able to increase metacognition compared to TAU by week-24.

Conclusions: Metacognition may be an important mechanism to explain how CR affects functioning outcomes in people with psychosis. The systematic assessment of metacognition as part of CR studies may help to evaluate more clearly its role and relevance to functioning.

Keywords: Cognitive Remediation; Psychosis; Metacognition; Schizophrenia; Cognition.

Introduction

Cognitive difficulties are a landmark feature of schizophrenia and recognised to be contributors to functioning difficulties (Wykes 1994, Keefe and Harvey 2012, Green and Harvey 2014). Cognitive remediation (CR) was developed in the attempt to reduce the impact of cognitive difficulties on functional outcome. CR is a psychological therapy which uses learning principles and behavioural techniques (e.g. massed practice and errorless learning) to improve cognition and ultimately to reduce functional difficulties. There are two main CR approaches, one based on drill and practice and one using drill and practice and strategy (Cella M. 2012). While drill and practice programmes rely solely on task practice to reduce cognitive difficulties, drill and practice plus strategy programmes actively teach strategy use to overcome cognitive difficulties and achieve functioning milestones. Evidence suggests that both these approaches are effective to improve cognition but drill and practice plus strategy is more effective in bringing about functioning improvements (Wykes, Huddy et al. 2011).

A key unanswered question for CR programmes is how to maximise functioning improvements. While strategies have been shown to contribute to functioning improvements, increasing this therapy ingredient on its own may not be enough to deliver large changes. For example, if a CR program teaches strategies that people forget to use or are not able to use efficiently then introducing strategies alone may be unlikely to influence functioning. A well learned strategy in a particular context may also suffer from difficulties in being generalised and adapted to new situations. This may restrict the overall utility and applicability of strategies in CR.

This is the context that prompted clinical researchers in this field to look for a process that can maximise the applicability and usefulness of strategies so that they can have a lasting and more significant effect on functioning difficulties. Research in people with psychosis has shown that metacognitive impairments are associated with difficulties in everyday life functioning including employment and social relationships (Koren, Seidman et al. 2006, Stratta, Daneluzzo et al. 2009, Lysaker, McCormick et al. 2011). Metacognition has also been suggested as a process that can aid strategy use and may extend their usefulness.

Although several therapeutic approaches have attempted to target metacognition, they have used different definitions. While all definitions largely revolve around Flavell's original conceptualisation of metacognition as the cognitive processes that relate to "thinking about thinking" (Flavell 1979), there are many subtle and sometime key differences in the way this term is used. Some proponents consider metacognition as the ability to make sense of one's own and other people's experiences (Lysaker and Dimaggio 2014). Others consider it a process responsible for illness insight and symptom awareness (Corcoran and Frith 2003, David, Bedford et al. 2012), and still others focus on narrower aspects of metacognition such as introspective accuracy, or the ability to accurately judge one's own skills and abilities (Pinkham, Klein et al. 2018). In the context of Cognitive Behavioural Therapy for people with psychosis this concept has been associated with the ability to recognise and regulate thinking biases (Moritz and Woodward 2007, Morrison, Pyle et al. 2014).

We have proposed that metacognition is particularly suited to Cognitive Remediation (CR) as it regulates learning and behaviour and links the task specific learning to effective behaviour in key functioning domains such as employment, education and social life (Wykes and Reeder 2005, Cella, Reeder et al. 2015, Cella, Reeder et al. 2015). We have proposed that two metacognitive functions are vital for translating cognitive to functional improvement. The first is metacognitive knowledge, which refers to knowledge of cognitive processes, such as someone's beliefs about their own cognitive strengths and weaknesses. The second is metacognitive regulation, which is responsible for planning, monitoring and improving cognitive processes and behaviours through evaluation. Metacognitive regulation and knowledge can both support effective strategy use. For example, by planning what strategies best apply to a journey, evaluating different transport options, taking enough money and anticipating possible problems.

Over the last ten years we have developed a CR programme targeting metacognitive knowledge and regulation alongside cognitive difficulties. The resulting therapy, called Computerised Interactive Remediation of Cognition–Interactive Training for Schizophrenia, or CIRCuiTS, is acceptable and feasible (Reeder, Pile et al. 2015). Recent research showed promising results for this therapy to improve cognitive difficulties and functioning (Reeder, Huddy et al. 2017). However, before we can investigate whether metacognitive CR effectively targets metacognitive processes we need a measure that can capture metacognitive regulation and knowledge. To this end the current study aims to: i) develop a metacognition measure based on task performance and strategy use and ii) evaluate whether metacognition-based CR can improve metacognition.

