



## Social cognition in early course of schizophrenia: Exploratory factor analysis

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### ABSTRACT

Social cognition is a central contributor to social functioning in schizophrenia. A better understanding of the underlying structure of social cognition in the early course schizophrenia could help us identify more precise targets for intervention in this population. In the present study, we performed an Exploratory Factor Analysis (EFA) on 90 patients within the early course of schizophrenia using 11 validated subtests assessing various domains of social cognitive skills. The factors derived from this analysis were then used to investigate relationships between these distinct domains of social cognition skills and neurocognitive performance, clinical symptoms, and social functioning satisfaction. The results revealed the presence of a 3-factor solution, representing the domains of Emotion Management, Emotion Recognition, and Theory of Mind, together accounting for 55.88% of the variance. Moreover, higher scores on the Theory of Mind factor were significantly related to higher social functioning satisfaction measures as well as with lower clinical symptoms severity. Our findings suggest that social cognitive skills are composed of three separate domains in the early course of schizophrenia and that theory of mind could be an important therapeutic target for early intervention.

### 1. Background

Impaired social cognition is related to poor social functioning in schizophrenia and is a key target for early intervention (Fett et al., 2011; Savla et al., 2013; Nahum et al., 2014). A better understanding of the structure of social cognitive subdomains that may be aberrant at early stages of illness, before the onset of chronicity, may help develop early interventions specific to this population.

Previous factor analysis studies focusing on social cognition have primarily been performed on individuals with chronic schizophrenia and schizoaffective disorder (Mancuso et al., 2011; Ziv et al., 2011). These studies found various solutions with different subdomains represented. Most exploratory factor analysis (EFA) and principal component analysis (PCA) studies identified 2-factor solutions (Eack et al., 2010a: Factor 1-Emotion perception and understanding, Factor 2-Emotion facilitation and management; Ziv et al., 2011 Factor 1-Theory of mind, Factor 2-Emotion Recognition and processing; Buck et al., 2016: Factor 1-Social cognition skill, Factor 2-Hostile attributional style). However, Mancuso et al., (2011) showed a 3-factor solution

(Factor 1-Hostile attributional style, Factor 2-Lower-level social cue detection, Factor 3-Higher-level inferential and regulatory processes). Furthermore, Browne et al., (2016) observed a one factor model for social cognition, which included measures of both emotion processing and theory of mind (Factor 1-Social cognitive ability). The variability in previous factor solutions reflect the variance in tasks, methods, and cognitive subdomains used in the different studies. Consequently, a clear and consistent underlying structure of social cognition in schizophrenia remains difficult to determine.

While social cognition is thought to be impaired across all stages of the disorder (Green et al., 2012), evidence suggests that social cognitive factors may also be dependent on symptomatic state (Balogh et al., 2014; Bilksted et al. 2017). In a three-year follow-up study, Maat et al., (2015) found that emotion processing performance was associated with remission status in schizophrenia, suggesting that clinical state may contribute to social cognition deficits. Moreover, given the heterogeneity of symptoms experienced over the course of the illness, it is possible that early schizophrenia patients show different variance in their social cognition structure compared to patients in more chronic

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stages of the illness. Investigating the underlying structure of social cognition in early schizophrenia is important as it could provide meaningful insights for early intervention aiming to improve functional outcome (Dworkin et al., 1993; Tarbox and Pogue-Geile, 2008). A number of studies have identified social cognitive impairments in first episode patients (Betrand et al. 2007; Vohs et al., 2014). Moreover, Williams et al., (2008) performed a PCA on first-episode schizophrenia patients and observed two distinct factors of social cognition (Factor 1-emotional intelligence, Factor 2-negativity). However, this study was limited through its use of self-report measures to assess social cognition ability, and while valuable, an analysis of performance is necessary to identify potential therapeutic targets. In addition, a small sample size was used, thus limiting whether the conclusions drawn are reflective of this specific study or the larger patient population as a whole. Thus, further studies using performance based assessments and larger samples of patients in the early course of the illness are necessary.

The aim of the current study is to better understand the structure of social cognitive skills in patients within the early course of illness, and to further examine its relationship with neurocognition, clinical symptoms, and social functioning satisfaction. We first performed an EFA on 90 patients within the early course of their illness, using validated measures of relevant subdomains of social cognitive skills in schizophrenia. Tasks assessing theory of mind (ToM)/social context appraisal, facial emotion perception, and emotional intelligence subdomains were included. We hypothesized that the factors would represent these areas. We also hypothesized that higher scores on the distinct factors would correlate with greater social functioning satisfaction and neurocognitive ability, as well as lower symptoms severity.

