

# **Metacognition as a mediating variable between neurocognition and functional outcome in first-episode psychosis.**

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## Abstract

*Background:* Neurocognitive and functional outcome deficits have long been acknowledged in schizophrenia and neurocognition has been found to account for functional disability to a greater extent than psychopathology. Much of the variance in functional outcome however still remains unexplained and metacognition may mediate the relationship between neurocognition, functional capacity, and self-reported social and occupational function.

*Method:* 80 first-episode psychosis participants were recruited and completed measures of neurocognition (memory, executive function and IQ), metacognition (Beck Cognitive Insight Scale, Metacognitive Awareness Interview), psychopathology (PANSS), and both functional capacity (UPSA) and real-life social and occupational function (The Time Use Survey). Path analyses investigated the relationships between variables through Structural Equation Modelling. *Results:* A series of path models demonstrated that metacognition partially mediates the relationship between neurocognition and functional capacity, and fully mediates the relationship between functional capacity and social and occupational function.

*Conclusion:* The present study findings identify that metacognition may be critical to translating cognitive and functional skills into real-world contexts, and this relationship is found at early stages of illness. Understanding how individuals translate cognitive and functional skills into the real-world (the competence-performance gap) may offer valuable guidance to intervention programmes. This finding is important to models of recovery as it suggests that intervention programmes that focus on enhancing metacognition abilities may have a greater impact than traditional rehabilitation programmes focusing on cognitive abilities, on social and occupational outcomes.

## Introduction

Neurocognitive deficits in schizophrenia are considered a core feature of the disorder<sup>1</sup> and a vulnerability marker for later illness development<sup>2</sup>. Cognitive ability may also predict functional recovery in the community<sup>3,4</sup>. Better cognitive performance has been associated with improved self-reported quality of life<sup>5</sup>, social and occupational outcomes<sup>6,7</sup> and these associations persist in longitudinal designs (see Green, Kern, & Heaton, 2004 or Lepage, Bodnar & Bowie, 2014 for a review). Cognitive and functional disability are also credible treatment targets<sup>10</sup>. This association of improved cognitive skills with improved functional outcome led to the introduction of cognitive remediation programmes aiming to improve an individual's cognitive skills, and thereby functional recovery and real world community outcomes<sup>11</sup>. However, currently the evidence for the impact on to real-world improvements in functional status is equivocal<sup>12</sup>. Some reviews suggest that neurocognition only accounts for around 40% of the relationship between cognitive ability and functional outcome, which suggests that 60% of the relationship remains unexplained<sup>13</sup>. The link between neurocognition and functional outcome is perhaps not direct and this has led some to the search for mediating variables to account for the relationship<sup>13</sup>.

Metacognition has been proposed as a candidate variable to explain the unaccounted variance in the relationship between neurocognition<sup>14</sup> and functional outcome<sup>15</sup> in schizophrenia.

Metacognition is broadly defined as 'thinking about thinking'<sup>16</sup> and relates to our ability to inspect cognitive products and mental states<sup>17</sup> and objectively scrutinise them<sup>18</sup>. This higher-order ability draws upon cognitive skills to process self-referential information and may be essential to the integration of raw cognitive processing into a complex and constantly evolving social world<sup>19</sup>. Thus it is what we know that we know, that is important<sup>20</sup>. Being unaware of erroneous decisions (possibly as a result of underlying neurocognitive deficits) may lead to inaccurate social interpretations and poor behavioural response choices fostering functional disability.

Metacognition can be both conceptualised and measured in a number of ways. One particular conceptualisation (synthetic metacognition) has been to assess an individual's ability to describe and reflect back on their own cognition, differentiate between mental state transitions, their relationship to emotion and behaviour and to differentiate between one's own and the mental states of others<sup>21,22</sup>. Other authors have conceptualised metacognition as the insight we have into the fallibility of our own cognition (cognitive insight)<sup>23</sup> or the appropriate level of confidence applied to cognition-based decisions (metacognitive accuracy)<sup>24</sup>. Relationships have been found between metacognition and functioning<sup>25,26</sup> and neurocognition<sup>27</sup> although the findings for