Methods

Design

This study used data from a single blind randomised controlled trial comparing a novel metacognitive CR approach, called CIRCuiTS, plus treatment as usual (TAU) to TAU alone. A detailed description of this study methods can be found in Reeder et al., (Reeder, Huddy et al. 2017). Outcomes were measured at three time points: baseline (week-0), post-treatment (week-12) and follow-up (week-24).

Participants

Participants for this study were recruited via Community Mental Health Teams and Rehabilitation services from the South London and Maudsley Mental Health National Health Service (NHS) Foundation Trust. Participant inclusion criteria were: (i) DSM-IV diagnosis of schizophrenia or schizo-affective disorder assessed with structured interview by a trained clinician, (ii) at least 1 year's contact with mental health services, (iii) 17–65 years, and (iv) performance more than one standard deviation below the normative mean in working

memory, as assessed by the digit span (Wechsler 2008) and/or cognitive flexibility, as assessed by the Wisconsin Card Sorting Test (WCST) (Heaton and Psychological Assessment Resources Inc. 1993) and/or executive function, as assessed by the Hayling Sentence Completion Test (Burgess and Shallice 1997). We chose to focus our inclusion criteria on these cognitive domains as they are strongly associated with functioning difficulties (Wykes, Reeder et al. 2012, Cella and Wykes 2017). Exclusion criteria were: (i) plans to change medication during the study, (ii) substance dependence or (iii) evidence of an organic cause to cognitive difficulties.

Interventions

Treatment-as-usual: This is routine psychiatric care offered by the service including individualised multi-disciplinary contacts for medication review and symptom and well-being monitoring. The professionals involved in these contacts were mostly psychiatrists and mental health nurses. Less frequently, psychologists, occupational therapists and residential support services were also offering relevant support.

Metacognitive CR: CR was delivered by a therapist using CIRCuiTS, a web-based computerised software. Sessions with therapist were supplemented with independent sessions. In addition to providing massed practice of basic cognitive functions (e.g. memory, attention, executive function), the programme targets metacognition and encourages strategy use. The therapist's role is centred around supporting motivation, strategy development and generalisation and teaching, as well as using metacognitive regulations skills to promote an understanding of cognitive and non-cognitive strengths and difficulties (i.e. metacognitive knowledge). The therapist also supports learning transfer to maximise participants real-world goals. Therapists provide additional scaffolding by simplifying task demands where needed and supporting clients' motivation to ensure consistent successful performance. The software targets memory, executive functioning and attention. Tasks increase in difficulty gradually in line with participants performance to maintain high levels of success allowing for errorless learning. Participants also develop a set of personalised strategies to improve their cognitive performance and achieve their goals.

At the beginning of the therapy, real-world goals are set collaboratively, and progress is reviewed regularly. Therapy sessions are offered at least three times a week (for maximum 12 weeks), up to 40 sessions each lasting approximately one hour. Where possible, according to participants' ability and choice, therapists encourage carrying out additional independent sessions.

CIRCuiTS tasks are either 'abstract' (neutral content, such as numbers, and designed to target specific cognitive functions) or 'exercises' (cognitively complex and ecologically valid) associated with work, social situations, cooking, shopping and travelling. Therapists encourage participants to apply the skills learnt in daily life and to practice in vivo to achieve their real-world goals. Thus, functional outcomes are directly targeted by the therapy.

Measures

Cognition

Verbal working memory was assessed using Digit Span (WAIS-IV-UK) (Wechsler 2008), and we used the total raw score output with high scores being indicative of good performance.

Visual memory was assessed with the Rey Osterreith Complex Figure (ROCF) (Meyers, Bayless et al. 1996), and we used the immediate recall raw score with high scores being indicative of good performance.

Verbal executive function was assessed with the Hayling Sentence Completion test (Burgess and Shallice 1997), and we used the total scaled score with high scores being indicative of good performance.

Visual executive function was assessed with the Wisconsin Card Sorting Task (WCST) (Heaton and Psychological Assessment Resources Inc. 1993), testing abstraction and cognitive flexibility. We used the percentage of errors with high scores being indicative of poor performance.

