



# What are the specificities of social cognition in schizophrenia? A cluster-analytic study comparing schizophrenia with the general population

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## ABSTRACT

While social cognition (SC) is widely recognized as being impaired in schizophrenia, little is known about the potential heterogeneity in individuals' functioning. Using a wide range of SC measures and a cluster-analytic approach, we compared SC profiles in the general population and in people with schizophrenia. A total of 131 healthy controls and 101 participants with schizophrenia were included. Groups were compared on socio-demographic, neurocognition, anxiety and depressive mood variables. Three profiles were identified in healthy controls: one with good SC abilities (Homogeneous SC group) and two with specific weaknesses in complex Facial Emotion Recognition (Low FER group) or Affective Theory of Mind (Low AToM group). However, these patterns were not found in participants with schizophrenia, who were characterized rather by levels of SC functioning (i.e., Low, Medium and High SC groups). Importantly, while the High SC group (47.9% of the sample) exhibited normal performances, the two others were underpinned by different pathological processes (i.e., alexithymia for Medium SC group or neurocognition dysfunctioning for Low SC group). These results have important implications for future research as well as for clinical practice regarding assessment methodology and therapeutic interventions.

## 1. Introduction

### 1.1. Social cognition in schizophrenia

Social cognition (SC) is a multifaceted construct that refers to the “ability to construct representations of the relations between oneself and others, and to use those representations flexibly to guide social behavior” (Adolphs, 2001). SC difficulties are widely recognized in schizophrenia spectrum disorders, impacting functional outcomes and social activities (Couture et al., 2006; Fett et al., 2011). They appear to be a specific domain of cognition, as they are only partially dependent on neurocognition (Addington and Piskulic, 2011; van Hooren et al., 2008; Ventura et al., 2013). Several meta-analyses have reported large effect sizes for impairments in theory of mind (Bora et al., 2009; Bora and Pantelis, 2013; Chung et al., 2014; Song et al., 2015; Sprong et al., 2007) and emotion perception (Hoekert et al., 2007; Kohler et al., 2009). In a recent meta-analysis, Savla et al. (2013) concluded people

with schizophrenia have deficits in theory of mind, emotion perception and processing, social perception and knowledge.

The SC domain encompasses a wide range of components that vary across studies. Table 1 describes the most frequently explored dimensions in the literature (for a recent review, see Etchepare and Prouteau, 2017).

It is currently admitted that SC deficits exist in schizophrenia, are stable over time (Healey et al., 2016; McCleery et al., 2016; Valaparla et al., 2017), are present at prodromal-like chronic stages (Green et al., 2012; Lee et al., 2015) and in first-degree relatives (Ay et al., 2016; Bora and Pantelis, 2013). These results are further considered as arguments to support the hypothesis that SC impairments are trait-like components of schizophrenia (Balogh et al., 2014; Valaparla et al., 2017). Some authors (Eack et al., 2010; Green et al., 2015; Mehta et al., 2013) have even suggested that SC impairments could be an endophenotype of the illness.

However, despite the growing body of research, important questions

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**Table 1**  
The most frequent components of SC.

Component	Definition
<b>Emotion perception</b>	Ability to “infer emotional information (i.e., what a person is feeling) from facial expressions, vocal inflections (i.e., prosody), or some combination of these (i.e., video clips)” (Couture et al., 2006)
<b>Theory of mind</b>	Ability to “impute mental states to oneself and others” (Premack and Woodruff, 1978). Two levels can be distinguished: cognitive/cold aspect (“inferences concerning epistemic states [like] beliefs, desires and knowledge”) and affective/hot aspect (“inferences about others’ affective states”) (Coricelli, 2005)
<b>Empathy</b>	“Ability to feel and describe the thoughts and feelings of others” (Dymond, 1948)
<b>Attributional style</b>	“Tendency to make particular kinds of causal inference, rather than others, across different situations and across time” (Metalsky and Abramson, 1981)
<b>Social perception</b>	Ability to judge roles, rules and context using social cues (Green et al., 2005)
<b>Social knowledge</b>	“Awareness of the roles, rules and goals that characterize social situations and guide social interactions” (Green et al., 2005)
<b>Emotional awareness</b>	Ability to identify and describe one's own emotions and those of other people (Lane and Schwartz, 1987)
<b>Alexithymia</b>	Characterized by difficulty identifying and describing feelings, a concrete and reality-based cognitive style and impoverished inner emotional and fantasy lives (Taylor et al., 1985)

remain about how to SC dysfunctioning should be considered in schizophrenia, an issue where there is still disagreement. This limitation can be overcome considering two points: heterogeneity of individual's abilities and discrepancies in studies' methods.

### 1.2. Not all persons with schizophrenia are impaired in social cognition

Though rarely referred to, some studies have clearly shown that some people with schizophrenia have preserved SC abilities. Fanning et al. (2012) found that, depending on the used task, 30% to 41.5% of participants with schizophrenia exhibited normal-range performances. Rocca et al. (2016) found that 42% of their schizophrenia participants had unimpaired social cognitive performances (z-scores between 0 and  $-0.5$ ). Similarly, contrasting with the above-mentioned meta-analyses that highlighted large theory of mind deficits, Brüne and Schaub (2012) estimated that 20 to 50% of people with schizophrenia exhibited performances similar to those of healthy subjects.

### 1.3. Divergent results in studies

Although the meta-analysis of Savla et al. (2013) found evidence of deficits in theory of mind, emotion perception and processing, social perception and knowledge, the studies it included had a high level of heterogeneity among the effect sizes depending on the SC domains. Furthermore, the authors reported no impairment regarding attributional style, whereas recent studies suggested otherwise (Berry et al., 2015; Mehl et al., 2014). Methodological issues may explain this discrepancy in results. First, the tasks used to measure SC domains vary across studies, limiting the comparability of results, and they often have inadequate or unknown psychometric properties. Studies investigating their validity are needed. Furthermore, small sample sizes limit the generalizability of their results and maximize the confounding effects of sociodemographic variables. Beside these methodological concerns, the discrepancy may be due to the existence of several profiles of SC functioning. Cluster analysis may be used to answer this question. Unlike discriminant analysis, it makes it possible to create groups of subjects based on similarities in patterns of variables and thereafter allows therapeutic interventions tailored to an individual's profile to be established (Gore, 2000). Despite its relevance, little research has been conducted on SC patterns in schizophrenia. To date, research has focused on groups with different levels of SC (Rocca et al., 2016), mostly along with neurocognition or symptoms (Bell et al., 2013; Bermond et al., 1994; Lee et al., 2017).

