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Abstract

Social cognition is a mediator between nonsocial cognition and functional outcome in schizophrenia. However, the relationship between specific nonsocial cognitive and social cognitive domains is less clear. The aim of this study was to investigate which specific nonsocial cognitive domains best predict theory of mind (ToM) performance in schizophrenia. We indexed ToM by a composite score of the video-based Movie for the Assessment of Social Cognition test (MASCtot) in a sample of 91 individuals with schizophrenia. Nonsocial cognition was measured with the nonsocial cognitive subtests of the MATRICS Consensus Cognitive Battery (MCCB) and the Wechsler Abbreviated Scale of Intelligence (WASI IQ). Bivariate and multiple regression analyses were applied. We found statistically significant bivariate associations between MASCtot and five nonsocial cognitive tests, measuring intelligence, speed of processing, verbal or visual memory, and non-verbal working memory. Together, they accounted for 17% of the variation in MASCtot, but none of the five tests made significant unique contributions to MASCtot in the regression analysis. Our results confirm that nonsocial cognition and ToM are associated, albeit distinct, constructs. The findings suggest that cognitive remediation must include social cognitive targets in order to achieve improved ToM and better functioning.

Keywords Schizophrenia, Social cognition, Theory of mind (ToM), Nonsocial cognition, MASC, MCCB

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Highlights

- Individuals with schizophrenia experience impairments in social and nonsocial cognition
- Significant associations exist between the two types of cognition with social cognition mediating the relationship between nonsocial cognition and functional outcome
- How specific neuropsychological functions relates to theory of mind is less clear
- This study found that none of the nonsocial cognitive tests uniquely predicted theory of mind although they together explained 17% of the variance

Social cognition is a mediator between nonsocial cognition and functional outcome in schizophrenia. However, the relationship between specific nonsocial cognitive and social cognitive domains is less clear. The aim of this study was to investigate which specific nonsocial cognitive domains best predict theory of mind (ToM) performance in schizophrenia. We indexed ToM by a composite score of the video-based Movie for the Assessment of Social Cognition test (MASCtot) in a sample of 91 individuals with schizophrenia. Nonsocial cognition was measured with the nonsocial cognitive subtests of the MATRICS Consensus Cognitive Battery (MCCB) and the Wechsler Abbreviated Scale of Intelligence (WASI IQ). Bivariate and multiple regression analyses were applied. We found statistically significant bivariate associations between MASCtot and five nonsocial cognitive tests, measuring intelligence, speed of processing, verbal or visual memory, and non-verbal working memory. Together, they accounted for 17% of the variation in MASCtot, but none of the five tests made significant unique contributions to MASCtot in the regression analysis. Our results confirm that nonsocial cognition and ToM are associated, albeit distinct, constructs. The findings suggest that cognitive remediation must include social cognitive targets in order to achieve improved ToM and better functioning.

Nonsocial cognitive underpinnings of theory of mind in schizophrenia

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1. Introduction

Impaired social and nonsocial cognition are common features of schizophrenia (Bora et al., 2016; Green et al., 2019). Nonsocial cognition, also referred to as neurocognition, typically involves speed of processing, attention/vigilance, working memory, verbal learning, visual learning, reasoning, and problem-solving (Green et al., 2019; Nuechterlein et al., 2008). Impairments in nonsocial cognition range from 0.75 to 1.5 standard deviations below healthy control individuals, with especially pervasive deficits seen for long-term memory and speed of processing (Green et al., 2019). Social cognition encompasses several domains; emotion processing, mentalizing/theory of mind (ToM), social perception/knowledge, and attributional bias (Green et al., 2008; Pinkham, 2014). A metaanalysis found large impairments compared to healthy control participants for all domains (Hedges' g

= 0.88 - 1.04), except attributional bias (Savla et al., 2013).