Current IQ was estimated using the Vocabulary and Block Design tests from the Wechsler Adult Intelligence Scale – Third Edition – UK (Christensen, Girard et al. 2007).

Functioning

Functioning was assessed using the Time Use Survey (UK 2000 Time Use Survey - Short 2006). This is a semi-structured interview recording how participants use their time which has been adapted for use with people with psychosis (Cella, Edwards et al. 2016). Key outcomes of this measure are expressed in total hours per week over the past month spent in structured activities including employment, education, voluntary employment, structured leisure activities, housework and chores, childcare, sports and hobbies.

Symptoms

Symptoms were assessed using the Positive and Negative Syndrome Scale (PANSS) (Kay, Fiszbein et al. 1987). This is a 30-item structured clinical interview assessing symptom severity. For this study we considered three symptoms dimensions: positive, negative and general symptoms.

Metacognition

This measure assessed how participants approach two cognitive tasks: the Rey-Osterreith Complex Figure (ROCF) and the Hayling Sentence Completion test. Performance on both these

tasks benefit from the implementation of strategy. We assessed four metacognitive components:

(1) *Understanding, monitoring and evaluating*: assess the participant's ability to acknowledge having mental functions, distinguish between mental operations using cognitive words (i.e. memorising, realising and imaging) and evaluate their task performance.

(2) *Strategy implementation*: evaluates whether the individual knew how they completed the task, if they acknowledge using a strategy which was either effective or ineffective, their capability to label and describe the strategy, as well as evaluating their chosen method.

(3) *Objective strategy*: assesses whether a clear and objective strategy was used to complete the task.

(4) *Strategy congruence*: evaluates whether the subjective strategy stated is congruent with the cognitive demands of the task and to what degree the strategy was implemented (e.g. only at the beginning and then dropped; during whole the task). This is evaluated by the interviewer and together objective strategy represents an index of metacognition independent from the participants' ability to describe strategy use, which may be indirectly supported by CR.

For each of these items participants answer, or performance is scored on a 0-3 scale. Raters were provided with a scoring manual with each score level anchoring description and examples. Lower scores indicate lack of or difficulties in the application and use of that metacognitive function while high scores are evidence of domain mastery. The total scale score is the sum of the four items scores and it ranges from 0 to 12. Each interview was scored independently by two raters and each score discrepancy that could not be resolved was discussed with a third senior author and a final score agreed.

The measure was administered as a structured interview after the administration of the text was completed. All interviews were audio recorded and transcribed. To ensure the reliability of each metacognition transcript, every transcript was assessed for interviewer adherence to the script, using a rating scale ranging from 0 (poor adherence) to 3 (highly adherent). Poor adherence reflects the interviewer inadvertently suggesting strategies or using words that could prompt the participants to use reflective language (e.g. what were you thinking while doing the task). Any transcript rated as 0 or 1 was excluded from the analysis. Scoring on Understanding, monitoring and evaluating and Strategy implementation was performed on interview transcripts while scoring on the Objective strategy and Strategy congruence was performed by the rater on the bases of the observed behaviour or the relevance of the strategy use to the task.

Analysis

We investigated the psychometric properties of our novel metacognitive measure. As two (i.e. metacognitive understanding and subjective strategy use) out of the four interview items rely on raters' scores, we calculated inter-rater reliability from two independent raters using

a Cohen's Kappa. Interpretation of Kappa levels was based on Viera and Garrett (Viera and Garrett 2005).

We evaluated the distribution properties of each measure considered by exploring distributional parameters (e.g. skewness) and using Shapiro-Wilks test to assess normality. We assessed correlation using Pearson correlation coefficients.

Scale reliability was measured by Cronbach's alpha coefficient. Conventionally, alpha values above 0.70 are considered satisfactory (Bland and Altman 1997). We evaluated the new metacognitive measure's construct validity using correlations with cognitive domains, functioning levels and symptom domains using Pearson correlation coefficients.

To explore whether metacognitive CR can improve scores on our novel metacognitive measure we conducted a mixed effect ANCOVA. The model considered the baseline score (week-0) of the metacognition measure as a covariate. The model considered time at Post-therapy (week-12) and Follow-up (week-24) assessments, treatment group (i.e. CR and TAU alone) and the interaction between time and group as fixed categorical variables. Partial eta squares are reported for effect size estimates.