Thus the aim of this study was to explore and compare SC functioning profiles in the general population and in schizophrenia.

## 2. Method

### 2.1. Participants

A total of 131 healthy controls were recruited through billboards and by word-of-mouth. Inclusion criteria were: 1) age between 18 and 65 years; 2) French as mother tongue, 3) no history of major mental health or neurological conditions; 4) no drug dependence; 5) no academic studies in psychology. A total of 101 participants with a diagnosis of schizophrenia or schizoaffective disorders according to the DSM 5 (American Psychiatric Association, 2013) were recruited through a multicenter study in France. The inclusion criteria were the same as for healthy controls but also included: 6) clinical stability as defined by no change in medication for the past month; 7) no psychiatric comorbidity. All participants gave their written informed consent before participation. The study was approved by the relevant research ethics committees

### 2.2. Measures

#### 2.2.1. Social cognition assessment

The PECS-B (Protocole d'Evaluation de la Cognition Sociale de Bordeaux - Bordeaux Social Cognition Assessment Protocol) was used to measure SC (see Table 2). Some tests drawn from the international literature (e.g., RMET, Faces Test, Faux-Pas, LEAS, BVAQ-B), have been translated in French and slightly adapted for clinical practice. The PECS-B has been validated preliminarily in the French population (Etchepare et al., 2014).

#### 2.2.2. Neurocognition and mood assessments

Table 3 describes the neurocognitive and mood assessments used.

### 2.3. Statistical analyses

Statistical analyses were carried out using SPSS Version 20.0 (IBM Corp., 2011) and R Studio (RStudio Team, 2017). Owing to the elimination of outliers, sample sizes were reduced to 120 in the healthy controls sample and 94 in the schizophrenia sample. A hierarchical cluster analysis (Ward method, squared Euclidian distance) was performed in each sample using total scores of six SC tasks: RMET, Attribution of Intention, Faces Test - Unconstrained Evocation, Faces Test - Forced Choice, Faux-Pas and LEAS. Two tasks were not included in cluster analyses: Emotional Fluency, as an original construct in PECS-B, does not reflect any usual SC dimensions; BVAQ-B, as the only self-administered questionnaire, cannot be directly compared to other SC tasks. Number of clusters was decided by examining the agglomeration schedule and the dendrogram, the most straightforward method

**Table 2**  
Brief description of PECS-B' tasks.

Task	Dimension assessed	Description	Selected score (min-max)
<b>Emotional Fluency</b> (Etchepare et al., 2014)	Emotional lexicon	- In 2 min - Produce as many emotional words as possible	- Number of total emotional words (0-∞) - Percentage of sophisticated emotional words amongst total of emotional words (0-100)
<b>Faces Test - Bordeaux version</b> (Baron-Cohen et al., 1997; Etchepare et al., 2014)	Facial emotion recognition	- 40 full-face photographs - 2 conditions: - « Unconstrained Evocation »: say without cue what the person is thinking or feeling; - « Forced Choice »: choose one of four words describing what the person is thinking or feeling	Number of correct answers in « Unconstrained Evocation » (0 - 20) and « Forced Choice » (0–20)
<b>RMET</b> (Baron-Cohen et al., 2001)	Facial emotion recognition/Affective theory of mind	- 36 photographs of eye regions - Choose one of four words to describe what the person is thinking or feeling	Number of correct answers (0 - 36)
<b>Faux-Pas - 10 stories version</b> (Baron-Cohen et al., 1999)	Affective theory of mind	- 10 stories involving two or three characters - Identify presence or absence of social maladjustment (or faux-pas)	Percent of correct answers (0–100)
<b>Attribution of Intention</b> (Brunet et al., 2003; Sarfati et al., 1997)	Cognitive theory of mind	- 42 comic strips - Choose the most logical end of the story among three propositions - 3 conditions with 14 items: - an experimental condition: intention to infer; - 2 control conditions: physical causality to deduct	Number of correct answers in experimental condition (0 - 14)
<b>LEAS</b> (Lane et al., 1990)	Emotional awareness	- 20 stories involving two characters - Describe one's own emotions and those of another character in each story	Total score (0–100)
<b>BVAQ-B</b> (Bermond et al., 1994; Vorst and Bermond, 2001)	Alexithymia	- Self-administered questionnaire (five-point Likert scale) - 20 items assessing 5 dimensions: 1) verbalizing emotions, 2) fantasizing, 3) identifying emotions, 4) emotionalizing, 5) analyzing	Total score (20–100)

Note: BVAQ-B = Bermond-Vorst Alexithymia Questionnaire - B version; LEAS = Levels of Emotional Awareness Scale; min = minimum; max = maximum; RMET = Reading the Mind in the Eyes Test.

according to Clatworthy et al. (2005).

Mean comparisons using Anova with the Bonferroni post-hoc comparison or the Kruskal-Wallis test if key assumptions for Anova were not fulfilled were performed to identify significant differences in SC measures in each sample (healthy controls or schizophrenia). To explore potential confounding effects of sociodemographic, neurocognitive, anxiety and depressive mood variables, mean comparisons were also performed using Anova with the Bonferroni post-hoc comparison or the Kruskal-Wallis test if key assumptions for Anova were not fulfilled. Finally, an independent sample Student *t*-test or the Mann-Whitney test

if assumptions were not fulfilled were performed to explore differences in SC measures between the two samples (healthy controls versus schizophrenia).