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metacognition as cognitive insight appear more mixed<sup>28</sup>. Metacognition has been found to mediate the relationship between neurocognition and social functioning in a chronic schizophrenia sample<sup>26</sup>. However, it is not known if this finding would be replicated in first episode psychosis or if metacognition predicts real world function<sup>26</sup>. Most research in this area has been completed on chronic cohorts which introduces confounds. In studies the use of chronic cohorts makes findings difficult to interpret as the effects on neurocognition and metacognition are difficult to disentangle from the longer-term impact of neuroleptic medication and differing access to long term contact with psychiatric services and psychological therapies<sup>29</sup>. Past researchers have also tended to employ only one measure of outcome (the frequency of social contacts) whereas functional recovery encompasses a variety of domains including occupational<sup>30</sup>, social<sup>31</sup> and capacity skills<sup>32</sup>.

In relation to functional outcome, metacognition may offer a unique account for functional disability aside from the known relationship with cognition. Metacognition has been found to associate with both social cognition and cognition<sup>26</sup> and factor analytic investigations have found it to load on a separate construct to both<sup>33</sup>. Metacognition uses similar skills to mentalization but specifically addresses the application of these mentalization skills into social contexts.

Assessment of functional outcome has become increasingly sophisticated in recent years with authors beginning to acknowledge the distinction between what one can do (functional capacity) from what one actually does in real-life. Assessments of functional capacity attempt to provide objective measures of current functional ability free from the impact of social factors such as denial of opportunity<sup>34</sup>. Functional capacity has been found to mediate the relationship between neurocognition and real-world function<sup>35</sup>. Gupta and colleagues<sup>36</sup> found that a larger competence-performance gap is associated with earlier onset of illness, depressive symptoms and greater time in hospital suggesting a complex relationship between the variables.

In summary metacognition, having the ability to reflect back and learn, may be critical to the initiation, integrating and application of cognitive skills into real-world situations. These metacognitive skills may aid the learning of new information, improve social and occupational recovery and promote self-management in the community. Incorporating metacognitive processing into cognitive remediation programmes has already begun in trials with positive results thus far<sup>37</sup>. However, research is needed to clarify how metacognition impacts on the relationship between neurocognition and both functional capacity *and* social and occupational function. To date few designs have differentiated between these variables.

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The present study investigated the association between metacognition, neurocognition, and both functional capacity and social and occupational functioning in a cohort of people with first episode psychosis using structural equation modelling. We predicted that metacognition would mediate the relationship between neurocognition and functional capacity (assessed by performance skills assessment UPSA) and secondly that metacognition will mediate the relationship between functional capacity and real-world functioning (assessed by time use). This is the first study of its type with first episode psychosis.

## Method

### *Participants*

Participants were recruited From Early Intervention in Psychosis (EIP) services in Sussex, UK. Ethical approval was obtained (Ref: 11/LO/1877, project ID 72141). All participants gave informed written consent to enter the research study. The study inclusion criteria were: A current diagnosis of FEP and being over the age of 18. Exclusion criteria were: A primary diagnosis of substance misuse or organic neurological impairment or insufficient English language skills to complete the assessments. Demographic and medication information was recorded and medication converted to Olanzapine atypical equivalents using conversion tables from Leucht and colleagues<sup>38</sup>.

### *Measures*

#### *Neurocognition*

Several specific domains of neurocognitive function known to be impaired in schizophrenia and psychosis were selected as previous research identifies the need for more comprehensive and more standardised<sup>39</sup> measurement of neurocognitive impairment.

Verbal and working memory were assessed using the Logical Memory and Letter-Number Sequencing subscales from the Wechsler Memory Scale (WMS-III)<sup>40</sup>. Executive function was assessed through phonological and semantic<sup>41</sup> Verbal Fluency, and the Trailmaking Task. IQ was captured through the Wechsler Abbreviated Scale of Intelligence<sup>42</sup>.

#### *Metacognition*

Metacognition was assessed through two measures; the Metacognitive Assessment Interview (MAI)<sup>43</sup> and the Beck Cognitive Insight Scale (BCIS)<sup>23</sup>. These measures were selected for their frequency of use as metacognitive measures in psychosis and schizophrenia and shared loading in a factor analysis investigation<sup>33</sup>. The MAI is an adaptation of the Metacognitive Assessment Scale (MAS)<sup>22</sup> and based on the same theoretical framework<sup>42</sup> but is less time consuming to administer as metacognitive function is directly questioned as opposed to assessing a standardised psychiatric interview retrospectively. The MAS upon which the MAI is based has been validated across numerous clinical populations<sup>17</sup> including FEP<sup>44</sup> and schizophrenia<sup>19</sup> and the MAI has been validated in a clinical population<sup>45</sup>.