Results

Of the 93 participants recruited in the study 76 completed the metacognitive interview. Reasons for non-completion were: not providing consent for the interview recording (11), recorder not available (3), poor audio quality or partial recording (3). Of these 76 interviews, 9 were rated as unreliable due to excessive interviewer influence or interviewer not following the script. Percentage of missing data from the 67 participants who took part was: 6% at baseline assessment; 12% at 12-week assessment and 19% at 24-week assessment.

Participants were mostly men (61%) and had an average age of 39.6 (SD 10.7). They all received antipsychotic medications with an average chlorpromazine level of 421.6 (SD323.9).

Metacognitive measure

Inter-rater agreement on interview scoring across the three assessment points for Understanding, Monitoring and Evaluating and Strategy Implementation were between 0.38 and 0.51. This is indicative of a fair to moderate inter-rater agreement. All disagreements were discussed and resolved with the help of a third author.

The scale reliability for baseline assessments was evaluated using Cronbach alpha and was 0.78.

The scale items intercorrelation ranged between 0.82 ($p < 0.001$) for the correlation between Strategy Congruence and Objective Strategy Use to 0.29 ($p < 0.001$) for the correlation between Understanding, Monitoring and Evaluating and Objective Strategy Use.

Correlations between the metacognitive measure total score and the cognitive and symptoms measures at week-0 are reported in Table 1.

----- Table 1 about here -----

The measure has moderate levels of correlation with executive function measures and modest relations with functioning and negative symptoms.

Is metacognitive CR improving metacognition?

Of the 67 participants considered 34 were randomised to CR and 33 to TAU.

Figure 1 shows the metacognitive mean scores for the CR and the TAU groups. ANCOVA analysis showed no group by time interaction at week-12 $F(1,56)=1.9$, $p=0.17$, $\eta^2=0.03$ (mean difference=0.75; SE 0.17) but did show a significant group by time interaction at week-24 $F(1,51)=6.5$, $p=0.01$, $\eta^2=0.15$ (mean difference=1.38; SE 0.51) suggesting that metacognition scores improve significantly by week-24 in the CR group compared to TAU.

-----Figure 1 about here-----

Discussion

Metacognition is a key element of an effective cognitive system allowing individuals to expand knowledge and effectively understand, control, and manipulate their own cognitive processes (Flavell 1979). Metacognitive skills also allow individuals to be more flexible and able to cope

with a rapidly changing environment. A wealth of research demonstrates that metacognition is important for learning and acquiring new skills and that individuals who have higher levels of metacognition tend to perform better in studies and work (Kentridge and Heywood 2000, Hong, Vadivelu et al. 2015). Similarly, research conducted in people with psychosis supports the notion that difficulties in metacognition are associated with higher levels of functioning difficulties. This is the rationale that prompted us to develop a cognitive remediation programme targeting metacognition to maximise its effects on functioning.

The results of this study showed that the new measure is feasible, and most trial participants were able to complete it. One aspect to consider in future studies is interviewer training as we lost 10% of participants' results because of a lack of adherence to the script. This lack of adherence occurred mostly at the beginning of the session and it was soon rectified in supervision sessions. So future studies using this measure should maintain close monitoring on how the measure is administered. The psychometric proprieties of the novel metacognitive measure were found to be acceptable. As with all interviewer-based assessments, rater agreement is crucial to the sensitivity of the measure and appropriate training for raters is necessary.

The correlations between the metacognition items and the internal consistency values suggest that the domains considered appear to be part of the same construct. This is important as it provides reassurance that the items representing the theoretical constructs are related to each other. While it is plausible to link effective strategy use to good metacognitive skills, it is reassuring that our measure shows links between effective strategy deployment and good metacognitive regulation. We consider this an important aspect that differentiates our programme from compensatory CR programmes where strategy may be provided, but limited consideration is given to how these are regulated and implemented.

The correlation results, presented in table 1, suggest that the new metacognitive measure is related more to executive function than other cognitive domains. This is not a new finding and is in line with previous research suggesting that metacognition and executive functions may be partly overlapping concepts (Follmer and Sperling 2016).

