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Cognitive mechanisms of alexithymia in schizophrenia: Investigating the role of basic neurocognitive functioning and cognitive biases

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ABSTRACT

Alexithymia is an important but poorly understood emotional deficit in schizophrenia. We aimed at investigating the role of basic cognitive functions, cognitive biases, and symptom severity in alexithymia among patients with schizophrenia. Sixty patients (31 females) with schizophrenia were assessed with standardized clinical interviews for symptom severity. Cognitive functioning was assessed with neuropsychological tests. A self-report scale (Davos Assessment of Cognitive Biases, DACOBS), as well as two experimental tasks assessing jumping to conclusions (the Fish task) and source monitoring (Action memory task), were used to investigate cognitive biases. Alexithymia was assessed with the Toronto Alexithymia Scale (TAS-20). Alexithymia was related to the severity of hallucinations but not delusions. Patients with a lifetime history of more psychotic symptoms had higher alexithymia. Alexithymia has broad relationships with different cognitive biases, especially in the self-reported measure. These relationships were not affected by neurocognition and symtpoms severity. In particular, difficulties in identification of feelings were related to various cognitive biases. Dysfunctional information processing can thus be considered as potential psychological correlates of alexithymia. The theoretical and clinical implications of our findings are discussed.

1. Introduction

An adequate interplay between self-awareness of emotional states and cognition determines efficient emotion regulation (Gross, 2015), and its disturbances are one of the features of schizophrenia (O'Driscoll et al., 2014; Strauss et al., 2015). However, knowledge regarding the cognitive underpinning of deficits in emotion self-awareness in schizophrenia remains unclear.

One of the conditions that hinders emotional regulation strategies due to emotion unawareness is alexithymia (Gross and Jazaieri, 2014), which has been observed to be an important emotional feature of schizophrenia (Cedro et al., 2001; Kubota et al., 2011). The term alexithymia means 'a lack of words for emotions' and refers to difficulties in identification, description, and communication of emotional states (Sifneos, 1973). Individuals with higher severity of alexithymia struggle with discrimination between feelings and body sensations, do not know what they feel, and are predominately oriented towards external stimuli (externally oriented cognitive style) (Taylor, 1984).

Although alexithymia has been investigated mostly in the context of psychosomatics, the concept has also found an important place in understanding emotional dysfunctions in psychiatric disorders. It was found that patients with depression (Saarijärvi et al., 2001), anxiety disorders (Karukivi et al., 2010), eating disorders (Westwood et al., 2017), or personality disorders (Nicolò et al., 2011) had a higher degree of alexithymia. Two early studies found that patients with schizophrenia had higher levels of alexithymia as compared to healthy controls (Cedro et al., 2001; Stanghellini and Ricca, 1995). Subsequent studies confirmed the early findings (Fogley et al., 2014; Kubota et al., 2011; Kubota et al., 2012; van 't Wout et al., 2007; van der Meer et al., 2009; van der Velde et al., 2015; Yu et al., 2011). More recently, a meta-analysis conducted on eight studies (O'Driscoll et al., 2014) revealed a moderate to large effect size (Hedges $g = -1.05$ (95% CI; -1.45 to -0.65) for the association between alexithymia and schizophrenia, thus confirming deficits in self-awareness of emotional states in this clinical group. It is less clear, however, what aspects of the disorder alexithymia plays a role in, e.g., only a few studies on the role of alexithymia in specific symptoms of schizophrenia were conducted. These studies provided inconsistent results suggesting relations to symptoms of emotional discomfort rather than to negative or positive symptoms (Fogley et al., 2014). However, some studies also found correlations between alexithymia and negative symptoms (van 't Wout et al., 2007).