### 3. Results

#### 3.1. Sample characteristics

Sociodemographic and clinical characteristics are provided in Table 4. Groups did not differ on age,  $t(212) = -0.091, p = 0.927$ , but

**Table 3**  
Tasks used for assessing neurocognition and mood.

Task(s)	Dimension(s) assessed	Selected score
<b>Neurocognition</b>		
<b>Coding</b> (Wechsler, 2011)	Information processing speed	Total score (scaled score)
<b>Literal Fluency / Semantic Fluency</b> (Godefroy and GREFEX, 2008)	Executive functioning: Spontaneous flexibility	Both: number of words given in 2 min: (0-∞)
<b>WCST-64</b> (Heaton et al., 2002)	Executive functioning: Reactive flexibility	Number of perseverative responses (percentile)
<b>RL/RI 16</b> (van der Linden and GREMEM, 2004)	Episodic memory	Number of recalled words on 3rd recall (z-score)
<b>Digit Span - Forward / Digit Span - Backward</b> (Wechsler, 2011)	Short-term memory / Working memory	Both: total score (scaled score)
<b>D2</b> (Brickenkamp, 1998)	Selective attention / Sustained attention <sup>a</sup>	- Number of correct answers in first part (percentile) / Number of overall correct answers (0–1269)
<b>Anxiety and depressed mood</b>		
<b>STAI-A / STAI-B</b> (Spielberger et al., 1993)	State anxiety / Trait anxiety	Both: total score (20–80)
<b>BDI II</b> (Beck et al., 1998)	Depressive mood	Total score (0–60)

Note: BDI II = Beck Depression Inventory II; RL/RI 16 = Rappel Libre/Rappel Indiqué 16 items; STAI-A/B = State Trait Anxiety Inventory - Form A/Form B; WCST-64 = Wisconsin Card Sorting Test - 64-card version.

<sup>a</sup> Sustained attention score was calculated by administering the D2 task twice without a break, thus requiring participants to sustain their attention for a longer period of time (9 min).

**Table 4**  
Demographic and clinical characteristics of participants.

	Healthy Controls (n = 120)	Schizophrenia (n = 94)
Mean age, in years (SD)	36.5 (12.9)	36.7 (10.3)
Mean duration of education, in years (SD)	13.3 (2.5)	11.9 (2.6)
Sex (% male)	45%	78.7%
		Diagnosis
Paranoid schizophrenia	–	61.7%
Hebephrenic schizophrenia	–	5.3%
Undifferentiated schizophrenia	–	7.4%
Simple schizophrenia	–	1.1%
Unspecified schizophrenia	–	3.2%
Schizoaffective disorder	–	21.3%

Note: SD = Standard Deviation.

schizophrenia participants (*median* = 12) had a lower education level than healthy controls (*median* = 13),  $U = 3986.5$ ,  $p < 0.001$ , and were predominantly male, unlike healthy controls,  $\chi^2(1) = 24.94$ ,  $p < 0.001$ .

### 3.2. Social cognition clusters in healthy controls sample

In the healthy controls sample, cluster analysis yielded three clusters. Fig. 1 displays the standardized means on each SC measure for the three groups. Groups scores and comparisons are provided in Table 5.

The first group was labelled **Low Facial Emotion Recognition (Low FER)** and included 30 healthy controls (25%) with lower scores in facial emotion recognition, particularly on complex tasks. Compared to the second and third groups, differences ranged respectively from 1.14 SD to 1.42 SD on the RMET and from 0.95 SD to 1.18 SD on the Faces Test - Unconstrained Evocation. The Low FER group also had a better score in cognitive theory of mind as measured with the Attribution of Intention task. The second group was labelled **Homogeneous Social Cognition (Homogeneous SC)** and included 63 healthy controls (52.5%) with the highest SC scores. Compared to the first group (Low FER), this group had significantly higher scores on all tasks (differences ranging from 0.40 SD to 1.42 SD according to the tasks) except for the Attribution of Intention. Compared to the third group, the Homogeneous SC group had significantly higher scores on the three tasks (Faces Test - Forced Choice, Faux-Pas, LEAS), differences ranging from 0.78 SD to 1.89 SD. The third group was labelled **Low Affective Theory of Mind (Low AToM)** and included 27 healthy controls (22.5%) with lower scores on the Faux-Pas and the LEAS. Compared to the other groups, differences ranged from 1.50 SD to 1.89 SD on the Faux-Pas and from 0.40 SD to 0.95 SD on the LEAS, respectively.

No differences were found between the three groups for age, sex, neurocognition abilities, alexithymia, anxiety or depressive mood.

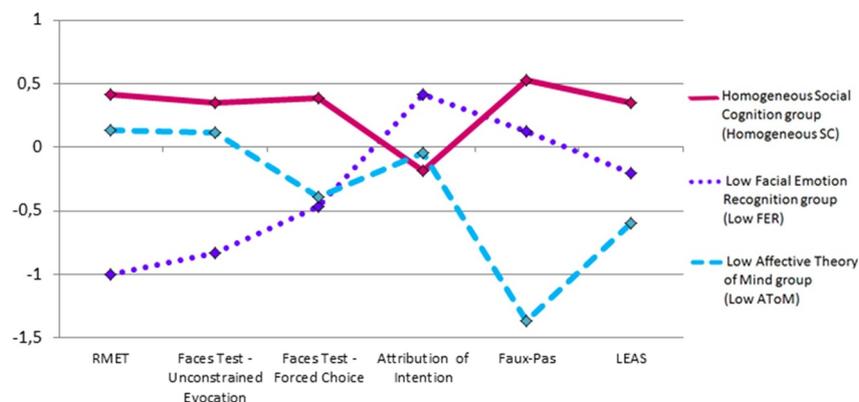


Fig. 1. Standardized SC measures (z-score) of healthy control groups.

Nevertheless, compared to the Homogeneous SC group, the Low FER group had a lower education level ( $p = 0.037$ ) and a lower emotional vocabulary ( $p = 0.020$ ) (see Table 6).

### 3.3. Social cognition clusters in schizophrenia sample

Upon inspection of the agglomeration schedule and dendrogram, a three-cluster solution was considered appropriate for the schizophrenia sample. Fig. 2 displays the standardized means on each SC measure for the three groups. Scores and comparisons are provided in Table 7.

The first group was labelled **Low Social Cognition (Low SC)** and included the 22 schizophrenia participants (23.4%) with the lowest SC scores. The second group was labeled **High Social Cognition (High SC)** and included the 45 participants (47.9%) with the highest SC scores. Compared to the Low SC group, the High SC group performed better on all tasks, differences ranging from 1.07 SD to 1.77 SD according to the tasks. The third group was labelled **Medium Social Cognition (Medium SC)** and included 27 participants (28.7%) with intermediate performances. Compared to the Low SC group, the Medium SC group had better scores on all SC tasks (differences ranging from 0.53 SD to 1.65 SD), except on the Faces Test - Unconstrained Evocation. Compared to the High SC group, the Medium SC group had lower scores on three tasks (Faces Test - Unconstrained Evocation, Attribution of Intention, Faux-Pas), the differences ranging from 0.71 SD to 1.18 SD.