It is not clear from the literature, however, if metacognitive gains, after therapy, are independent from executive function. Part of our concept of metacognition, metacognitive regulation, is similar to self-regulation and considers cognitive skills necessary to plan, monitor and evaluate behaviours, including strategy use. The effect of metacognitive CR on executive function, as reported in Reeder et al., (Reeder, Huddy et al. 2017), suggests that a course of this therapy can improve performance on executive function and this effect may not be independent from the effect on metacognition. It may be that metacognition exerts an effect on functioning via executive functions but also directly via metacognitive knowledge. Planning a visit to a family member should be positively affected by planning skills, but realising that the plan may be poorly executed on a low mood day may equally be important and prevent failure.

Our measure is based largely on how participants approach a task and deal with its cognitive demands, apply and regulate strategies and it is different to other conceptualisations (e.g.

Moritz and Lysaker 2018). As such our measure is more akin to performance-based assessments such as neuropsychological tests however, we consider this concept still within the family of metacognition on the bases this is an essential process regulating behaviour. Most of the research to date has measured metacognition using self-assessment measures (e.g. Barbato, Penn et al. 2014) and this may be problematic, particularly in people with psychosis. Research suggests, in fact that there is a discrepancy between self-assessed, interviewer based and performance-based measures (Medalia and Thysen 2010, Cella, Swan et al. 2014). It is therefore likely that a performance-based measure of metacognition may better captures how metacognitive skills are deployed in everyday life and how they may influence functioning. The correlation between our metacognitive and functioning measure, as presented in table 1, suggests the amount of time people spend in structured activities in their everyday life is associated with their metacognitive competencies and strategy implementation skills.

In this study we showed, for the first time, that our CR approach was effective in improving metacognitive scores compared to TAU. This is important as it shows that the measure is sensitive to change and that the therapy program targets the intended competencies. What remains to be established is whether and how metacognitive improvement transfers to functional gains. Result of this study, reported in Reeder et al., (Reeder, Huddy et al. 2017), found that individuals in the CR group improved their functioning at post-therapy, but these gains were not maintained at follow-up. This effect was likely due to the lack of opportunities and support participants were experiencing after therapy and this might have resulted in limited opportunities to expand functioning levels. Despite the lack of functioning improvement at follow-up in this study we showed that metacognitive levels are different between the groups and significantly higher in the metacognitive CR group. This suggests that improving metacognition alone may not be sufficient for people who experience high levels of social and functioning difficulties and that providing opportunities to deploy new strategies may be a necessary precondition for programmes to have a lasting effect on functioning.

Figure 1

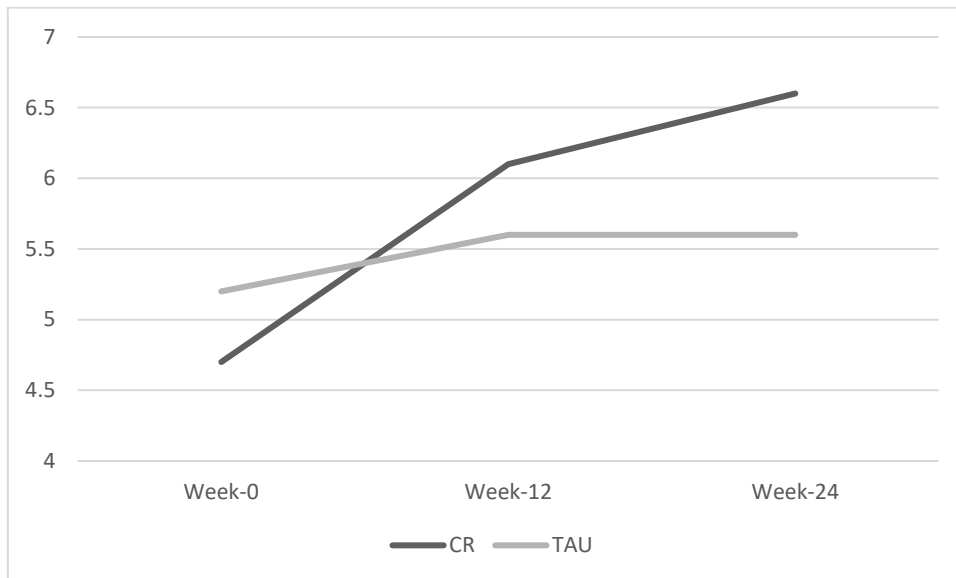


Figure 1 Shows mean metacognition scores at week-0, -12 and -24 for the CR and TAU groups.