## 2. Methods

### 2.1. Subjects & characteristics

Subjects were recruited through a National Institute of Mental Health (NIMH) funded study: Brain Imaging, Cognitive Enhancement and Early Schizophrenia (BICEPS); (study number MH092440, M.S. Keshavan MD, PI) and was registered in ClinicalTrials.gov #NCT01561859. The study received ethics committee approval from Beth Israel Deaconess Medical Center as well as University of Pittsburgh, and participants signed a written, informed consent prior to participation. A total of 126 subjects within the early course of schizophrenia or schizoaffective disorder diagnosed as per DSM-IV, based on SCID interviews, were recruited from well-established early course outpatient treatment programs and referral sources in Boston, MA and Pittsburgh, PA. Patients had stable positive symptoms for at least two months. With the aim to assess patients specifically in the early course of the illness, only individuals aged 18–45 with duration of less than 8 years from time of first psychotic symptom were included, as the trajectory of outcome in the early course is highly variable during these first years of the illness (Hegelstad et al. 2017). Patients with a duration of illness of < 8 years were included in the study, a majority of patients (>85%) had a duration of illness of 5 years or lower. The average duration of illness was 3.65 years, which is much below the 8-year cutoff. Previous studies examining social cognition in early schizophrenia population have used similar inclusion criteria with regards to duration of illness (Eack et al., 2009). After exclusion for duration of illness and outliers in social cognitive data, the final sample was comprised of 90 patients within the early course of schizophrenia. Thirty subjects were excluded for having incomplete data and an additional 3 subjects were excluded for having outlier scores of 3 standard deviations or higher on a social cognitive subtest. In addition, 3 other subjects were excluded due to a duration of illness greater than 8 years (two were included in the clinical trial despite having a duration of illness of 9 years while the third reported after the beginning that his symptoms were present many years prior to what he had reported in the

initial clinical interview) (see Supplementary Material 1.1.1 for full exclusion and inclusion criteria of the study).

### 2.2. Social cognitive measures

All social cognitive measures used in the present study reflect social cognitive skills identified in previous studies investigating social cognition in patients with schizophrenia (Green et al., 2005).

#### 2.2.1. Theory of mind/social context appraisal

*Hinting Task* (Corcoran et al., 1995). The Hinting Task assessed the participants' ability to decipher the true meaning and intent behind indirect speech. For this task, the participants read a passage presenting a social situation between two characters and were asked to determine the true meaning behind one of the character's statements or actions.

*The Awareness of Social Inferences Test (TASIT- Part 3)* (McDonald et al., 2003). The TASIT-Part 3 examined the participants' ability to detect lies and sarcasm through the recognition of visual cues presented in a series of videos. The TASIT-Part 3 includes 16 video scenes total, each lasting from 15–60 s, in which the actors act out an everyday social interaction involving either a lie or sarcasm. After viewing each scene, the participants were asked four separate questions which deal with the thoughts, intentions, and feelings of one of the actors. The responses could be "yes", "no", or "don't know". Separate subscores for lies and sarcasm were computed, as they are two different kinds of counterfactual comments.

#### 2.2.2. Facial emotion perception

*Penn Emotion Recognition Task* (Kohler et al., 2004). This task consisted of displaying 40 color photographs of faces depicting a given emotion (i.e. happiness, sadness, anger, or fear) or a neutral expression. In the recognition task, the participants were required to identify the correct emotion for the face presented.

*Penn Emotion Acuity Task* (Gur et al., 1992). This task consisted of displaying 40 color photographs of faces depicting varying degrees of a given emotion (i.e. happiness or sadness) or a neutral expression. Specifically, the participants were required to rate the faces on the intensity of the specified emotion. Previous research indicates that emotion acuity performance is impaired in first episode patients (Herbener et al., 2005). Emotion acuity performance also positively correlates with symptoms severity in both, first episode and chronic schizophrenia populations (Silver et al., 2002; Herbener et al., 2005). This test also has good internal consistency (Erwin et al., 1992).