Regarding potential confounding factors, some differences were found between the groups (see Table 8). The Low SC group was older than the High SC group ( $p < 0.001$ ) and the Medium SC group ( $p = 0.012$ ). It also had a lower education level than the High SC group ( $p = 0.018$ ). Regarding other SC abilities, the Low SC group had less emotional vocabulary than the High SC group ( $p = 0.001$ ) and the Medium SC group had greater difficulties on one dimension of alexithymia (i.e., verbalizing one's own emotions) than the High SC group ( $p = 0.037$ ). Regarding neurocognitive abilities, the Low SC group had lower scores on spontaneous flexibility as measured by semantic fluency than the High SC and the Medium SC groups, respectively  $p = 0.030$  and  $p = 0.009$ , and on spontaneous flexibility as measured by literal fluency, short-term memory, sustained attention and reactive flexibility than the High SC group, respectively  $p = 0.032$ ,  $p = 0.003$ ,  $p = 0.019$ ,  $p = 0.018$ . Finally, no difference was found between the three groups regarding sex, diagnosis, anxiety or depressive mood.

### 3.4. Comparisons between healthy controls and schizophrenia samples

The Low SC group had lower SC scores than healthy controls on all tasks, differences ranging from 1.50 SD to 2.45 SD. Conversely, no significant differences in SC scores were found between the High SC group and healthy controls, differences ranging from 0.09 SD to 0.28 SD, except on the LEAS,  $t(163) = 4.77$ ,  $p < 0.001$ , but with a small effect size ( $d = 0.120$ ). The Medium SC group had lower scores than

**Table 5**  
Differences in SC measures between healthy control groups.

	Homogeneous SC (n = 63)		Low FER (n = 30)		Low AToM (n = 27)		F/H	$\eta^2$ <sup>c</sup>	Bonferroni post-hoc comparison
	Total score <sup>a</sup>	z-score	Total score <sup>a</sup>	z-score	Total score <sup>a</sup>	z-score			
<b>RMET</b>	25.89 (2.65)	0.42	21.40 (2.33)	-1.00	25.00 (2.63)	0.14	31.47***	0.35	Homogeneous SC = Low AToM > Low FER
<b>Faces Test - Unconstrained Evocation</b>	9.21 (2.19)	0.35	6.63 (1.59)	-0.84	8.70 (1.46)	0.12	31.09***	0.26	Homogeneous SC = Low AToM > Low FER
<b>Faces Test - Forced Choice Attribution of Intention</b>	17.06 (1.50)	0.39	15.57 (1.43)	-0.47	15.70 (2.00)	-0.39	11.91***	0.17	Homogeneous SC > Low FER = Low AToM
<b>Faux-Pas</b>	13.06 (1.28)	-0.18	13.73 (0.69)	0.42	13.20 (0.93)	0.04	9.28***	0.08	Low FER > Homogeneous SC = Low AToM
<b>LEAS</b>	95.54 (6.85)	0.52	89.22 (12.43)	0.13	65.31 (14.71)	-1.37	57.65***	0.48	Homogeneous SC > Low FER > Low AToM
	63.27 (6.29)	0.35	59.37 (5.77)	-0.20	56.59 (7.54)	-0.60	11.04***	0.16	Homogeneous SC > Low FER = Low AToM

Note:  $\eta^2$  = Anova and Kruskal-Wallis effect size; AToM = Affective Theory of Mind; F = ANOVA statistic; FER = Facial Emotion Recognition; H = Kruskal-Wallis statistic; LEAS = Levels of Emotional Awareness Scale; RMET = Reading the Mind in the Eyes Test; SC = Social Cognition.

\*\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

<sup>a</sup> Total score given as mean (standard deviation).

<sup>b</sup> Kruskal-Wallis used for mean comparisons.

<sup>c</sup>  $\eta^2$  benchmarks:  $\eta^2 = 0.01$ : small effect;  $\eta^2 = 0.06$ : medium effect;  $\eta^2 = 0.14$ : large effect (Cohen, 1988).

healthy controls, differences ranging from 0.59 SD to 1.27 SD, except on the LEAS,  $t(145) = -0.063, p = 0.950$ , with a very small effect size ( $d = 0.002$ ). Table 9 shows results of these comparisons.

#### 4. Discussion

Our aim was to explore and compare SC functioning profiles in the general population and in schizophrenia.

##### 4.1. Social cognition profiles in healthy controls sample

Three different profiles were identified in healthy controls sample. The Homogeneous SC profile displayed good SC functioning and represents more than half of the sample. In comparison, the two other profiles showed specific SC functioning: the first with a weakness in complex facial emotion recognition (Low FER profile) and the second in affective theory of mind and emotional awareness (Low AToM profile). The Low FER profile experienced difficulties in recognizing emotion on a face when cues were absent or partial (i.e., eyes only, or a whole face without words to choose the targeted emotion). Further group comparisons suggested that this could be partly explained by a restricted emotional vocabulary and a lower education level. This result is consistent with other research reporting that a higher education level is associated with better facial emotion recognition (Mill et al., 2009; Nandirino et al., 2013; Wolfgang and Cohen, 1988). The Low AToM profile was characterized by a large weakness in affective theory of mind and a moderate one in emotional awareness. Of note, the association between affective theory of mind and emotional awareness has been previously reported (Lane et al., 2015; Subic-Wrana et al., 2010). Moreover, our results suggest that these three profiles are specific to SC, because no group differences were found in age, sex, neurocognition, anxiety or depressive mood.