Table1

Measure	Metacognition (total score)
Rey recall (memory)	0.28*
Digit Symbol (processing speed)	0.23
WCST errors (executive function)	-0.43**
Digit Span (working memory)	0.35**
Hayling errors (executive function)	-0.55**
WTAR (premorbid IQ)	0.42**
IQ	0.51**
Time Use SA (functioning)	0.35**
PANSS positive	-0.2
PANSS negative	-0.33**
PANSS general	-0.01

Table 1 Shows the correlation between the total metacognitive measure score, cognitive performance and symptoms. * $p < .05$; ** $p < 0.001$.

References

- Barbato, M., D. L. Penn, D. O. Perkins, S. W. Woods, L. Liu and J. Addington (2014). "Metacognitive functioning in individuals at clinical high risk for psychosis." *Behav Cogn Psychother* **42**(5): 526-534.
- Bland, J. M. and D. G. Altman (1997). "Cronbach's alpha." *BMJ* **314**(7080): 572.
- Burgess, P. W. and T. Shallice (1997). *The Hayling and Brixton Tests Manual*. Thames Valley testing Company. Bury St. Edmunds.
- Cella, M., C. Edwards and T. Wykes (2016). "A question of time: A study of time use in people with schizophrenia." *Schizophr Res* **176**(2-3): 480-484.
- Cella, M., C. Reeder and T. Wykes (2015). "Group cognitive remediation for schizophrenia: Exploring the role of therapist support and metacognition." *Psychol Psychother*.
- Cella, M., C. Reeder and T. Wykes (2015). "Lessons learnt? The importance of metacognition and its implications for Cognitive Remediation in schizophrenia." *Front Psychol* **6**: 1259.
- Cella, M., S. Swan, E. Medin, C. Reeder and T. Wykes (2014). "Metacognitive awareness of cognitive problems in schizophrenia: exploring the role of symptoms and self-esteem." *Psychol Med* **44**(3): 469-476.
- Cella, M. and T. Wykes (2017). "The nuts and bolts of Cognitive Remediation: Exploring how different training components relate to cognitive and functional gains." *Schizophr Res*.
- Cella M., H. V., Reeder C., Wykes T (2012). "Cognitive remediation therapy for schizophrenia." *Minerva Psichiatria* **53**(3): 185-196.
- Christensen, B. K., T. A. Girard and R. M. Bagby (2007). "Wechsler Adult Intelligence Scale-Third Edition short form for index and IQ scores in a psychiatric population." *Psychol Assess* **19**(2): 236-240.
- Corcoran, R. and C. D. Frith (2003). "Autobiographical memory and theory of mind: evidence of a relationship in schizophrenia." *Psychol Med* **33**(5): 897-905.
- David, A. S., N. Bedford, B. Wiffen and J. Gilleen (2012). "Failures of metacognition and lack of insight in neuropsychiatric disorders." *Philos Trans R Soc Lond B Biol Sci* **367**(1594): 1379-1390.
- Flavell, J. H. (1979). "Meta-Cognition and Cognitive Monitoring - New Area of Cognitive-Developmental Inquiry." *American Psychologist* **34**(10): 906-911.
- Follmer, D. J. and R. A. Sperling (2016). "The mediating role of metacognition in the relationship between executive function and self-regulated learning." *Br J Educ Psychol* **86**(4): 559-575.
- Green, M. F. and P. D. Harvey (2014). "Cognition in schizophrenia: Past, present, and future." *Schizophr Res Cogn* **1**(1): e1-e9.
- Heaton, R. K. and Psychological Assessment Resources Inc. (1993). *Wisconsin Card Sorting Test manual*. Odessa, Fla. (P.O. Box 998, Odessa 33556), Psychological Assessment Resources.
- Hong, W. H., J. Vadelu, E. G. Daniel and J. H. Sim (2015). "Thinking about thinking: changes in first-year medical students' metacognition and its relation to performance." *Med Educ Online* **20**: 27561.
- Kay, S. R., A. Fiszbein and L. A. Opler (1987). "The positive and negative syndrome scale (PANSS) for schizophrenia." *Schizophr Bull* **13**(2): 261-276.
- Keefe, R. S. and P. D. Harvey (2012). "Cognitive impairment in schizophrenia." *Handb Exp Pharmacol*(213): 11-37.
- Kentridge, R. W. and C. A. Heywood (2000). "Metacognition and awareness." *Conscious Cogn* **9**(2 Pt 1): 308-312; discussion 324-306.