Besides investigating the question regarding relationships between alexithymia and the psychopathology of schizophrenia, it is also

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important to search for other potential mechanisms of unawareness of emotional states. Following the fact that alexithymia is considered a deficit of cognitive processing and emotional regulation (Taylor et al., 1999), numerous studies found that disruptions in neurocognitive functioning, in both a healthy and different clinical population, correlated with the severity of alexithymia (Wingbermühle et al., 2012). Neuroimaging studies have suggested that difficulties in identifying and describing emotional states in schizophrenia are related to structural and functional neuronal alternations (Kubota et al., 2011; Kubota et al., 2012), yet knowledge regarding the neurocognitive underpinning of alexithymia is still limited. In their behavioral study, Fogley et al. (2014) found that alexithymia, in particular identifying emotions and externally oriented thinking, but not difficulties in describing feelings, is related to processing speed and working memory in schizophrenia.

Some authors suggested that impairments in self-reflection, including emotion awareness, i.e., alexithymia, as well as cognitive biases, constitute a network of different, reciprocally linked processes (Dimaggio et al., 2009). An interaction between cognitive biases and distortions in processes of self-reflection, including alexithymia, have been suggested by Dimaggio et al. (2002) in the pathology of personality. However, to our best knowledge, there has been no study to date that investigated the mechanisms of alexithymia in schizophrenia associated with the role of cognitive biases which have been hypothesized as important factors contributing to development of the condition (Dudley et al., 2015; Garety and Freeman, 1999; Gawęda et al., 2018a, b). Contrary to basic neurocognitive functioning, cognitive biases refer to active information processing that shapes the meaning one ascribes to an event or stimuli from the internal (e.g., body sensations) and external (e.g., interpersonal context) environment. Cognitive biases influence event appraisals and thus may play an important role in emotion regulation, including emotional self-awareness (Everaert et al., 2017). Furthermore, the inability to adequately identify and distinguish emotional states may promote inadequate appraisals of internal and external stimuli.

Numerous studies have found elevated levels of dysfunctional information processing (e.g., cognitive biases) among patients with schizophrenia. Attributional biases in general and a tendency for external attributions, in particular, have been linked to psychotic symptoms (e.g., Garety et al., 2001). Consistent findings also suggest that patients with schizophrenia tend to exhibit both a tendency for hasty decisions (i.e., jumping to conclusions) (Dudley et al., 2015; McLean et al., 2017) and belief inflexibility (So et al., 2012). Some studies have also revealed that patients with schizophrenia have a cognitive tendency to search for interpersonal threat (e.g., attention to threat) (Reininghaus et al., 2016), which may increase emotional arousal that, in fact, precedes exposures to actual interpersonal contact. A strong bond between different dysfunctions of self-reflection, including emotion self-awareness and cognitive biases, may enhance the propagation of failures in the network, which lead to psychopathological symptoms (Dimaggio et al., 2009). Other words, a combination of lack of emotional awareness (what do I feel?) and cognitive biases ('I should stay alert in interpersonal relationships') is likely to provoke more disruptions in the system, comparing to the situation in which only one factor occurs. For instance, an inverse relationship between dysfunction in emotional self-awareness and cognitive biases may cause the situation that the impact of cognitive biases on the system is reduced by a higher degree of emotional awareness. However, the question of whether and, if so, which of the cognitive biases is related to alexithymia in schizophrenia has not been investigated so far.

Hence the present study aimed to establish the relationships between alexithymia and cognitive functioning in schizophrenia. We considered two types of cognitive functions: 1. neuropsychological functioning, which mostly refers to cognitive capacity, and 2. information processing biases (i.e., cognitive biases). Furthermore, we considered the relationship between alexithymia and a history of symptoms as well as the actual severity of schizophrenia symptoms. Previous studies are inconsistent whether alexithymia is related to positive symptoms. One of the reasons might be that alexithymia is related to different positive symptoms, as similar to studies showing that hallucinations and delusions have different cognitive mechanisms. Hence, we investigate the relationship between alexithymia and delusions and hallucinations in separation. Given the fact that according to TAS-20 alexithymia is a multidimensional construct relating to different cognitive functions (Fogley et al., 2014) and symptoms we considered separate subscales of TAS-20 along with total scores in our analyses.