#### 2.2.3. Emotional intelligence

*Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT)* (Mayer and Salovey 1990). This web-based test consisted of multiple-choice questions that access the participants' competence in a number of areas of emotional intelligence. As with previous factor analysis research using the MSCEIT, we used the subdomain task scores in our analysis (Mayer and Salovey 1990; Eack et al., 2010a). The standard scores with consensus norms uncorrected for age or sex were used. Moreover, we observed that participants' scores on the two tasks recruiting emotion perception processes in the MSCEIT (i.e. Faces, Pictures) showed an abnormal distribution due to a ceiling effect, and therefore we excluded these tasks from the analysis in favor of the more robust measures of emotion perception in the Penn battery (Pinkham et al., 2014). Hence, the scores of only six tasks from the MSCEIT were included in our analysis: 1) Emotion Facilitation, 2) Emotion Sensations, 3) Emotion Changes, 4) Emotion Blends, 5) Emotion Management, and 6) Emotion Relations. Emotion Facilitation tests the knowledge of how mood impact thinking while Emotion Sensations examines the subject's ability to relate various feeling of sensations to emotions. On the other hand, Emotion Changes tests if the subject understands how emotions change over time (e.g. An individual is feeling stressed with his work when his manager gives him another

task, the individual felt what emotion?) and Emotion blends examines subject's ability to identify how emotions blend together to form new emotions, both of which require contextual consideration and the application of such information to a novel situation. Finally, Emotion Management asks subjects to indicate effectiveness of various solutions to internal problems (e.g. an individual is coming home from vacation feeling content and happy, which action would preserve this mood?) while Emotion Relations asks subjects to indicate effectiveness of various solutions to problems involving other people. A higher score in one of the tasks indicates greater emotional intelligence ability in that specific domain.

### 2.3. Neurocognitive measures

*MATRICES Consensus Cognitive Battery (MCCB) (Nuechterlein et al., 2008)*. The MCCB was used to assess neurocognitive functions including speed of processing (SOP), attention/vigilance (AV), working memory (WM), verbal learning (VLHVL), visual learning (VLBMV), reasoning and problem solving (RPS), and Overall Composite Score (OCS). The individual test scores were first standardized, then composite scores were derived for each domain. T-scores corrected for sex and age were used. The MATRICES total composite score was derived by taking the average of all six neurocognitive subdomains, while excluding the social cognition domain (which consists of the MSCEIT managing emotions subtest already assessed during the MSCEIT administration). Higher scores on these measures indicate higher neurocognitive ability.

### 2.4. Social functioning satisfaction

*Social Adjustment Scale-II (SAS-II) (Schooler et al., 1979)*. The SAS-II is a self-report and clinician graded scale that assesses the subjects' satisfaction with their social situation and includes 44 items. Here, we solely used global scores which focus on work (Area 1), household (area 2), external family (area 3), social leisure (area 4), and general adjustment. The global scores were rated by a trained expert, from 0 (excellent adjustment) to 6 (severe maladjustment). This scale has previously been used in early schizophrenia population (Eack et al., 2010b).

### 2.5. Clinical measures

*Scale for Assessment of Positive Symptoms (SAPS) (Andreasen, 1984)*. The SAPS was used to assess positive symptoms in patients. Higher scores on this measure indicate more severe symptomatology and a greater number of symptoms. Only the total score was used in the analysis.

*Scale for Assessment of Negative Symptoms (SANS) (Andreasen, 1989)*. The SANS was used to assess negative symptoms in patients. Higher scores on this measure indicate more severe symptomatology and a greater number of symptoms. Only the total score without attention was used.

### 2.6. Statistical analysis

All statistical analyses were conducted using IBM Statistical Package for Social Scientists (SPSS), Version 24.

#### 2.6.1. Sample characteristics

Chi-squared and independent *t*-tests were performed to examine differences on demographic information between recruitment sites (Pittsburgh and Boston) (see Table 1). Social cognitive skills, neurocognitive, clinical, and social functioning satisfaction measures were also compared between the two sites (See Supplementary Material Table 1).

**Table 1**  
Demographic and clinical characteristics.

	Boston site (N = 43)	Pittsburgh site (N = 47)	p-value
Race			0.247
Caucasian	24	28	
Black	8	13	
Other	11	6	
Sex			0.278
M	32	30	
F	11	17	
Age	23.84/4.31 (Mean/ SD)	26.05/6.25 (Mean/ SD)	0.052
Duration of Illness (years)	3.33/2.13 (Mean/ SD)	3.97/2.16 (Mean/SD)	0.163

Note. M = Male; F = Female; SD = Standard deviation.