The MAI is a semi-structured clinical interview designed to assess 4 domains of metacognition; *monitoring, integration, differentiation* and *decentralisation*. A manualised set of interview questions are conducted, with the participant response guiding the interview sequence to assess the

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aforementioned domains. The *monitoring* subsection is comprised of questions that capture the interviewee's ability to identify and monitor the thoughts and emotions that make up their own mental state. The *integration* subscale assesses the individual's ability to reflect back on the transitions between their own mental states and identify causal reasons behind the transitions. The *differentiation* subscale assesses the individual's ability to consider their point of view as subjective and fallible and distinguish between fantasies, beliefs and assumptions about reality in relation to factual events. The final *decentralisation* subscale requires the participant to describe and interpret the mental state of another person and to understand how that person's beliefs, values and perspectives are separate from their own.

The BCIS captures the participant's self-reported ability to reflect on their own cognitive products, distance themselves from and re-evaluate thoughts, beliefs, and subjective interpretations<sup>23</sup>. It comprises 2 subscales; the self-reflectiveness scale assesses the individual's willingness to reflect upon and be objective about thoughts. The self-certainty subscale relates to the individual's certainty about being right and their resistance to correction. This information is measured through 15 self-report questionnaire items rated from 0 (do not agree at all) to 3 (agree completely). The BCIS has been assessed for validity and reliability<sup>23 46</sup> and employed in FEP<sup>48</sup>.

### *Symptoms*

Symptoms were measured by the Positive and Negative Syndrome Scale (PANSS)<sup>49</sup>. The PANSS has been well validated in research<sup>50</sup> and employed in FEP<sup>44</sup>.

### *Functioning*

Function was measured through two methods; functional capacity and self-reported social and occupational functioning (SOF). Functional capacity was measured by the UCSD Performance-Based Skills Assessment (UPSA)<sup>51</sup> and SOF was captured by the Time Use Survey<sup>52</sup>. The UPSA is an instrument to assess capacity to complete everyday tasks across five domains; finance, communication, comprehension and planning, transportation and household chores. The UPSA has been assessed for reliability and validated in schizophrenia<sup>52</sup> and employed in FEP before<sup>53 54</sup>.

The Time Use Survey<sup>51</sup> is a semi-structured interview in which the participant is asked about the amount of time spent undertaking a variety of activities in the preceding month. The activities capture a host of functional domains including employment, education, voluntary work, leisure and sport, childcare and household maintenance. The total time spent in structured activities was

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calculated from the aforementioned domains and included in analysis as a measure of SOF. The Time Use survey has been used in healthy individuals, FEP and CHR groups<sup>56</sup> in previous research.

### *Data Analysis*

First, descriptive statistics for all variables were computed using SPSS version 22 and inspected for normality and suitability for factor analysis. Second, preliminary relationships between variables were investigated through correlation analysis. The factor structure of observed variables was next explored using Mplus version 6. Factor structure was assessed through Confirmatory Factor Analysis (CFA) where pre-existing data was available and Exploratory Structural Equation Modeling (ESEM) where no existing research had assessed factor structure in the population.

Third, Mediation analyses were conducted using Mplus (version 6), to investigate the relationships between the key factors of neurocognition, functional capacity and SOF, with metacognition as a mediator. The role of negative symptoms was also explored. The mediation model was investigated through indirect pathway statistics and Confidence Intervals (CI) derived through bootstrapping as suggested by Preacher and Hayes<sup>56</sup>. To support the direction of the relationships investigated, reverse models were also assessed. Lastly, to rule out the role of medication, the relationship between Olanzapine equivalent and metacognitive variables and function was investigated through correlation analysis.



## Results

### *Sample statistics*

Eighty FEP patients were recruited in total, mean age 26.08 (SD. 5.53, range 18-40) and the sample was comprised of 49 male and 31 female patients (see table 1 for demographic information).