Both social and nonsocial cognition are important determinants of functional outcome in schizophrenia (Combs et al., 2011; Couture et al., 2006; Fett et al., 2011; Ludwig et al., 2017; Mehta et al., 2014). A meta-analysis showed that nonsocial cognition explained 6% of the variance, while social cognition was accountable for 16% of the variance in functional outcome (Fett et al., 2011). ToM, i.e. “the ability to infer the intentions, dispositions, and beliefs of others” (Green & Horan, 2010), is among the stronger social cognitive predictors of functional outcome (Fett et al., 2011; Halverson et al., 2019). Further, several studies find that social cognition mediates the relationship between nonsocial cognition and functional outcome (Fett et al., 2011; Halverson et al., 2019; Schmidt et al., 2011), indicating a link between nonsocial cognition, social cognition and functional outcome (Brekke et al., 2005; Schmidt et al., 2011; Vauth et al., 2004). Mediation models of this relationship explain around 25% of the variance in functional outcome (Schmidt et al., 2011). Hence, there is some degree of overlap between nonsocial and social cognition in schizophrenia (Green et al., 2015). A meta-analysis showed that nonsocial cognition can account for 5–11% of social cognition (Ventura et al., 2013), suggesting that nonsocial cognitive abilities may be necessary to process socially relevant information (Fanning et al., 2012). A detailed understanding of the relationship between specific nonsocial cognitive functions and social cognition has practical benefits by suggesting treatment targets that may be of value for improving social cognition and functional outcome.

Of special interest among the social cognitive domains is ToM since it is often impaired (Savla et al., 2013) and a particularly strong predictor of outcome in schizophrenia (Fett et al., 2011). Several schizophrenia studies have found statistical associations between ToM and specific nonsocial cognitive functions, such as executive functions (EF) (Mehta et al., 2014), visual memory (Mehta et al., 2014), verbal memory (Deckler et al., 2018; Mehta et al., 2014; Mike et al., 2019), verbal working memory (Deckler et al., 2018), and speed of processing (Deckler et al., 2018). A meta-analysis concluded that moderate associations exist between ToM and nonsocial cognitive domains, without significant differences between domains (Thibaudeau et al., 2020). Intelligence (i.e., IQ) has also been found to be moderately correlated with ToM (Fretland et al., 2015; Ventura et al., 2013). Other studies, however, have failed to show significant associations between ToM and nonsocial cognition (Oh et al., 2010; Parola et al., 2018; Pickup, 2008). Also, a study that explored the relationship between ToM, IQ and EF in schizophrenia, found that ToM deficits remained after controlling for IQ and EF (Abdel-Hamid et al., 2009). Similarly, other experimental studies (Janssen et al., 2003; Pickup and Frith, 2001), as well as a meta-analysis (Sprong et al., 2007), have found only minor effects of IQ on ToM. Overall, therefore, findings regarding the relationship between ToM and nonsocial cognition are mixed.

One reason may be the use of a wide range of ToM tasks that differ in test characteristics. For instance, tests may show divergent patterns of convergent and discriminant validity related to variations in which nonsocial cognitive processes they rely on (Bora et al., 2009). Hence, heterogeneous test characteristics may rend it difficult to obtain consensus regarding ToM and its nonsocial cognitive underpinnings. The strength of the association between nonsocial cognition and ToM may depend on the test used (Thibaudeau et al., 2020). For instance, several ToM tests have limited ecological validity (Feyerabend et al., 2018), i.e. are not closely related to real-life experiences and interactions (Bora et al., 2009; Montag et al., 2011). This is the case with tests that use static stimuli. Among these is the commonly used Reading the Mind in the Eyes Test (Baron-Cohen et al.,

1997) which consists of static, still pictures reflecting a specific emotion rather than dynamic stimuli (complex, shifting emotions in real life interactions) (Feyerabend et al., 2018). Other examples of static ToM tests are false-belief tasks (Bora et al., 2009; Fernandez-Gonzalo et al., 2013), many of which also only incorporate verbal stimuli (Bora et al., 2009). Tests with high ecological validity that use dynamic stimuli to capture the complexity of ToM (Adolphs et al., 2003; Weyers et al., 2006) are probably more likely to depend on multiple nonsocial cognitive domains than simple, static ToM tests. ToM tests with different degrees of ecological validity may show different associations with nonsocial cognition.

One measure with good ecological validity is the Movie for the Assessment of Social Cognition (MASC) (Dziobek et al., 2006). It is a reliable measure with high interrater reliability, internal consistency, and test-retest stability, and includes ToM concepts such as irony, sarcasm, metaphor, persuasion, *faux pas*, deception, as well as first and second order false belief (Dziobek et al., 2006). MASC can provide information about mentalizing style, i.e. if a person undermentalizes or overmentalizes when committing errors (Dziobek et al., 2006), and about affective (understanding the emotional state of others) and cognitive (understanding the thoughts, beliefs and intentions of others) ToM (Shamay-Tsoory et al., 2007). Unlike many other ToM tests, MASC encompasses dynamic stimuli (i.e., real persons in interaction), and displays everyday life situations (Andreou et al., 2015; Feyerabend et al., 2018). The use of MASC may contribute to a more precise and ecologically relevant understanding of ToM impairment in schizophrenia.