#### 2.6.2. Exploratory factor analysis

Before the EFA was conducted, each participant's social cognitive task scores were inspected for normality by looking at skewness and kurtosis. Social cognition scores were then converted into z-scores using the mean for each site separately to control for potential site differences. For the factor extraction analysis, we used the maximum likelihood method, since the primary aim was to develop factors that could reflect the structure of the larger early schizophrenia population. To determine the rotation type employed in our EFA, we assessed the correlations among factors using an oblique rotation (approach suggested by Tabachnick and Fidell, 2007, p. 646). On average, factor correlations were strongly driven by the data and therefore an oblique rotation (promax) was kept for the EFA. To select an appropriate number of reliable factors, the Eigenvalue greater-than-1-rule was applied in conjunction with the examination of the scree plot. Furthermore, to determine whether the correct number of factors was selected, chi-squared tests were performed between the different levels of factor solution. Individual variables were considered to load on a given factor if the factor loading was greater than 0.4. Finally, composite scores were derived for each subject by averaging the z-scores of each test relevant to each factor.

#### 2.6.3. Neurocognitive, functional, and clinical factor correlates

We used the composite score for each factor to perform Pearson correlations with neurocognitive, functional, and clinical outcome data. Bonferroni correction for multiple comparisons were applied for each factor separately to keep the type I error rate below an alpha level of 0.05. As site significantly differed on two measures of social functioning satisfaction scores (see Supplementary Material Table 1) we performed post hoc correlations with site as a covariate. In addition, exploratory independent *t*-tests, comparing male versus female patients on each factor score were performed (See Supplementary Material Fig. 1).

## 3. Results

### 3.1. Sample characteristics and exploratory factor analysis

We did not observe any significant differences between sites for race, sex, age, and duration of illness (see Table 1). The mean duration of illness in patients including both sites was 3.6 years (SD = 2.14).

The factor loadings from the EFA are presented in Table 2. The EFA analysis on the various social cognitive tasks identified a 3-factor solution, that accounted for 55.88% of the total variance. More specifically, the three distinct factors accounted for 30.09%, 13.52%, and 12.26% of the variance respectively. The three subdomains of social cognition that we identified included an Emotion Management factor (Factor 1-Emotion Management) that consists of the MSCEIT Facilitation, Sensations, Emotional Management, and Emotional Relations tasks; a ToM factor (Factor 2-ToM) that consists of the Hinting Task,

**Table 2**  
Social cognition exploratory factor analysis rotated pattern matrix.

	Factor 1-Emotion management	Factor 2-ToM	Factor 3-emotion perception
Hinting Task	−0.090	<b>0.462</b>	−0.064
TASIT-Lie	−0.252	<b>0.429</b>	0.126
TASIT-Sarcasm	−0.022	<b>0.618</b>	−0.098
MSCEIT-Facilitation	<b>0.454</b>	−0.100	0.087
MSCEIT-Sensations	<b>0.591</b>	−0.269	0.171
MSCEIT-Changes	0.311	<b>0.413</b>	0.169
MSCEIT-Blends	0.133	<b>0.506</b>	0.079
MSCEIT-Emotional Management	<b>0.804</b>	−0.018	−0.076
MSCEIT-Emotional Relations	<b>0.787</b>	0.108	−0.126
ER-40-Emotion Recognition	0.016	−0.025	<b>0.693</b>
PEAT-40-Emotion Acuity	0.040	0.029	<b>0.719</b>

Note. MSCEIT = Mayer–Salovey–Caruso Emotional Intelligence Test, PEAT-40 = Penn Emotion Acuity Task; ER = Emotion Recognition; TASIT = The Awareness of Social Inference Test; ToM = Theory of Mind; Bolded numbers correspond to variables included in designated factor ( $> 0.4$ ).

TASIT-sarcasm, TASIT-lies, MSCEIT Changes and Blends tasks; and an Emotion Perception factor (Factor 3-Emotion perception) that consists of the Penn Emotion Recognition and Acuity tasks. Importantly, we observed a significant improvement from the 3-factor solution over the 2-factor ( $\Delta\chi^2 = 21.87$ ,  $df = 9$ ,  $p = 0.01$ ), but no significant improvement from the 4-factor solution over the 3-factor ( $\Delta\chi^2 = 19.22$ ,  $df = 25$ ,  $p = 0.75$ ), which confirm the final 3-factor solution.