### **[Insert table 1 here]**

The means and standard deviations of the neurocognitive, metacognitive and functional capacity and outcome variables are available in table 2 below. Detailed test statistics are provided in table 3 and 4. In addition appropriate summary test statistics (r values) have been included throughout. Missing data was treated as Missing at Random (MAR) therefore a maximum likelihood model estimation was used to address missing data issues as the default in Mplus.

Model selection and assessment was made using the criteria outlined by Preacher and Hayes<sup>57</sup> where bootstrapping and confidence intervals are advised to assess the presence of mediation rather than the more traditional Baron and Kenny approach.

### **[Insert table 2 here]**

### *Factor analysis*

A CFA confirmed that neurocognition was a 1-factor solution containing verbal and working memory, executive function, verbal and performance IQ. The model demonstrated an acceptable fit to the observed data ( $\chi^2(29) = 29.55, p=.06, CFI= 0.96, TLI=0.95, RMSEA= 0.08$ ). An ESEM analysis suggested that metacognition was best captured by the BCIS self-reflectivity and MAI total score. The CFA for functional capacity suggested that a 1-factor solution offered acceptable model fit statistics test ( $\chi^2(5)=10.59, p=.06, CFI= .94, TLI= .89, RMSEA= .13$ ). Self-reported social and occupational function was included a single item observed variable in mediation analysis.

### *Correlation analysis*

### **[Insert table 3 here]**

Table 3 reveals that, as suggested by previous research, neurocognitive ability is significantly associated with one's ability to conduct everyday tasks (functional capacity) and the amount of time spent in structured activities (SOF). Higher neurocognitive ability is associated with better

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individual functioning. The analysis also demonstrates that metacognitive ability, both measured by the MAI and the BCIS self-reflectivity scale, is positively associated with both functional capacity and SOF. This suggests that better metacognitive function is associated with greater capacity to complete daily living tasks and spending more time in structured activities. Due to the high correlation between neurocognition and education level, neurocognition alone was selected for further analysis. No significant relationship was found between medication dose and metacognition ( $p=.687$ ) or functional capacity ( $p=.407$ ) or SOF ( $p=.369$ ) so excluded from further analysis.

### *Path Analysis*

To replicate existing work, the role of functional capacity in mediating the relationship between neurocognition and SOF was investigated and a significant mediation pathway was found. In order to test the mediating effect of metacognition on the relationship between neurocognition and functional capacity, model 1 (figure 1 below) was tested. A significant direct pathway was found between neurocognition and both functional capacity ( $p<.001$ ) and metacognition ( $p=.02$ ) and between metacognition and functional capacity ( $p=.005$ ). The mediation model was then run and metacognition significantly mediated the relationship between neurocognition and functional capacity ( $\beta=.29, p=.009, +/-95\% [.07, .50]$ ). As the direct pathway remained significant in the mediation model the data is consistent with partial mediation. The mediation model accounted for 67% ( $R^2=.67$ ) of the variation in capacity to complete simulated daily living tasks and 31% of the variation in metacognitive ability ( $R^2=.31$ ). The reverse model (X and Y reversed and Y and M reversed) was not significant. Additional models were run with a significant secondary mediation pathway through negative symptoms and negative symptoms as an individual mediator of cognition and functional capacity. However introducing negative symptoms into the model led to the model fit statistics (CFI, TFI and chi square model fit) deteriorated below what is considered acceptable model fit therefore the simple model with only metacognition was selected.

**[insert fig 1 here]**

Next, the relationship between functional capacity and SOF was assessed, with metacognition as a mediator (figure 2 below). Metacognition significantly mediated the relationship between functional capacity and SOF as evidenced by the indirect path ( $\beta=.41, p=.001, 95\%CI [.31, .64]$ ). Interestingly, as the direct path is not significant, this suggests the presence of full mediation and the model accounted for 66% of the variance in SOF ( $R^2=.66$ ). The reverse model was not

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significant. Alternative models were also run and metacognition was found to significantly mediate the relationship between neurocognition and SOF (available in table 4. Table 4 contains the indirect (mediation) path statistics, CIs and overall model fit statistics). This confirms that the ability to conduct daily tasks and the ability to scrutinise cognitive products are implicated in translating cognitive abilities into real-life contexts.