Four previous studies have explored the relationship between MASC performance and measures of nonsocial cognition in schizophrenia. Andreou et al. (2015) found that patients with schizophrenia differed from healthy controls and patients with personality disorder primarily by making significantly more undermentalizing errors. These errors were related to verbal memory, facial emotion recognition and premorbid IQ, but not to attention or cognitive flexibility. Fretland et al. (2015) reported that MASCtot score was associated with IQ, but did not investigate other nonsocial cognitive variables. Catalan et al. (2018) found that MASCtot was associated with speed of processing, visual memory and EF, but not with IQ. Vaskinn et al. (2018) reported that all MASC measures (total ToM, cognitive ToM, affective ToM, overmentalizing, undermentalizing, and no mentalizing errors) were associated with a composite nonsocial cognitive score, which accounted for about 17% of the variance in MASCtot.

To sum up, findings are mixed concerning which specific nonsocial cognitive processes, or neuropsychological function might be of significance for ToM performance. Clarifying this relationship might contribute to advances in treatments that aim to improve social cognition and functional outcome, such as cognitive remediation (Mehta et al., 2014; Ventura et al., 2015). For MASC, specifically, there is no consensus regarding the importance of IQ. Visual and verbal memory seem important, but whether one or the other is more important for MASC performance is currently not well understood.

The aim of the current study was to examine which neuropsychological function, measured with the MATRICS Consensus Cognitive Battery (MCCB) (Nuechterlein et al., 2008) and Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 2007), best predicts ToM. Based on existing literature, we hypothesized that MASCtot would be positively correlated with IQ, visual and verbal memory, speed of processing, and EF. Second, given the consensus in the literature regarding social and nonsocial cognition as related, yet distinct constructs, we expected that the nonsocial cognitive measures would account for < 20% explained variance in MASCtot.

2. Methods

2.1. Participants

This is a follow-up study of Fretland et al. (2015) (same data set, smaller sample) and Vaskinn et al. (2018) (same sample). Ninety-one participants (57 men, 34 women) with a diagnosis of schizophrenia (*n* = 69) or schizoaffective disorder (*n* = 22) according to the 4th edition of the Diagnostic and Statistical Manual for Mental Disorders, DSM-IV (APA, 2000) were included. All participants were recruited from hospitals in the greater Oslo area to the Thematically Organized Psychosis (TOP) study at the Norwegian Centre for Mental Disorder Research (NORMENT) at Oslo University Hospital. Study participation usually included 3-5 study visits, with cognitive assessments taking place within 2 weeks of symptom measurement. Inclusion criteria were age between 18 and 55 years, as well as all compulsory schooling conducted in Norway, or Norwegian as mother tongue.

Criteria for exclusion were neurological disease or head trauma causing hospitalization and IQ < 70 as measured by WASI. Participants provided their informed consent, and the study was approved by the regional committee for medical research ethics. Some of the participants (n = 48) took part in a social cognition treatment study (Clinicaltrials.gov ID NCT01206842) (Vaskinn et al., 2019), and their baseline data was used in the current study. None of the participants had undergone repeated assessments with the cognitive tests before inclusion in the study. Psychologists and medical doctors who have undergone an international training program (Ventura et al., 1998) and who receive supervision by experienced specialists in clinical psychology or psychiatry conduct the diagnostic and clinical assessments at NORMENT. Diagnoses were determined using The Structured Clinical Interview for DSM-IV Axis I (First et al., 1995). Other clinical instruments included the Positive and Negative Syndrome Scale (Kay et al., 1987) and the Global Assessment of Functioning (Pedersen et al., 2007). See Table 1 for demographic and clinical information.