### 3.2. Factor correlates

All factor correlates results are presented in details in Table 3.

#### 3.2.1. Neurocognition

All factors significantly positively correlated with the neurocognitive MATRICS overall composite score (Factor 1-Emotion management,  $r = 0.383$ ,  $p < 0.001$ ; Factor 2-ToM,  $r = 0.345$ ,  $p = 0.001$ ; Factor 3-Emotion perception,  $r = 0.341$ ;  $p = 0.001$ ). More specifically, Factor 1-Emotion management was significantly positively correlated with AV ( $r = 0.369$ ;  $p < 0.001$ ) and VLBVM ( $r = 0.285$ ;  $p = 0.007$ ), Factor 2-ToM was significantly positively correlated with VLHVL ( $r = 0.480$ ;  $p < 0.001$ ) and VLBVM ( $r = 0.316$ ,  $p = 0.003$ ), and Factor 3-Emotion Perception was significantly positively correlated with AV ( $r = 0.421$ ;  $p < 0.001$ ) and VLBVM ( $r = 0.325$ ;  $p = 0.002$ ). Three subjects had missing values for these scales.

#### 3.2.2. Social functioning satisfaction

We observed significant negative correlations between the scores on the Factor 2-ToM and social functioning satisfaction scores on the SAS-work ( $r = -0.332$ ;  $p = 0.002$ ), SAS-social leisure ( $r = -0.317$ ;  $p = 0.003$ ), and SAS-general adjustment ( $r = -0.342$ ;  $p = 0.001$ ). However, when site was used as covariate, solely the correlations with SAS-social leisure ( $r = -0.274$ ;  $p = 0.031$ ) and SAS-general adjustment ( $r = -0.39$ ;  $p = 0.002$ ) remains significant after Bonferroni correction (see Fig. 1(a)). No significant or trending correlations was observed with the other two factors.

#### 3.2.3. Clinical

Greater scores on Factor 2-ToM were significantly associated with less severe negative symptoms ( $r = -0.286$ ;  $p = 0.007$ ) and positive symptoms ( $r = -0.240$ ;  $p = 0.023$ ) (see Fig. 1(b)). No significant or trending correlations were observed between the other two factors and the clinical measures.

## 4. Discussion

The results of this study indicate a 3-factor structure of social cognitive skills within the early course of schizophrenia, namely Emotion Perception, Emotion Management, and ToM. The subdomains identified by our EFA are in line with social cognitive factors previously observed (Eack et al., 2010a; Ziv et al., 2011), but differ from the subdomains identified by Buck et al., (2016), Mancuso et al., (2011) and Browne et al., (2016). The inclusion of different social cognitive subdomains and measures in these studies could explain the inconsistencies in the structures observed. Moreover, previous EFA studies included samples of patients who were predominantly in the chronic stages of the illness. Hence, the underlying structure of social cognitive skills we observed may be more specific to patients within the early course of illness. This could be explained by findings which suggest that clinical state in early stage of schizophrenia may be greater than in enduring stage of the illness (Green et al., 2012). Thus, variability in clinical symptomatology and its associations with social cognitive skills could explain the different factor structure observed in this study in comparison to previous studies investigating enduring schizophrenia population.

The three independent subdomains of social cognition that we identified are commonly impaired in schizophrenia (Green et al., 2005). Moreover, as we hypothesized, the face emotion perception tasks formed a single Emotion Perception factor. However, while our initial hypothesis was that all MSCEIT tasks would be related to one emotional intelligence factor, the MSCEIT Changes and Blends tasks were related to the ToM factor. Our results can be explained by the fact that the MSCEIT Changes and Blends tasks required higher emotional insight processes that were also important for the ToM tasks, such as the Hinting Task and the TASIT. Interestingly, the remaining tasks from the MSCEIT that formed the Emotion Management factor are more related to the way people manage and regulate emotions.