**[insert fig 2 about here]**

**[Insert table 4 here]**

## Discussion

The present study offers two important findings; a) that metacognition partially mediates the relationship between neurocognition and functional capacity, and b) that metacognition fully mediates the relationship between functional capacity and SOF. All models reported demonstrated acceptable model fit statistics (table 4) and the effect sizes ( $R^2$ ) are large adding to the importance of the present work. In relation to the hypotheses, hypothesis one that metacognition would significantly mediate the relationship between neurocognition and functional capacity, was partially accepted as a significant partial mediation relationship was found. Hypothesis two that metacognition would significantly mediate the relationship between functional capacity and SOF was fully supported.

### *Neurocognition and functional capacity*

The mediation analysis found that metacognition partially mediates the relationship between neurocognition and functional capacity explaining 67% of the overall variance in functional capacity. This suggests that raw cognitive ability may not be sufficient in itself to successfully complete everyday tasks but rather the metacognitive ability to accurately reflect back on cognition may be a key ingredient in equipping those recovering from psychosis to apply these cognitive process to function effectively.

### *Functional capacity and SOF*

In terms of the relationship between functional capacity and SOF, metacognition was found to fully mediate this relationship. This is an important finding as this suggests that, whilst individuals may possess the capacity to complete tasks essential to community function, without sufficient metacognitive abilities, these skills may not be initiated, integrated and applied successfully to support real-world function and recovery. This finding suggest that metacognition and the ability to reflect back on cognitive products and accurately identify their relationship to emotions and behaviour in both the self and others, is critical to translating cognitive skills into real-world behaviour.

In terms of the relationship between neurocognition and metacognition, the present study corroborates the work of Hamm et al.,<sup>58</sup> Nicolò et al.,<sup>14</sup> and Abu-Akel and Bo<sup>59</sup> and a host of papers by Paul Lysaker<sup>17,21,26</sup> in which improved neurocognition is associated with better metacognition. The present sample report similar scores to a paper by Lepage<sup>28</sup> in FEP on both

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self-reflectivity (mean 13 versus the present study 15.88) and self-certainty subscales (7.9 versus the present study 5.88). The work available on synthetic metacognition is more difficult to compare as the other studies in the area<sup>45 29</sup> used a slightly different measure. The present study does however offer corollary support in that deficits in metacognition are present in FEP however goes further by offering an account for the relationship between neurocognition and functional outcome. The findings that self-reflectivity but not self-certainty loaded onto an overall metacognitive factor is interesting and can be accounted for by known work in the area. Gilleen, David and Greenwood<sup>60</sup> found a relationship between self-reflectivity and awareness but not with self-certainty. Self-certainty may be more related to pathology and delusional thinking than higher-order synthetic metacognition. The present study also confirms that metacognition is an important determinant of community function as suggested by Giusti et al.,<sup>25</sup> and Brüne et al.,<sup>18</sup>. These studies were predominantly obtained in chronic samples however and this is the first study in first episode psychosis.

The present study builds on Lysaker et al.'s<sup>26</sup> study which found that metacognition mediated the relationship between cognition and social function. The present study extends this finding going on to demonstrate that this mediation effect may also be found using a measure of real life function (time use), as well as functional capacity (UPSA) and using a richer overall construct of metacognition. The present study was conducted in first episode psychosis which minimises the problems of interpretation associated with findings from chronic participants due to confounding with chronicity of illness and associated medication and treatment therapy exposure. The present paper adds to our understanding of the competence-performance gap<sup>35</sup> by suggesting that metacognition may account for the disparity in the ability to complete daily living tasks, and actually performing them in the community. The present findings may imply that the relationship between cognition and functional outcome may be a multi-step pathway, with metacognition as well as social cognitive and belief driven causal mechanisms. While Green, Llerena and Kern<sup>61</sup> have discussed this possibility, they suggest that a single pathway through social cognition is the most parsimonious solution.

The role of social cognition was not investigated in the present study although has been investigated at length elsewhere<sup>8 30</sup>. However some shared relationship between the MAI domain understanding the mind of others and social cognitive domains such as theory of mind would be expected as both require the individual to adopt the perspective of others which may be key to a host of functional domains such as social relationships and occupational functioning. A future study investigating the relationship between social cognitive and metacognitive variables on

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different aspects of functional outcome would be valuable to understand the unique contribution each offers different aspects of community functioning. Our findings suggest that metacognition may be a key mediating variable which is able to offer an account for how these pathways interact.