2.2. Social cognitive measures

We used the Norwegian version (Fretland et al., 2015) of the MASC test (Dziobek et al., 2006) to assess ToM. MASC consists of a 15-minute video which follows two men and two women during a dinner party. The video is paused 45 times, and each time the participants are presented with multiple choice questions. Each question consists of four response alternatives. To measure mentalizing ability, the participants are instructed to make inferences regarding the four characters' thoughts, feelings and intentions. The various response alternatives represent different aspects of mentalizing (Vaskinn et al., 2018). Because MCCB has been found to predict 8-18% of the variance of all the MASC measures (Vaskinn et al., 2018), the MASCtot score was used as the dependent variable in our analyses.

2.3. Nonsocial cognitive measures

Nonsocial cognition was measured with WASI (Wechsler, 2007) and the nine nonsocial cognitive subtests of the MCCB (Nuechterlein et al., 2008): Trail Making Test Part A (TMT-A); Symbol Coding from Brief Assessment of Cognition in Schizophrenia (BACS); Category Fluency Animal Naming (Verbal fluency); Continuous Performance Test—Identical Pairs (CPT-IP), Hopkins Verbal Learning Test— Revised (HVLT-R); Spatial Span from Wechsler Memory Scale, Third Edition (WMS-III), Letter–Number Span (LNS); Brief Visuospatial Memory Test—Revised (BVMT-R); and Mazes from the Neuropsychological Assessment Battery (NAB). The T-scores of these nine tests were used in the analyses. Missing data was handled as described in Vaskinn et al. (2018): four participants had missing data for one MCCB subtest, and one participant had missing data for three MCCB subtests.

The mean T-score of the group for the specific subtests was entered for the statistical analyses. Trained psychologists or master level psychology students undertook the neuropsychological assessments.

2.4. Statistical analysis

Several of the nonsocial cognitive variables were non-normally distributed according to the Kolmogorov Smirnov test with Lilliefors Significance Correction. Thus, nonparametric statistics were used in the first step, where the relationship between WASI, the nine MCCB test scores and MASCtot, were investigated with bivariate correlation analysis (Spearman's rho). The strength of all correlations was determined according to Cohen's guidelines (1988), in which small is indicated by $r > .10$, medium $r > .30$ and large $r > .50$. Two-tailed tests were applied to all analyses and p-levels were Bonferroni-corrected (.05/10 nonsocial cognitive tests = new p-level .005). In the second step, nonsocial cognitive variables that were significantly associated with MASCtot at the corrected p-level with a moderate effect size ($r > .30$) were entered as independent variables in a standard multiple regression analysis. To assess collinearity, the correlation coefficients between each of the nonsocial cognitive variables in the bivariate correlation analysis were examined. MASCtot was entered as the dependent variable. Standard multiple regression was used since the aim was to investigate which of the nonsocial cognitive variables made the strongest unique prediction to MASCtot.

3. Results

Table 2 presents participants' MASC and MCCB data. Bivariate correlations between ToM performance (MASCtot) and cognition (MCCB and WASI) are presented in Table 3. Based on Bonferroni corrected p-levels and moderate effect size, BACS, HVLT, WMS, BVMT-R, and WASI were found to correlate with MASCtot at the preselected level. These five nonsocial cognitive variables were therefore entered as predictors of MASCtot in a standard multiple regression analysis, after controlling for collinearity. None of the variables exceeded r =.70, thus the rule of collinearity was not violated, as displayed in Table 3. The regression analysis for predictors of MASCtot is presented in Table 4. Together all the nonsocial cognitive variables explained 17% of the variance. BVMT-R had the highest beta value, followed by BACS. However, neither of the independent variables made a unique significant contribution to the model.

4. Discussion

The aim of this study was to examine which neuropsychological function, measured with MCCB and WASI, best predict ToM. Our first hypothesis received partial support. We expected significant associations between ToM on the one side, and IQ, visual and verbal memory, speed of processing, and EF, respectively, on the other side. The strongest association was found for speed of processing (medium-large), as measured by BACS. Further, the bivariate correlation analyses yielded moderate-sized correlations with IQ, visual memory, and verbal memory. EF was not significantly associated with ToM. A non-expected moderate correlation with nonverbal working memory appeared. Still, none of the nonsocial cognitive variables made significant, unique contributions to ToM, suggesting that none of these variables alone are prominent predictors of ToM performance. Instead, this implies that variance shared among neuropsychological tests – or even a general nonsocial cognitive deficit (Bora et al., 2009) – partly underlies ToM in schizophrenia. The results corroborate a recent meta-analysis that found no differences in the strength of associations between ToM and the examined nonsocial cognitive domains (Thibaudeau et al., 2020).