2. Methods

2.1. Participants

Sixty patients (31 females and 29 males) diagnosed with paranoid schizophrenia according to DSM-IV criteria took part in the study after informed consent was obtained. The diagnosis was established based on clinical interviews by a certified psychiatrist and was confirmed with clinical records and the Neuropsychiatric Interview (MINI 5.0, Sheehan et al., 1998). Patients with equivocal diagnosis were excluded from the study. Patients were recruited from in- and outpatient departments cooperating with the II Department of Psychiatry of the Medical University of Warsaw in Poland. All patients were reimbursed for their participation (25 USD, i.e., 80 PLN). Only patients with stabilized symptoms (i.e., non-acute phase) or in clinical remission were included. All patients were on antipsychotic treatment. A history of neurological diseases and active substance dependency served as exclusion criteria. For a detailed demographic and clinical description of the sample, see Table 1. The study received the approval of the local ethics committee.

2.2. Measures

2.2.1. Psychopathology

The severity of symptoms in the timeframe of one week preceding the study was assessed with the Positive and Negative Syndrome Scale (PANSS, Kay et al., 1987) following a structured clinical interview. Based on the recent and well established five-factor solution of the PANSS derived from van der Gaag et al. (2006), we calculated the following symptoms dimensions: positive symptoms, negative symptoms, disorganized symptoms, excitement, and emotional distress. In order to provide more detailed analyses, we focused on also analyzing two individual items from the PANSS for the severity of delusions (P1) and hallucinations (P3).

Furthermore, we assessed the prevalence of lifetime psychotic symptoms based on the psychotic symptoms section from the MINI 5.0.

2.2.2. Neurocognition

We used a battery of neuropsychological tests capturing different cognitive domains. The battery included the following tests:

Color Trails Test (CTT) (D'Elia et al.; 1994, Łojek and Stańczak, 2012) was used to assess selective attention, mental flexibility, visuospatial skills, and motor speed. The CTT-1 requires that the individual connect numbers in ascending order from 1–25 as quickly as possible. The CTT-2 requires alternation between two different sets of stimuli, i.e., between numbers and two colors (1 - pink, 2 - yellow, 3 - pink, etc.). The variable included in the analysis was the time of test completion (in seconds).

Forward Digit Span from the WAIS-R (PL) (Brzeziński et al., 2004) was used to assess the short-term memory. The Backward Digit Span subtest was used to assess the working memory. The variable included in the analysis was the total number of lists reported correctly.

Block Design Test from the WAIS-R was used to evaluate eye-hand coordination, analytic and synthetic abilities, and the ability to reorganize one's actions. The variable included in the analysis was the total score (accuracy in matching the pattern and speed in completing each item).

Table 1
Sample characteristics.

Characteristic	*M* (SD)
Basic characteristics gender [female/male]	31/29
Age	42.66 (11.91)
Duration of illness	17.00 (10.42)
Age of the onset	25.95 (9.08)
Number of hospitalizations	4.72 (5.99)
Chlorpromazine eqv (mg/day)	448.43 (375.32)
Alexithymia	
TAS-20	51.15 (12.11)
DIF	18.18 (6.33)
EXT	14.55 (3.63)
DES	13.66 (4.27)
Symptoms severity	
PANSS positive	9.72 (4.44)
PANSS negative	12.89 (5.81)
PANSS disorganization	6.96 (3.49)
PANSS excitement	5.96 (2.44)
PANSS emotional distress	7.98 (2.74)
PANSS total score	43.87 (13.09)
History of past psychotic symptoms	4.42 (1.61)
Neurocognition	
CTT 1 (sec.)	63.65 (26.38)
CTT 2 (sec.)	119.21 (46.26)
Forward digit span	6.20 (2.14)
Backward digit span	5.60 (1.99)
Block design	25.03 (10.77)
Attention D2	341.55 (85.56)
CVLT	51.67 (10.89)
Cognitive biases	
Jumping to conclusions	24.79 (5.82)
Belief inflexibility	21.51 (5.96)
Attention to threat	24.79 (7.35)
External attribution	22.01 (6.48)
Social cognition problems	24.43 (6.03)
Subjective cognitive problems	24.96 (7.07)
Safety behaviors	16.08 (7.55)
DACOBS total score	157.76 (33.24)
Jumping to conclusions (Fish task):	
JTC 60/40 (number of draws)	6.15 (3.89)
JTC 80/20 (number of draws)	4.37 (3.25)
Source monitoring errors:	
Imagined actions recognized as performed	3.36 (2.58)
Performed actions recognized as imagined	3.02 (2.87)