This study had methodological strengths in contrast to previous studies using chronic samples. No significant relationships were found between medication and metacognitive domains or outcome domains in this first episode sample thus the impact of medication may be minimised. Furthermore although the sample was still predominantly male, the ratio was much more even (61% male versus 39% female) than in past studies. This is also the first study to incorporate cognitive insight into this analysis and suggests that self-reflectivity may contribute to community function in addition to cognitive ability.

In addition to work with CRT, the present study adds to the evidence base supporting treatment initiatives such as the Metacognitive Reflection and Insight Therapy (MERIT) and Neurocognitive Enhancement Therapy (NET) which also directly target the mechanisms discussed in the present paper for development in psychotherapy. MERIT seeks to assist those in treatment with developing a more complex narrative of their own mental lives and to be able to reflect on interpersonal events to better assist reducing social disability<sup>62</sup>. The present study offers a clear link between these abilities and their importance to improving functional outcome at early stage of illness. One of the key outcomes for NET has been identified as translating cognitive skills into real-world benefits<sup>63</sup> and the present study demonstrates that metacognitive ability may be key to facilitating this.

Engaging in normative social and occupational activity<sup>64</sup> and participating in social and meaningful activity<sup>65</sup> have been identified as key to personal recovery<sup>66</sup>. Thus a greater understanding of factors that allow individuals to maintain or regain these structured activities is crucial to treatments to improve functional outcome

The study findings are of clinical relevance as they suggests that cognitive abilities are an important determinant of the capacity to complete everyday tasks however metacognition is also required to navigate the complexities of daily life. When it comes to translating these skills into a real-world setting, targeting metacognition is potentially at least as important as a focus on raw cognitive ability which may be less amenable to intervention. In summary, one's ability to reflect

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back on cognition and monitor the transitions between mental states may improve both the capacity to complete daily tasks and apply these competencies to real-world situations.

### **Limitations**

Whilst the present study attempted to address many of the identified issues with known research, a number of limitations must be held in mind when considering the findings. Firstly, the present study is cross-sectional so the impact of changes in neurocognition and metacognition and how these may impact on functional levels in the individual are not known. The reverse model testing offers support to the direction of effects however Maxwell and Cole<sup>67</sup> warn against claims of causation when employing cross-sectional data. Future studies tracking the changes in all three domains across time would offer greater insight into the mechanisms of the temporal relationship between variables.

The MAI, as a measure of synthetic metacognitive ability, relies on self-report of internal mechanisms. Language disturbances have been identified as a primary feature of schizophrenia<sup>68</sup> or as a result of current symptoms<sup>69</sup>. As a self-report interview measure reliant upon verbalisation of internal experiences, deficits may be due to linguistic deficits or descriptive impairment rather than metacognition per se. However as one of the measures of neurocognition is verbal IQ, logical memory and verbal fluency also draw on these abilities, both neurocognition and metacognition measurement would have been impacted on by language deficits in the study.

Secondly, the present study was potentially underpowered however sample size was acceptable for simple path analysis to detect mediation effects according to Fritz and MacKinnon<sup>70</sup>. In addition to maximise power, the models assessed were restricted; ideally the path models would have been measurement models with all indicators included however the present study had to approach this in a stepwise manner and run through multiple models to maintain a respectable case to parameter ratio<sup>71</sup>. Finally, due to the poor factor loading of self-certainty, the latent variable of metacognition was only measured by two indicators. Whilst Kenny suggests this as a minimum number, three is a safer option<sup>72</sup> and under estimation may lead to biased parameter estimates<sup>73</sup>. The significant correlation however between the two indicators helps to justify the use of only two indicators.

### **Implications**

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Despite these restrictions, the present study implicates metacognition in both functional capacity and real-world functioning. This confirms the relationship between neurocognition and function being mediated by metacognition. This also demonstrates that this relationship is present at early stages of illness. Metacognition may be a critical ingredient in initiating, integrating and applying a host of skills into occupational and social situations and this may suggest that treatment programmes may wish to target this ability in care pathways. Cognitive remediation programmes have already started to incorporate metacognitive content to traditional cognitive remediation exercises<sup>36</sup> and the present study suggests that this is a valuable addition. By improving both cognition and metacognition rather than solely the former, recovery from psychosis after symptoms have subsided may be maximised. The effect sizes (variance accounted for) were also larger than previous studies investigating the relationship between neurocognition and function accounting for a large proportion of the overall variance in outcome. This offers far more explanation of functioning and highlights the importance of metacognition in functional outcome.