An important finding from this study is that the ToM factor demonstrated a stronger relationship with social functioning satisfaction and clinical outcome (negative and positive symptoms) than the other factors. Our results are in line with previous studies that have found that greater ToM ability correlates with greater neurocognitive capacity and less negative symptom severity (Harrington et al., 2005; Pickup and Frith, 2001). On the other hand, previous studies have shown inconsistent relationships between positive symptoms and social cognition (Green et al., 2012). The difference in symptom severity of samples included in previous studies could potentially explain inconsistent findings. A number of studies have also indicated a potential relationship between social functioning and ToM ability (Bora et al., 2006; Fett et al., 2011; Couture et al. 2006; Derks et al., 2012). For example, Derks et al., (2012) revealed that ToM ability in patients was specifically associated with subjective quality of life. Furthermore, a meta-analysis by Fett et al., (2011) found that social cognition is more strongly associated with objective community functioning than neurocognition, with the strongest associations between ToM and community functioning. Our results provide further evidence to support ToM as a potential moderator of social functioning in schizophrenia patients. Furthermore, although a number of previous analyses indicated relations with social functioning to span across a greater number of social cognitive subdomains (Bora et al., 2006; Couture et al., 2006; Derks et al., 2012; Fett et al., 2011), our results suggest a more specific relationship with ToM, which may be a characteristic of patients earlier in the course of illness. The widespread correlations with social functioning in other studies could be a function of the cognitive decline observed as the illness progresses, placing ToM as one of the early course or trait indicators of social functioning decline in schizophrenia. However, we are limited in our ability to make conclusions regarding social functioning in general, as our studied used satisfaction scales rather than skill-based measures. Therefore, our results suggest the need for further investigation regarding the association between social

**Table 3**  
Correlation between factor scores and neurocognitive, clinical, and functional scores.

Correlations		Factor1-emotion management	Factor2-ToM	Factor3-emotion perception
SAS-work	Pearson correlation	−0.036	−0.332**	0.096
	Sig. (2-tailed)	0.748	0.002	0.393
	N	81	81	81
SAS-household	Pearson correlation	0.051	−0.178	0.199
	Sig. (2-tailed)	0.671	0.137	0.096
	N	71	71	71
SAS-external family	Pearson correlation	−0.137	−0.236*	0.126
	Sig. (2-tailed)	0.207	0.027	0.243
	N	87	87	87
SAS-social leisure	Pearson correlation	−0.186	−0.317**	−0.034
	Sig. (2-tailed)	0.082	0.003	0.755
	N	88	88	88
SAS-general adjustment	Pearson correlation	−0.043	−0.342**	−0.002
	Sig. (2-tailed)	0.692	0.001	0.988
	N	88	88	88
SANS	Pearson correlation	−0.021	−0.286**	0.045
	Sig. (2-tailed)	0.845	0.007	0.675
	N	89	89	89
SAPS	Pearson correlation	−0.15	−0.240*	−0.011
	Sig. (2-tailed)	0.159	0.023	0.918
	N	89	89	89
SOP	Pearson correlation	0.123	0.102	0.206
	Sig. (2-tailed)	0.256	0.345	0.056
	N	87	87	87
AV	Pearson correlation	0.369**	0.115	0.421**
	Sig. (2-tailed)	0	0.291	0
	N	87	87	87
WM	Pearson correlation	0.264*	0.217*	0.1
	Sig. (2-tailed)	0.014	0.044	0.358
	N	87	87	87
VLHVL	Pearson correlation	0.274*	0.480**	0.085
	Sig. (2-tailed)	0.01	0	0.433
	N	87	87	87
VLBVM	Pearson correlation	0.285**	0.316**	0.325**
	Sig. (2-tailed)	0.007	0.003	0.002
	N	87	87	87
RPS	Pearson correlation	0.146	0.136	0.129
	Sig. (2-tailed)	0.178	0.209	0.235
	N	87	87	87
OCS	Pearson correlation	0.383**	0.345**	0.341**
	Sig. (2-tailed)	0	0.001	0.001
	N	87	87	87

Note. MATRICS = Measurement and Treatment Research to Improve Cognition in Schizophrenia; SOP = speed of processing (Composite of Trail Making Test, Brief assessment of cognition in Schizophrenia, Category Fluency); AV = attention/vigilance (Continuous Performance Test- Identical Pairs); WM = working memory (Composite of Wechsler Memory Scale-III Spatial Span, Letter-Number Span); VLHVL = verbal learning (Hopkins Verbal Learning Test); VLBVM = visual learning (Brief Visuospatial Memory Test); RPS = reasoning and problem solving (Neuropsychological Assessment Battery Mazes); OCS = Overall Composite Score (Composite Score of all Neurocognitive Measures); SAS = Social Adjustment Scale; SANS = Scale for Assessment of Negative Symptoms (without attention); SAPS = Scale for Assessment of Positive Symptoms. SAS-Work, Household, External Family, Social Leisure, and General Adjustment had N values of 81, 71, 87, 88, 88 respectively. Clinical data  $N = 89$ . Neurocognitive data  $N = 87$ .