##### 4.2. Social cognition profiles in schizophrenia sample

In the schizophrenia sample, three different SC profiles were also identified. Compared to healthy controls, schizophrenia profiles were not obviously differentiated by the nature of SC weaknesses but rather by the level of performance. These findings are consistent with previous research reporting several levels of SC functioning (low, intermediate, high) in schizophrenia (Bell et al., 2013; Rocca et al., 2016). One important result of our study is that the High SC profile (i.e., 47.9% of schizophrenia sample) exhibited a normal-range SC. Some intact SC abilities have also been reported previously (e.g., Fanning et al., 2012; Rocca et al., 2016; Uren et al., 2017). Our findings further generalize this unimpaired SC functioning to several domains of SC. Taken globally, these results are in clear contradiction with the widely accepted idea that a deficit in SC is a core feature of schizophrenia (Eack et al., 2010; Green et al., 2015; Mehta et al., 2013).

In comparison, the two other schizophrenia profiles exhibited different levels of SC difficulties. The Medium SC profile had mild-to-moderate difficulties (z-scores ranging from -0.83 to -1.27) and the Low SC profile had large difficulties (z-scores ranging from -1.50 to -2.45). However, further group comparisons provided important information about the specificity of SC profiles in schizophrenia. Indeed, the Medium SC profile was characterized by specific difficulties, especially on the “verbalizing emotion” dimension of alexithymia. This result appears to be consistent with previous literature reporting difficulties in describing and identifying emotions in schizophrenia (Cedro et al., 2001; Kimhy et al., 2012; Kubota et al., 2011; Yu et al., 2011). However, this is in disagreement with other reports (Henry et al., 2010; van der Meer et al., 2009). Our results suggest that one explanation for this discrepancy is that alexithymia is characteristic of one SC profile rather than being an overall deficit in schizophrenia. Further research is also needed to test the hypothesis that alexithymia is accountable for other SC difficulties in the Medium SC profile such as in theory of mind

**Table 6**  
Differences in sociodemographic, neurocognition, other SC and mood variables between healthy control groups.

	Homogeneous SC (n = 63)	Low FER (n = 30)	Low AToM (n = 27)	F/H/ $\chi^2$	$\eta^2$ / $V^d$	Bonferroni post-hoc comparison
<b>Sociodemographic characteristics</b>						
Age	34.49 (12.12)	39.77 (13.90)	37.67 (13.22)	1.86	0.03	ns
Education level	13.73 (2.32)	12.63 (2.19)	13.11 (2.98)	7.17 <sup>b*</sup>	0.06	Low FER = Low AToM; Homogeneous SC = Low AToM; Homogeneous SC > Low FER
Sex (% male)	49.21	36.67	44.44	1.30	0.10	ns
<b>Neurocognition measures</b>						
Coding	10.56 (2.47)	10.57 (2.60)	9.59 (2.72)	1.49	0.03	ns
Literal Fluency	24.49 (5.81)	21.90 (5.54)	23.81 (5.02)	2.20	0.04	ns
Semantic Fluency	32.21 (6.95)	29.97 (7.29)	31.93 (8.07)	1.00	0.02	ns
RL/RI 16 (3rd free recall)	0.03 (0.71)	0.00 (0.59)	-0.20 (0.78)	0.79 <sup>b</sup>	0.01	ns
Digit Span - Forward	46.07 (27.01)	40.86 (26.51)	38.01 (29.21)	0.94	0.02	ns
Digit Span - Backward	43.59 (28.46)	35.71 (30.75)	41.40 (28.53)	0.75	0.01	ns
D2 (part 1)	50.80 (27.87)	47.71 (31.20)	41.73 (26.92)	0.95	0.02	ns
D2 (overall)	836.90 (138.58)	813.50 (182.91)	800.00 (134.63)	0.64	0.01	ns
WCST-64 (perseverative responses)	49.70 (27.42)	51.30 (26.72)	41.15 (27.78)	1.19	0.02	ns
<b>Other SC variables</b>						
Emotional Fluency - Number of emotional words	14.75 (4.14)	12.13 (4.28)	14.67 (4.54)	4.14*	0.07	Homogeneous SC = Low AToM; Low FER = Low AToM; Homogeneous SC > Low FER
Emotional Fluency - Percent of sophisticated words	69.48 (14.49)	69.90 (17.50)	67.88 (14.25)	0.14	0.00	ns
BVAQ-B: Verbalizing dimension <sup>a</sup>	11.00 (4.10)	12.10 (3.03)	11.85 (3.95)	1.02	0.02	ns
BVAQ-B: Fantasizing dimension <sup>a</sup>	9.11 (3.75)	10.07 (3.97)	9.59 (3.56)	0.68	0.01	ns
BVAQ-B: Identifying dimension <sup>a</sup>	7.86 (2.98)	8.17 (3.17)	7.00 (2.35)	1.25	0.02	ns
BVAQ-B: Emotionalizing dimension <sup>a</sup>	8.76 (2.54)	8.63 (3.46)	9.63(3.15)	1.03	0.02	ns
BVAQ-B: Analyzing dimension <sup>a</sup>	6.84 (2.05)	7.53 (2.19)	7.78 (2.44)	2.14	0.04	ns
<b>Anxiety and depressive mood measures</b>						
STAI-A	29.50 (7.36)	29.43 (6.70)	27.48 (5.86)	0.88	0.02	ns
STAI-B	39.63 (9.84)	40.23 (8.48)	37.74 (9.23)	0.56	0.01	ns
BDI II	6.60 (5.74)	7.07 (6.10)	8.48 (7.14)	0.88	0.02	ns

Note:  $\eta^2$  = Anova and Kruskal-Wallis effect size; AToM = Affective Theory of Mind; BVAQ-B = Bermond-Vorst Alexithymia Questionnaire - B version; BDI II = Beck Depression Inventory II; F = ANOVA statistic; FER = Facial Emotion Recognition; H = Kruskal-Wallis statistic; ns = non-significant; RL/RI 16 = Rappel Libre/Rappel Indicé 16 items; SC = Social Cognition; STAI-A/STAI-B = State Trait Anxiety Inventory - A version/B version; V =  $\chi^2$  effect size; WCST-64 = Wisconsin Card Sorting Test - 64-card version;  $\chi^2$  = Chi-square statistic.

Data are given as mean (standard deviation) unless otherwise indicated.