Our second hypothesis, that nonsocial cognition would explain < 20 % in ToM, was confirmed. In line with the previous study that used the same data set (Vaskinn et al., 2018), a regression analysis showed that the nonsocial cognitive measures accounted for 17% of the explained variance in ToM. This also aligns with other previous studies, indicating that ToM and nonsocial cognition are related, yet distinct constructs (Allen et al., 2007; Combs et al., 2011; Hoe et al., 2012; Pinkham et al., 2003; van Hooren et al., 2008). Note however, that the degree of explained variance does not preclude that ToM may be related to an aspect of nonsocial cognition that we have not examined.

One nonsocial cognitive domain of interest in this regard is EF. EF is an umbrella term covering several sub-functions, such as attention and inhibition, task management, planning, monitoring, and temporal coding (Kerns et al., 2008). Different executive tests capture different components of EF (Holmén, et al., 2012). The MCCB includes the Mazes test that taps some of these components, in particular the ability to plan one's actions, but not the total spectrum of EF (Holmén et al., 2012; Mohn et al., 2014). In fact, a study that examined several EF tests, including Mazes, concluded that the Stroop test is better suited for the assessment of EF in first episode psychosis (Holmén et al., 2012). In addition, the above-mentioned meta-analysis (Thibaudeau et al., 2020) reported that within the EF domain, abstraction showed significantly stronger associations with ToM than other executive subdomains. It is therefore possible that the use of other measures of EF would increase the total explained variance in ToM.

In line with our previous work (Fretland et al. 2015), we found a moderate correlation of IQ with ToM. However, unlike in the Fretland et al. (2015) study, IQ was not a significant predictor of ToM performance, in the current, larger sample, and it had the lowest beta value. These diverging findings may be due to the inclusion of negative and positive symptoms as predictors in our first paper (Fretland et al., 2015) and of other nonsocial cognitive tests as predictors in the current study.

Studies have found a strong association between IQ and MCCB (August et al., 2012; Mohn et al., 2014). In particular, working memory, speed of processing, and visual and verbal memory have especially strong associations with IQ (Mohn et al., 2014), indicating an overlap between WASI and MCCB subtests. The observed overlap may explain why none of the nonsocial cognitive tests in our study had a unique contribution to ToM, instead pointing to shared variance across nonsocial cognitive tests.

Visual memory (as measured by BVMT-R) had the strongest effect in the model, followed by speed of processing (as measured by BACS). MASC is a visual task, in which participants are required to make sense of visual information and identify visual features in faces or objects (Green et al., 2019). Given the strong visual aspect, MASC might be more sensitive to deficits in visual memory, thus, BVMT-R yielded the strongest contribution in the model. Moreover, deficits in speed of processing is a central aspect of schizophrenia and is important for the ability to perceive and comprehend information (Dickinson et al., 2007; Schaefer et al., 2013). MASC displays social interactions between different characters at a normal pace. Reduced speed of processing might challenge the ability to perceive normally paced interactions, such as apprehending details in the conversations and to distinguish between who said what to whom. Even though BACS did not have a unique significant contribution to ToM, speed of processing is a domain that is more closely related to processing socially relevant information, compared to other nonsocial cognitive domains, such as the cognitive demands required by MASC.

The finding that nonsocial cognition explained 17% of the variance without unique contributions from any specific nonsocial cognitive function, implies that cognitive remediation should include social cognitive targets. For cognitive remediation to provide clinical benefits such as improved ToM and better social functioning, it is probably not sufficient to limit the treatment efforts to nonsocial cognition.

The limited explained variance in ToM accounted for by nonsocial cognition also begs the question of what other factors may underlie this complex social cognitive function. A first answer is that complex social cognition depends on basic social cognition. According to a hierarchical model of social cognition, bottom-up recognition of social and emotional cues underlies top-down inferences about the mental state of others (Ochsner, 2008). In a previous study, we provided empirical evidence for this notion: the decoding of emotions from human point-light walkers, i.e. emotional biological motion, influenced ToM (Vaskinn et al., 2018). Moreover, clinical symptoms, both negative and positive, have small to moderate associations with ToM (Ventura et al., 2013). Another variable of great potential interest for social cognition and ToM is trauma. Childhood trauma, more specifically emotional neglect, has been linked to ToM impairment in schizophrenia (Kincaid et al., 2018). In addition, a number of non-illness related factors can impact on social cognition, including social class (Dodell-Feder et al., 2020) and culture (Kessler et al., 2014). From this, follows that limited exposure to situations similar to the ones in the MASC movie may contribute to ToM impairments. The aim of the present study was by no means to examine all of these issues, but we look forward to future studies that can increase our understanding of how they relate to ToM in schizophrenia.