\* Correlation is significant at the 0.05 level (2-tailed).

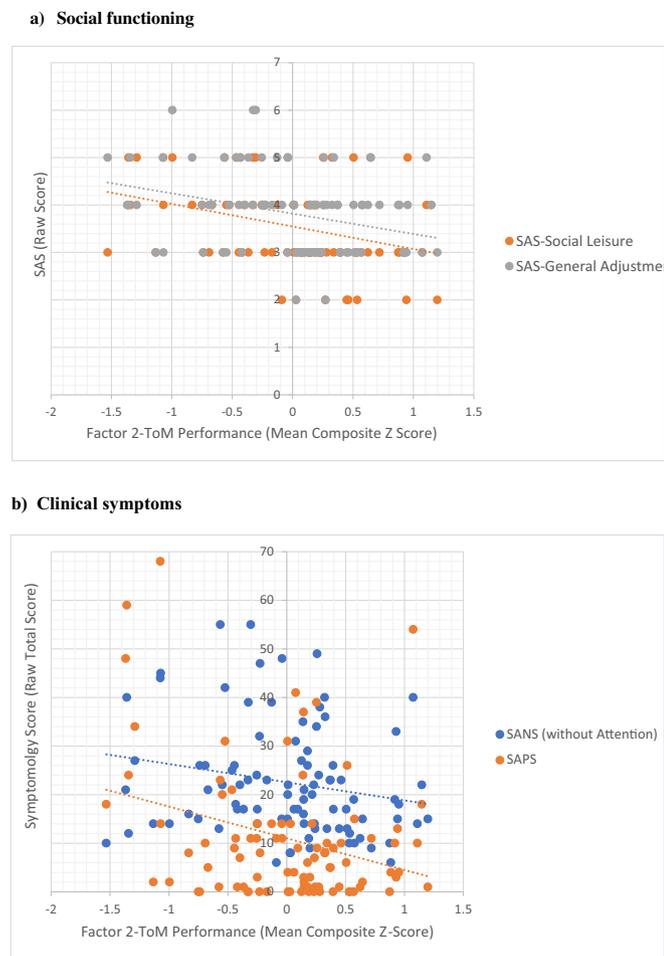
\*\* Correlation is significant at the 0.01 level (2-tailed).

cognition and social functioning using skill-based measures in this population.

Finally, the present results also improve our understanding of the dynamic interplay between specific neurocognitive and social cognitive deficits earlier in the course schizophrenia. We observed strong positive correlations between our social cognition factors and many neurocognitive subdomains. Previous studies suggested that social cognition is separate from neurocognition in predicting outcomes (Fett et al., 2011). Social cognition and neurocognition have also been found to represent separate factors in schizophrenia (Mehta et al., 2013). This suggests that social cognition in schizophrenia provides additional information that is not accounted for solely by neurocognition. Specifically, our results support previous findings indicating that social cognition subdomains are linked to specific subdomains of neurocognition (Greig et al., 2004). Moreover, the present factor grouping of the Hinting task, TASIT Lie & Sarcasm, and MSCEIT Changes and Blends tasks is consistent with previous studies which hypothesized ToM

deficits to be related to deficits in context processing (Champagne-Lavau et al., 2012; Schenkel et al., 2005). Contextual information must be integrated with pre-existing representations of past experiences to make informed judgments about novel situations (Rubin et al., 2014). Both the Changes and Blends tasks of the MSCEIT fit well with this profile as they require participants to consider the context of a pre-existing condition and apply it to a novel situation. In addition, deficits in verbal memory have been associated with impaired ToM in schizophrenia (Paulsen et al., 1995). Interestingly, the current study the ToM factor demonstrated a specific positive relationship with verbal learning and memory. Therefore, our results suggest that ToM deficits observed in schizophrenia could be partly explained by impairments in contextual processing ability and verbal memory. This finding could provide useful insight for the development of more efficient interventions to improve ToM.