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Figure 1: *Mediation of the effect of neurocognition on functional capacity through metacognition.*

\*\*\* $p < .001$ , \*\*  $p < .01$ , \* $p < .05$

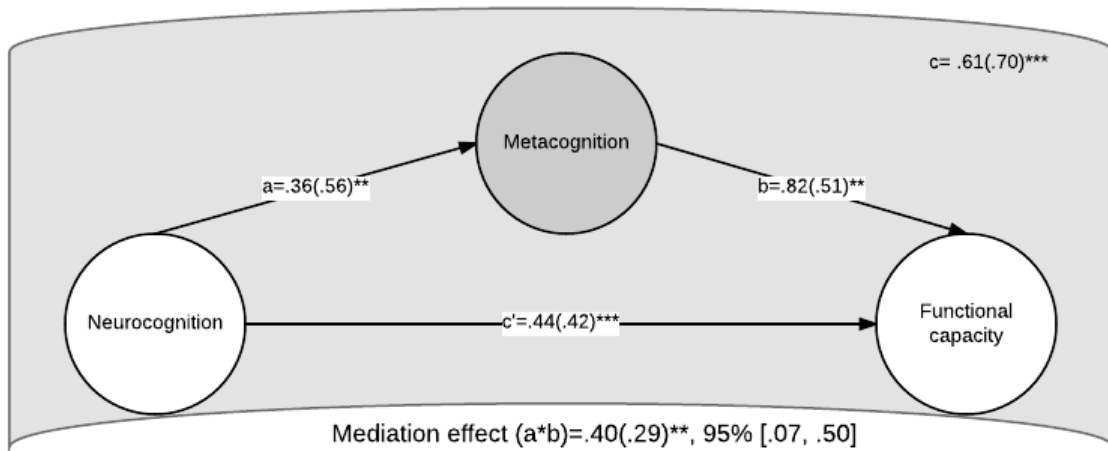
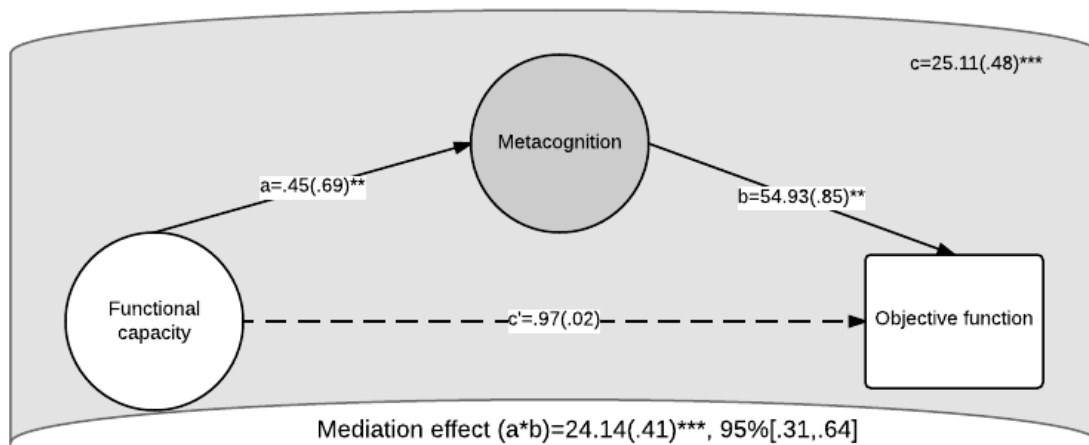


Figure 2: *Suggested mediation model of functional capacity to relationship objective community function mediated by metacognition.* Key: \*\*\* $p < .001$ , \*\*  $p < .01$ , \* $p < .05$



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Table 1: Sample characteristics

Sample characteristics	Mean (SD)
Age	26.08 (5.53)
Gender (M/F)	49/31
Symptoms (positive)	12.01 (3.5)
Symptoms (negative)	13.6 (4.92)
Symptoms (general)	28.35 (6.7)
Prescribed anti-psychotic medication (Y/N)	48/32
Olanzapine equivalent dose (of those prescribed medication) (mg/day)	12.77 (7.79)