4.1. Limitations

The present study has some limitations. First, it did not include an optimal measure of EF. To obtain a better understanding of the relationship between EF and ToM, several EF tests should be used. Furthermore, only the MASC total score was investigated in relation to nonsocial cognition. Investigating various ToM components, such as affective and cognitive ToM, or different types of mentalizing errors, may have yielded other results, although our previous findings of similar associations with nonsocial cognition across ToM components (Vaskinn et al., 2018) do not suggest so. Also, this study was based on single subtests of the MCCB. We did not combine the subtests into nonsocial cognitive domains. While unlikely, it remains unknown if this would influence our results. Moreover, the study sample included participants with schizoaffective disorder as well as schizophrenia. Although meta-analytic data for nonsocial cognition failed to find performance differences between the two diagnostic categories (Bora et al., 2009), results for social cognition are mixed. Since schizoaffective disorder may present with better social cognition compared to schizophrenia for some subdomains (Hartman et al., 2019), it is possible that findings would have been different with the inclusion only of individuals with a diagnosis of schizophrenia. Lastly, although social and nonsocial cognitive impairments seen in schizophrenia are not secondary to antipsychotic medication or side effects (Green et al., 2019), we cannot rule out that psychotropic medications or their side effects might have biased the results of our study.

5. Conclusion and clinical implications

In summary, this study found moderate associations between ToM and IQ, speed of processing, and memory. Nonsocial cognition in total accounted for 17% of the variance in ToM. None of the nonsocial cognitive tests were unique predictors of ToM performance. This implies that nonsocial cognitive processes that are shared by the different neuropsychological tests, and not specific neuropsychological functions, constitute one building block for ToM. Our findings further suggest that differentiating between specific nonsocial cognitive variables may not be necessary and use of a composite score of these variables is equitable, when investigating the relationship between ToM and nonsocial cognition. Moreover, our results support the notion that ToM and nonsocial cognition are distinct constructs. Of clinical relevance, our results imply that cognitive remediation of neuropsychological functions should be complemented with social cognitive targets in order to achieve improved ToM and perhaps also improved functional outcome.

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Conflict of interest. None of the authors report any conflict of interest.

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Tables

Table 1

Demographics and clinical characteristics in participants with schizophrenia (n = 91)

	Mean (*SD*)
Demographics	
Age	29.1 (8.4)
Sex (males/females)	57/34
Education (years)	12.2 (2.4)
WASI IQ	100.3 (13.2)
Clinical features	
GAF-symptoms[a]	44.3 (12.2)
GAF-function[a]	44.8 (10.9)
PANSS positive symptoms (range 7-49)	14.1 (4.8)
PANSS negative symptoms (range 7-49)	14.7 (5.2)
Illness duration[b] (years)	7.1 (7.1)
Medication[c]	1.41 (0.91)

	n = 81 (89%)

WASI: Wechsler Abbreviated Scale of Intelligence
GAF: Global Assessment of Functioning
PANSS: Positive and Negative Syndrome Scale
[a] n = 90 due to missing data
[b] n = 89 due to missing data
[c] Amount of defined daily dose of antipsychotic treatment

Table 2

MASC total correct and MCCB performance in participants with schizophrenia (n = 91)

	Mean (*SD*)
MASCtot (range 0-45)	29.4 (*6.9*)
Trail Making Test	41.5 (*10.5*)
Brief Assessment of Cognition in Schizophrenia	32.5 (*10.0*)
Hopkins Verbal Learning Test	40.9 (*9.0*)
Wechsler Memory Scale	46.9 (*10.4*)
Neuropsychological Assessment Battery, mazes subtest	46.2 (*12.1*)
Brief Visuospatial Memory Test	32.4 (*11.9*)
Category fluency test, animal naming	46.3 (*11.0*)
Continuous Performance Test	37.4 (*10.0*)
Letter-Number Span Test	39.4 (*9.3*)

With the exception of MASCtot, all scores are T-scores.