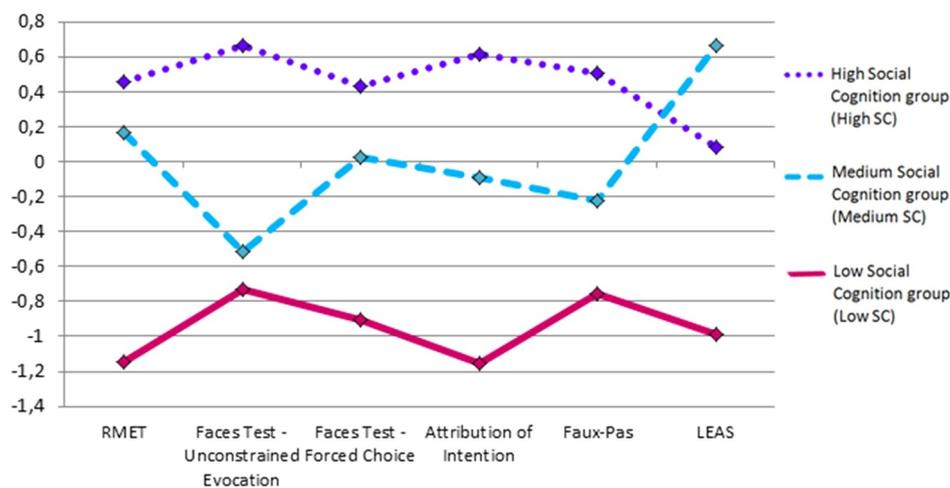
\*  $p < 0.05$ .

<sup>a</sup> BVAQ-B scores are reversed.

<sup>b</sup> Kruskal-Wallis used for mean comparisons.

<sup>c</sup>  $\eta^2$  benchmarks:  $\eta^2 = 0.01$ : small effect;  $\eta^2 = 0.06$ : medium effect;  $\eta^2 = 0.14$ : large effect (Cohen et al., 1988).

<sup>d</sup> V benchmarks: V = 0.10: small effect; V = 0.30: medium effect; V = 0.50: large effect (Cohen et al., 1988).



**Fig. 2.** Standardized SC measures (z-score) of schizophrenia sample.

**Table 7**  
Differences in SC measures between schizophrenia groups.

	High SC (n = 45)		Medium SC (n = 27)		Low SC (n = 22)		F/H	$\eta^{2c}$	Bonferroni post-hoc comparison
	Total score <sup>a</sup>	z-score	Total score <sup>a</sup>	z-score	Total score <sup>a</sup>	z-score			
<b>RMET</b>	23.89 (3.59)	0.46	22.67 (2.91)	0.17	17.14 (2.73)	-1.15	33.36***	0.42	High SC = Medium SC > Low SC
<b>Faces Test - Unconstrained Evocation</b>	8.33 (1.77)	0.67	5.70 (1.38)	-0.51	5.23 (1.97)	-0.73	32.49***	0.42	High SC > Medium SC = Low SC
<b>Faces Test - Forced Choice</b>	15.93 (1.79)	0.43	14.93 (2.27)	0.02	12.64 (2.52)	-0.90	17.94***	0.28	High SC = Medium SC > Low SC
<b>Attribution of Intention</b>	13.47 (0.66)	0.62	12.30 (1.17)	-0.09	10.55 (1.85)	-1.15	44.76***	0.48	High SC > Medium SC > Low SC
<b>Faux-Pas</b>	88.63 (12.51)	0.51	73.09 (21.52)	-0.23	61.89 (23.36)	-0.76	25.54***	0.27	High SC > Medium SC > Low SC
<b>LEAS</b>	56.07 (5.08)	0.08	60.89 (8.20)	0.66	47.23 (7.57)	-0.98	29.33***	0.32	High SC = Medium SC > Low SC

Note:  $\eta^2$  = Anova and Kruskal-Wallis effect size; F = ANOVA statistic; H = Kruskal-Wallis statistic; LEAS = Levels of Emotional Awareness Scale; RMET = Reading the Mind in the Eyes Test; SC = Social Cognition.

\*\*\*  $p < 0.001$ .

<sup>a</sup> Total score are given as mean (standard deviation).

<sup>b</sup> Kruskal-Wallis used for mean comparisons.

<sup>c</sup>  $\eta^2$  benchmarks:  $\eta^2 = 0.01$ : small effect;  $\eta^2 = 0.06$ : medium effect;  $\eta^2 = 0.14$ : large effect (Cohen, 1988).

or facial emotion recognition when cues are absent. Group comparisons also suggested that the Low SC profile was characterized by a higher age, a lower education level, a restricted emotional vocabulary and some neurocognitive difficulties. The relationships between older age and SC impairments have also been reported in some other studies, especially for facial emotion perception impairments (for a meta-analysis, see Kohler et al., 2009). At this time, several explanations have been proposed. Ruffman et al. (2008) suggested that this lower perception of emotion could be due to specific age-related changes as a lower activation of regions involved in SC, a reduction of their volume or of the levels of neurotransmitters such as dopamine and norepinephrine. Other studies suggested that elderly adults paid less attention to the most informative elements of a face conveying an emotion (Sullivan et al., 2007; Wong et al., 2005). Nevertheless, these explanations are not specific to schizophrenia and further investigations should be conducted to better understand specificity of age in SC in schizophrenia. Moreover, numerous studies showed that neurocognition and SC are both related and separate constructs in schizophrenia (for a meta-analysis, see Ventura et al., 2013). Thus, the Low SC profile appears not to be specific to SC but could rather reflect more general difficulties in neurocognition, which is also known to be affected by age and education (Lezak, 2004). This result provides support for the idea that neurocognition functioning underlies SC functioning (Hoe et al., 2012; Mehta et al., 2014). In schizophrenia, neurocognitive disorders could directly contribute to SC disorders. Further research should now provide details about which specific neurocognitive ability is selectively associated with specific social cognitive ones.