Table 2: Variable mean scores and range

Variables	Raw score mean (SD)	Range
Neurocognition	Logical Memory I <sup>(0-75)</sup>	27.7 (10.9) (10-55)
	Logical Memory II <sup>(0-50)</sup>	16.28 (8.26) (0-35)
	Letter-number Sequencing <sup>(0-21)</sup>	8.64 (2.46) (4-15)
	Verbal Fluency (phonetic)	32.28 (10.27) (5-56)
	Verbal Fluency (semantic)	18.49 (4.77) (9-29)
	Matrix Reasoning <sup>(0-35)</sup>	25.82 (4.13) (13-34)
	Vocabulary <sup>(0-80)</sup>	52.8 (11.67) (11-73)
	Trailmaking Task (B-A)	37.99 (33.88)
Metacognition	(MAI) Monitoring <sup>(0-5)</sup>	2.93 (1.25) (0-5)
	(MAI) Differentiation <sup>(0-5)</sup>	2.77 (1.17) (0-5)
	(MAI) Integration <sup>(0-5)</sup>	2.83 (1.22) (0-5)
	(MAI) Decentralism <sup>(0-5)</sup>	2.57 (1.43) (0-5)
	(BCIS) Self-reflectivity <sup>(0-27)</sup>	14.3 (5.06) (0-5)
	(BCIS) Self-certainty <sup>(0-18)</sup>	5.88 (2.88) (0-5)
Functional outcome	(UPSA) Finance <sup>(0-20)</sup>	15.68 (3.06) (7.27-20)
	(UPSA) Communication <sup>(0-20)</sup>	12.99 (3.69) (5-18.33)
	(UPSA) Comprehension & planning <sup>(0-20)</sup>	12.48 (4.65) (0-20)
	(UPSA) Transport <sup>(0-20)</sup>	15.12 (3.03) (8.89-20)
	(UPSA) Household <sup>(0-20)</sup>	15.75 (4.42) (0-20)
	(Time Use) Structured activity (total hours per week)	24.97 (23.09) (2.3-96.74)

Key: Scale total range indicated in brackets (x-x)

Table 3: Bivariate correlations between variables

	Education	Neurocognition	BCIS self-reflectivity	MAI	UPSA	Time Use
Neurocognition	.56***	1				
Beck Cognitive Insight Scale: self-reflectivity	.37**	.19	1			
Synthetic metacognition (MAI)	.56***	.61***	.43***	1		
Functional capacity (UPSA)	.57***	.70***	.31**	.81***	1	
Self-report social and occupational function (Time Use)	.43**	.48***	.33**	.84***	.64***	1

\*\*\* $p < .001$ , \*\* $p < .01$ , \* $p < .05$

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Table 4: Full list of mediation models with fit statistics

<i>Predictor</i>	<i>Mediator</i>	<i>Outcome</i>	<i>Model fit</i> ( $\chi^2$ (df), <i>p</i> )	<i>CFI/TFI/RMSEA</i>	<i>Indirect</i> ( <i>a*b</i> , [95%CI])	<i>R<sup>2</sup><sub>med</sub></i>	<i>R<sup>2</sup><sub>out</sub></i>
NC	MC	FX	.03(1), .86	1.00, 1.04, .00	.40(.29)** [.07, .50]	.313	.673
NC	MC	FO	.11(1), .74	1.00, 1.04, .00	18.55(.41)*** [.31, .64]	.317	.594
NC	FX	FO	.00(0), .00 <sup>a</sup>	1.00, 1.00, .00	18.74(.40)*** [.26, .55]	.495	.413
FX	MC	FO	.17(1), .68	1.00, 1.00, 0.00	24.14(.41)*** [.31, .64]	.314	.66
NC	MC, Neg	FX	.22(3), .00	.89, .63, .00	25.68(.60)** [.24, .95]	.595	.71

\*\*\*= $p < .001$ , \*\*= $p < .01$ , \*= $p < .05$ . Notes: NC=neurocognition, MC=metacognition, FX=functional capacity, FO=self-report structured activity, Neg=negative symptoms, <sup>a</sup>= just identified model, ()=standardised value

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