Koren, D., L. J. Seidman, M. Goldsmith and P. D. Harvey (2006). "Real-world cognitive - and metacognitive - dysfunction in schizophrenia: A new approach for measuring (and remediating) more "right stuff"." *Schizophrenia Bulletin* **32**(2): 310-326.

Lysaker, P. H. and G. Dimaggio (2014). "Metacognitive capacities for reflection in schizophrenia: implications for developing treatments." *Schizophr Bull* **40**(3): 487-491.

Lysaker, P. H., B. P. McCormick, G. Snethen, K. D. Buck, J. A. Hamm, M. Grant, G. Nicolo and G. Dimaggio (2011). "Metacognition and social function in schizophrenia: associations of mastery with functional skills competence." *Schizophr Res* **131**(1-3): 214-218.

Medalia, A. and J. Thysen (2010). "A comparison of insight into clinical symptoms versus insight into neuro-cognitive symptoms in schizophrenia." *Schizophr Res* **118**(1-3): 134-139.

Meyers, J. E., J. D. Bayless and K. R. Meyers (1996). "Rey complex figure: memory error patterns and functional abilities." *Appl Neuropsychol* **3**(2): 89-92.

Moritz, S. and P. H. Lysaker (2018). "Metacognition - What did James H. Flavell really say and the implications for the conceptualization and design of metacognitive interventions." *Schizophr Res* **201**: 20-26.

Moritz, S. and T. S. Woodward (2007). "Metacognitive training in schizophrenia: from basic research to knowledge translation and intervention." *Curr Opin Psychiatry* **20**(6): 619-625.

Morrison, A. P., M. Pyle, N. Chapman, P. French, S. K. Parker and A. Wells (2014). "Metacognitive therapy in people with a schizophrenia spectrum diagnosis and medication resistant symptoms: a feasibility study." *J Behav Ther Exp Psychiatry* **45**(2): 280-284.

Pinkham, A. E., H. S. Klein, G. B. Hardaway, K. C. Kemp and P. D. Harvey (2018). "Neural correlates of social cognitive introspective accuracy in schizophrenia." *Schizophr Res*.

Reeder, C., V. Huddy, M. Cella, R. Taylor, K. Greenwood, S. Landau and T. Wykes (2017). "A new generation computerised metacognitive cognitive remediation programme for schizophrenia (CIRCuiTS): a randomised controlled trial." *Psychological Medicine* **47**(15): 2720-2730.

Reeder, C., V. Pile, P. Crawford, M. Cella, D. Rose, T. Wykes, A. Watson, V. Huddy and F. Callard (2015). "The Feasibility and Acceptability to Service Users of CIRCuiTS, a Computerized Cognitive Remediation Therapy Programme for Schizophrenia." *Behav Cogn Psychother*: 1-18.

Short, S. (2006). Review of the UK 2000 Time Use Survey. London, Office for National Statistics.

Stratta, P., E. Daneluzzo, I. Riccardi, M. Bustini and A. Rossi (2009). "Metacognitive ability and social functioning are related in persons with schizophrenic disorder." *Schizophr Res* **108**(1-3): 301-302.

Viera, A. J. and J. M. Garrett (2005). "Understanding interobserver agreement: the kappa statistic." *Fam Med* **37**(5): 360-363.

Wechsler, D. (2008). *Wechsler Adult Intelligence Scale Fourth Edition*. San Antonio, TX, Pearson.

Wykes, T. (1994). "Predicting symptomatic and behavioural outcomes of community care." *Br J Psychiatry* **165**(4): 486-492.

Wykes, T., V. Huddy, C. Cellard, S. R. McGurk and P. Czobor (2011). "A meta-analysis of cognitive remediation for schizophrenia: methodology and effect sizes." *Am J Psychiatry* **168**(5): 472-485.

Wykes, T. and C. Reeder (2005). *Cognitive remediation therapy for schizophrenia: Theory and practice*. London, UK, Brunner Routledge.

Wykes, T., C. Reeder, V. Huddy, R. Taylor, H. Wood, N. Ghirasim, D. Kontis and S. Landau (2012). "Developing models of how cognitive improvements change functioning: mediation, moderation and moderated mediation." *Schizophr Res* **138**(1): 88-93.