#### 4.3. Comparison between healthy controls and schizophrenia samples

One crucial result is that the schizophrenia profiles were not similar to those of healthy controls. The latter exhibited some very specific SC weaknesses such as in facial emotion recognition or affective theory of mind. Rather, the SC profiles of schizophrenia subjects were differentiated by the level of SC functioning (low, medium, high). This difference between healthy controls and schizophrenia could be partly explained by the presence of pathological phenomena in schizophrenia (i.e., neurocognition dysfunctioning or alexithymia) that profoundly impact the Low and Medium SC profiles. These differences are also reminiscent of some neurodevelopmental specificities in schizophrenia (for a review, see Green et al., 2015). Several studies have reported aberrant neural activity during social cognitive processing. Indeed, compared to healthy controls, key regions devoted to emotion perception and theory of mind processing are often hypo-activated in schizophrenia (Dodell-Feder et al., 2014; Li et al., 2010; Taylor et al., 2012). On the contrary, other brain regions not devoted to the processing of these dimensions are hyper-activated (Taylor et al., 2012). Neuroimaging studies are now needed to provide new insights into the

different SC profiles of functioning.

#### 4.4. Implications for clinical practice

These results provide additional arguments for the relevance of considering SC as multidimensional clinical issue. The differences in profiles revealed by this study imply that SC should be measured by several tasks corresponding to several SC dimensions so as to define and pinpoint specific difficulties. Moreover, neurocognition should be assessed specifically, and before SC assessment in order to better adapt the choice of SC tools and avoid confusion about the nature of difficulties (i.e., social vs. basic cognition). Finally, the existence of different SC functioning profiles that differ in nature and level of functioning further emphasizes the need for individually designed therapeutic interventions in SC (Penn et al., 2007b; Statucka and Walder, 2013). Indeed, SC remediation should not be systematized in schizophrenia. If the person has impairments in a specific SC dimension, a targeted intervention is more adapted, like the Training Affect Recognition (TAR) (Wölwer et al., 2005) for facial emotion recognition impairment. If the person has impairments in several SC dimensions, a global intervention could be used, like the Social Cognitive and Interaction Training (SCIT) (Penn et al., 2007a) which focuses on four SC domains (emotion recognition, theory of mind, social perception and attributional style).

#### 4.5. Limitations

This study has some methodological limitations. First, further clinical characteristics, like detailed symptoms, medication and global daily functioning have not been specifically assessed. Regarding symptoms, schizophrenia diagnosis according to ICD-10 has been provided in this study as a mainstream symptoms indicator. As associations have been reported between symptoms and SC (for a meta-analysis, see Ventura et al. (2013), assessing specific clinical characteristics with an appropriate tool, like the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987), would be more accurate in order to further study specificities in SC profiles in schizophrenia. Regarding medication, no information is available, which prevents us from assessing possible influences of this feature on neurocognition and SC abilities. Furthermore, global daily functioning assessment would be relevant because of the functional outcome of SC impairments in several domains such as work, social functioning or independent living. We thus don't have information about relationships between each SC profile and functioning in daily life. Second, some SC dimensions were not assessed such as attributional style, social knowledge and empathy, even though they have been considered as potentially relevant by some authors (Happé et al., 2017; Pinkham et al., 2014). Thus, the present results cannot be generalized to all SC domains. Third, the PECS-B battery used

**Table 8**  
Differences in sociodemographic, neurocognition, other SC and mood variables between schizophrenia groups.

	High SC (n = 45)	Medium SC (n = 27)	Low SC (n = 22)	F/H/ $\chi^2$	$\eta^2$ / $V^d$	Bonferroni post-hoc comparison
<b>Sociodemographic characteristics</b>						
Age	33.38 (8.41)	36.07 (10.92)	44.14 (9.64)	9.60***	0.17	Low SC > High SC = Medium SC
Education level	12.15 (2.32)	11.89 (2.44)	10.68 (2.87)	3.99*	0.08	High SC = Medium SC; Low SC = Medium SC; High SC > Low SC
Sex (% male)	84.44	77.78	68.18	2.35	0.16	ns
Diagnosis				11.09	0.34	ns
% Paranoid schizophrenia	62.20	70.40	50.00			
% Hebephrenic schizophrenia	8.90	/	4.50			
% Undifferentiated schizophrenia	8.90	7.40	4.50			
% Simple schizophrenia	/	/	4.50			
% Unspecified schizophrenia	4.40	3.70	/			
% Schizoaffective disorder	15.60	18.50	36.40			
<b>Neurocognitive measures</b>						
Coding	7.38 (2.63)	8.04 (3.37)	6.59 (3.23)	1.41	0.03	ns
Literal Fluency	20.42 (5.52)	18.33 (6.70)	16.09 (6.48)	3.84*	0.08	High SC = Medium SC; Low SC = Medium SC; High SC > Low SC
Semantic Fluency	25.00 (6.51)	26.33 (7.78)	19.91 (6.23)	5.96**	0.12	High SC = Medium SC > Low SC
RL/RI 16 (3rd free recall)	-0.72 (1.03)	-0.48 (0.94)	-1.09 (1.11)	4.49 <sup>b</sup>	0.05	ns
Digit Span - Forward	37.90 (28.22)	24.93 (23.84)	14.64 (17.10)	11.81 <sup>b,***</sup>	0.13	High SC = Medium SC; Low SC = Medium SC; High SC > Low SC
Digit Span - Backward	31.49 (27.53)	26.74 (22.96)	16.68 (20.65)	4.41 <sup>b</sup>	0.05	ns
D2 (part 1)	20.98 (21.97)	17.85 (22.42)	11.52 (15.86)	1.36	0.03	ns
D2 (overall)	679.18 (129.81)	652.04 (129.04)	580.76 (145.02)	3.92*	0.08	High SC = Medium SC; Low SC = Medium SC; High SC > Low SC
WCST-64 (perseverative responses)	46.40 (32.53)	35.92 (34.29)	22.05 (22.53)	7.69 <sup>b,*</sup>	0.09	High SC = Medium SC; Low SC = Medium SC; High SC > Low SC
<b>Other SC variables</b>						
Emotional Fluency - Number of emotional words	11.71 (4.36)	9.70 (5.29)	7.23 (4.14)	7.16***	0.14	High SC = Medium SC; Low SC = Medium SC; High SC > Low SC
Emotional Fluency - Percent of sophisticated words	69.69 (17.01)	67.59 (24.64)	70.00 (21.62)	0.11	0.00	ns
BVAQ-B: Verbalizing dimension <sup>a</sup>	11.49 (2.86)	13.37 (2.65)	12.95 (3.74)	3.79*	0.08	High SC = Low SC; Medium SC = Low SC; High SC > Medium SC
BVAQ-B: Fantasizing dimension <sup>a</sup>	10.31 (4.10)	11.48 (3.84)	12.05 (4.07)	1.59	0.03	ns
BVAQ-B: Identifying dimension <sup>a</sup>	8.96 (3.14)	10.56 (3.23)	9.45 (4.32)	1.80	0.04	ns
BVAQ-B: Emotionalizing dimension <sup>a</sup>	9.91 (2.93)	10.30 (3.35)	11.27 (3.87)	1.27	0.03	ns
BVAQ-B: Analyzing dimension <sup>a</sup>	8.60 (3.32)	8.63 (2.75)	9.59 (3.07)	0.84	0.02	ns
<b>Anxiety and depressive mood measures</b>						
STAI-A	37.80 (11.80)	37.78 (8.69)	36.23 (10.72)	0.18	0.00	ns
STAI-B	49.69 (12.41)	45.89 (7.72)	44.82 (12.15)	2.12 <sup>b</sup>	0.02	ns
BDI II	14.67 (8.60)	14.48 (8.86)	17.33 (8.60)	0.81	0.02	ns