Table 3

Bivariate associations (Spearman`s rho) between ToM performance and cognition (MCCB and WASI) in participants with schizophrenia (n=91)

	MASCtot	TMT A	BACS	HVLT	WMS	Mazes	BVMT	Verbal fluency	CPT	LNS	WASI
MASCtot	—										
TMT A	.185 (p= .079)										
BACS	**.423 (p= <.001)**	**.611 (p= <.001)**									
HVLT	**.318 (p= .002)**	.184 (p= .081)	**.425 (p= <.001)**								
WMS	**.360 (p=<.001)**	**.483 (p= <.001)**	**.552 (p= <.001)**	**.449 (p= <.001)**							
Mazes	.161 (p= .128)	**.621 (p= <.001)**	**.433 (p= <.001)**	.196 (p= .063)	**.469 (p= <.001)**						
BVMT	**.422 (p= <.001)**	.263 (p= .012)	**.497 (p= <.001)**	**.542 (p= <.001)**	**.520 (p= <.001)**	.278 (p= .008)					
Verbal fluency	.249 (p= .017)	.299 (p= .004)	**.366 (p= <.001)**	**.474 (p= <.001)**	**.437 (p= <.001)**	**.313 (p= .002)**	**.444 (p= <.001)**				
CPT	.165 (p= .118)	**.320 (p= .002)**	**.452 (p= <.001)**	**.355 (p= .001)**	**.393 (p= <.001)**	.196 (p= .063)	**.369 (p= <.001)**	.161 (p= .128)			
LNS	.297 (p= .004)	**.526 (p= <.001)**	**.545 (p= <.001)**	**.440 (p= <.001)**	**.574 (p= <.001)**	**.499 (p= <.001)**	**.458 (p= <.001)**	**.335 (p= .001)**	**.423 (p= <.001)**		
WASI	**.347 (p=.001)**	**.439 (p= <.001)**	**.646 (p= <.001)**	**.463 (p= <.001)**	**.596 (p= <.001)**	**.461 (p= <.001)**	**.620 (p= <.001)**	**.327 (p= .002)**	**.488 (p= <.001)**	**.544 (p= <.001)**	—

Note: **Bold.** Correlation is significant at the Bonferroni-corrected *p*-level (.05/10=.005). MASCtot: The Norwegian version of Movie for the Assessment of Social Cognition, total score. TMT-A: Trail Making Test, Part A. BACS: Brief Assessment of Cognition in schizophrenia, symbol coding subtest. HVLT: Hopkins Verbal Learning Test – Revised. WMS: Wechsler Memory Scale, spatial span subtest. Mazes: Neuropsychological Assessment Battery, mazes subtest. BVMT: Brief Visuospatial Memory Test –Revised. Verbal fluency: Category fluency test, animal naming. CPT: Continuous Performance Test. LNS: Letter-Number Span Test. WASI: Wechsler Abbreviated Scale of Intelligence.

Table 4

Regression analysis in participants with schizophrenia (n=91) investigating predictors of ToM performance

	Model					Predictors
	R^2	Adj. R^2	ΔR^2	Sig F change	F (df), *p*	Beta, *p*
ToM: *MASCtot*						
Model 1	.216	.170	.216	.001	4,70 (5, 85), .001	
BACS						.167, *p*=.207
HVLT						.057, *p*=.640
WMS						.109, *p*=.391
BVMT						.199, *p*=.145
WASI						.047, *p*=.747

Declaration of competing interest

The authors have no conflicts to declare.

Sample CRediT author statement

Charlotte Sjølie: Methodology, Formal Analysis, Writing – Original Draft, Writing – Review and Editing. **Emilie K. Meyn:** Methodology, Formal Analysis, Writing – Original Draft, Writing – Review and Editing. **Rune Raudeberg:** Methodology, Formal Analysis, Writing – Original Draft, Writing – Review and Editing, Supervision. **Ole A. Andreassen** : Conceptualization, Resources, Writing – Original Draft, Writing – Review and Editing, Funding Aquisition. **Anja Vaskinn** : Conceptualization, Methodology, Formal Analysis, Investigation, Resources, Writing – Original Draft, Writing – Review and Editing, Supervision, Funding Aquisition.