Interpretation of these results is made in the context of its limitations. Many patients were in the early course of schizophrenia and



**Fig. 1. Correlation with Factor 2-ToM. Note.** a) ToM = Theory of Mind; SAS = Social Adjustment Scale. SAS-Social Leisure correlation with Factor 2-ToM was significant, SAS-General Adjustment correlation with Factor 2-ToM was significant ( $r = -0.274$ ;  $r = -0.39$ ). SAS raw scores = higher the number, the poorer the adjustment. Two subjects had missing values on these two scale. b) SANS = Scale for the Assessment of Negative Symptoms. SANS without attention correlation with Factor 2-ToM was significant ( $r = -0.286$ ). SAPS correlation with Factor 2-ToM was significant ( $r = -0.240$ ). One subject had a missing value on these two scales.

medicated, thus limiting the inferences that can be drawn about whether a consistent pattern would be observed in chronic or unmedicated patients. Similarly, although we attempted to perform EFA on social cognitive skills in schizophrenia population within the early course of illness, we used a large window of illness duration (cut-off of 8 years), thus limiting conclusions we can draw about very early course population (e.g. first-episode or less than 1 year of illness). Nonetheless, given the relatively young age of our sample (24.94 years of age) and the low average duration of illness of our sample (3.65 years), the study does provide some important insight into social cognitive skills during the earlier stages of illness in comparison to the previous studies who explored this question in enduring schizophrenia, with patients having a mean of age around 40 years old and more than 10 years of duration of illness (Mancuso et al., 2011; Ziv et al., 2011). Our sample size was relatively small, and therefore future studies should replicate these results using a larger sample size. However, the 3-factor solution was stable as our EFA met the recommended 5:1 participant-to-variable ratio (MacCallum et al., 1999). Future studies should also include a healthy control sample is lacking to determine whether our EFA solution is representative of pathology or of the general population. Furthermore, while we used skill-based tasks representing three relevant

subdomains of social cognition impaired in schizophrenia, additional subdomains are implicated in the illness, such as the non-skill based, attribution bias and social knowledge. These data were not available for this sample, and therefore future studies should include these measures in subsequent analyses. Moreover, some could argue that methodological variance amongst social cognitive tasks, or overlapping measurement methods, could partially explain the variance accounted for in the factor loadings. However, the lack of correlations between tasks using similar methodology, such as the TASIT and Penn recognition, which both utilize a visual component, makes it unlikely (see Supplementary Material Table 2). Furthermore, the branch of the MSCEIT that were all from the same measurement methods are not all loading on the same factor. Nonetheless, the effect of measurement might have played a role in the Emotion Recognition factor, and future factor analysis studies should include tests with various methodologies to assess this domain. In terms of social functioning, we did not use a skills-based measure and are thus limited in our ability to draw conclusions on functional outcome. Subsequent studies should aim to assess the association between social cognition and functional outcome in this population. Our current results were also cross-sectional, but we are currently following these patients longitudinally and aim to examine whether these social cognition factors predict outcome and treatment response. Finally, the psychometric properties of social cognitive tasks have been the subject of scrutiny. Many candidate measures of social cognition contain only a limited amount of psychometric information (including the TASIT Part 3 used in our study) (Pinkham et al., 2014; Pinkham et al., 2015; Pinkham et al., 2018). However, tasks such as the Penn Emotion Regulation and Hinting Task were recognized as having acceptable psychometric properties (Pinkham et al., 2018). Interestingly, Penn Emotion Regulation and TASIT were not recommended for early course schizophrenia due to concerns of test-retest reliability (Ludwig et al. 2017), thus bringing into question of the reproducibility of the present study. While important and raising some valid concerns, the study was limited in its relatively small sample size (Ludwig et al. 2017). Together, the results emphasize the need for further psychometric studies on social cognitive measures in the schizophrenia population.

To summarize, the present study investigated the factor structure of social cognitive skills in patients early in the course of schizophrenia, using a broad range of social cognitive skills measures. Our results indicate that Emotion Management, Emotion Perception, and ToM are distinct social cognitive subdomains in schizophrenia patients in the early course of illness. Therapeutic approaches to improve social cognitive skills in this population could gain from treating these subdomains individually rather than using a broad scale approach. Specifically, our results suggest a unique relationship between ToM ability and social functioning satisfaction, which establish this subdomain as a specific therapeutic target for early intervention.

### Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.psychres.2018.12.152](https://doi.org/10.1016/j.psychres.2018.12.152).

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