Note:  $\eta^2$  = Anova and Kruskal-Wallis effect size; BVAQ-B = Bermond-Vorst Alexithymia Questionnaire - B version; BDI II = Beck Depression Inventory II; F = ANOVA statistic; H = Kruskal-Wallis statistic; ns = non-significant; RL/RI 16 = Rappel Libre/Rappel Indicé 16; SC = Social Cognition; STAI-A/STAI-B = State Trait Anxiety Inventory - A version/B version; V =  $\chi^2$  effect size; WCST-64 = Wisconsin Card Sorting Test - 64-card version;  $\chi^2$  = Chi-square statistic.

Data are given as mean (standard deviation) unless otherwise indicated.

\*  $p < 0.05$ ;

\*\*  $p < 0.01$ ;

\*\*\*  $p < 0.001$ .

<sup>a</sup> BVAQ-B scores are reversed.

<sup>b</sup> Kruskal-Wallis used for mean comparisons.

<sup>c</sup>  $\eta^2$  benchmarks:  $\eta^2 = 0.01$ : small effect;  $\eta^2 = 0.06$ : medium effect;  $\eta^2 = 0.14$ : large effect (Cohen et al., 1988).

<sup>d</sup> V benchmarks: V = 0.10: small effect; V = 0.30: medium effect; V = 0.50: large effect (Cohen et al., 1988).

to assess SC has only been validated preliminarily. Further investigations are needed to complete its psychometric properties. Fourth, in healthy controls, young and high education level participants were over-represented while males were over-represented in the schizophrenia sample. Consequently, group comparisons may be partly influenced by sociodemographic factors. Fifth, the generalizability of the results is limited by the sample sizes. Finally, the cross-sectional design prevented us from specifying the stability of the SC profiles in general and schizophrenia populations. A longitudinal design would now throw

more light on the course of SC functioning and its predictive power regarding everyday life and social relationships.

#### 4.6. Conclusion

Using a wide range of SC measures and a cluster-analytic approach, our study is the first to explore the specificity of SC profiles in both schizophrenia and healthy controls. The main finding is that healthy controls exhibited three SC profiles, including two with specific

**Table 9**  
Differences in SC measures between healthy controls and schizophrenia samples.

	Healthy controls vs. High SC		Healthy controls vs. Medium SC		Healthy controls vs. Low SC	
	<i>t/U</i>	<i>d/r</i>	<i>t/U</i>	<i>d/r</i>	<i>t/U</i>	<i>d/r</i>
RMET	1.18	0.01 <sup>b</sup>	2.86**	0.05 <sup>b</sup>	10.33***	0.43 <sup>b</sup>
Faces Test - Unconstrained Evocation	2513.50 <sup>a</sup>	0.05 <sup>c</sup>	498.00 <sup>a,***</sup>	0.47 <sup>c</sup>	377.50 <sup>a,***</sup>	0.45 <sup>c</sup>
Faces Test - Forced Choice	2316.50 <sup>a</sup>	0.11 <sup>c</sup>	1040.00 <sup>a,***</sup>	0.24 <sup>c</sup>	287.00 <sup>a,***</sup>	0.50 <sup>c</sup>
Attribution of Intention	2653.50 <sup>a</sup>	0.01 <sup>c</sup>	821.50 <sup>a,***</sup>	0.36 <sup>c</sup>	276.00 <sup>a,***</sup>	0.53 <sup>c</sup>
Faux-Pas	2601.50 <sup>a</sup>	0.03 <sup>c</sup>	893.50 <sup>a,***</sup>	0.30 <sup>c</sup>	431.00 <sup>a,***</sup>	0.43 <sup>c</sup>
LEAS	4.77***	0.12 <sup>b</sup>	−0.06	0.00 <sup>b</sup>	8.26***	0.33 <sup>b</sup>

Note: *d* = T-Test effect size; LEAS = Levels of Emotional Awareness Scale; *r* = Mann-Whitney effect size; RMET = Reading the Mind in the Eyes Test; SC = Social Cognition; *t* = T-Test statistic, *U* = Mann-Whitney statistic.

<sup>a</sup> Mann-Whitney used for mean comparisons.

<sup>b</sup> *d* benchmarks: *d* = 0.20: small effect; *d* = 0.50: medium effect; *d* = 0.80: large effect.

<sup>c</sup> *r* benchmarks: *r* = 0.10: small effect; *r* = 0.30: medium effect; *r* = 0.50: large effect.

weaknesses (i.e., facial emotion recognition or affective theory of mind). However, these profiles are not the same in schizophrenia which are characterized rather by levels of SC functioning (i.e., low, medium and high). Furthermore, these SC levels are underpinned by various pathological processes such as alexithymia or neurocognition dysfunctioning. Another major finding is that one schizophrenia profile (47.9% of the sample) is characterized by high SC functioning. Consistent with previous studies, these results suggest that SC impairments are not systematic in schizophrenia. Taken globally, they have important implications for assessment methodology and therapeutic interventions. Indeed, neurocognition should be assessed before SC and results should be crossed in order to correctly identify etiology of difficulties. Furthermore, therapeutic interventions should be individually tailored to each person and targeted to their own difficulties.

#### Declaration of interests

None

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