TEC, traumatic events checklist; PQ 16, prodromal questionnaire; PAM, psychotic attachment measure; DACOBS, Davos assessment of cognitive biases; IPASE, inventory of psychotic-like anomalous self-experiences.

D2 Test of Attention (Brickenkamp et al., 2010) was used to test attention factors concerning the speed of perception, mistakes, overall perception ability (speed factor in relation to the number of mistakes), and alertness. The test requires that participants cross out distinctively marked letters "*d*" in lines comprising diversely marked letters "*p*" and "*d*." The variable included in the analysis was the sum of the number of characters processed before the final cancellation of each trial minus the sum of all errors of omission and commission.

California Verbal Learning Test (CVLT, Delis et al., 2000) was used to measure verbal learning and memorizing abilities. Participants memorized words from the A-List, repeating the words five times immediately after their presentation. The variable included in the analysis was the total number of words recalled in all trials (1–5).

2.2.3. Cognitive biases

We assessed cognitive biases with a self-report Davos Assessment of Cognitive Biases (DACOBS, van der Gaag et al., 2013). A 42-item Polish version of the original scale was used (Gawęda et al., 2015). The DACOBS consisted of 42 items sub-grouped into seven dimensions: 1. jumping to conclusions (e.g. '. I don't need long to reach a conclusion'), belief inflexibility bias (e.g., 'I don't need to consider alternatives when making a decision'), attention to threat bias (e.g., 'People cannot be trusted'), external attribution bias (e.g., 'Things went wrong in my life because of other people'), social cognition problems (e.g., 'I'm often not sure what people mean'), subjective cognitive problems (e.g., 'I get easily distracted by irrelevant information'), and safety behaviors(e.g., 'I don't go to restaurants because it's not safe'). Responses are made on a 7-point Likert scale ranging from 1 – strongly disagree to 7 – strongly agree. Cronbach's alpha for the DACOBS total score in the sample was 0.91.

In addition to the DACOBS, we used experimental tasks to assess two prominent cognitive biases in psychosis, namely Jumping to Conclusions (JTC) and source monitoring deficits.

JTC was assessed using a revised and computerized version of the beads task (Moritz et al., 2009; Speechley et al., 2010), which differs from the original task in that a different scenario (lakes with fish instead of jars with beads) is displayed. We used two versions of the probabilistic reasoning task which varied regarding the discrimination ratio. The first version had a high discrimination ratio (80:20) with unambiguous evidence, whereas the second was more difficult with fish in low discriminability (60:40) with more ambiguous evidence. The instructions were standardized and presented on a computer screen. After each fish was "caught," the participant was required to make two judgments: (1) a probability judgment about the likelihood that the fish was caught from either lake A or lake B, and (2) judgment as to whether the available amount of information would justify the decision or not.

Source monitoring deficits were assessed with the Action Memory Task (Moritz et al., 2009) that was previously used in schizophrenia (Gawęda et al., 2012, 2013). In this task, participants are presented with either verbal instructions or nonverbal pictograms showing actions. Instructions set in a green frame have to be performed, whereas action instructions set in a red frame have to be imagined but not performed. In addition, some actions are presented verbally and some are presented as pictograms; hence the task allows for separate analysis of the ability to discriminate between imagined and performed actions (self-monitoring) and between the verbal and non-verbal type of action presentation (external source monitoring).

2.2.4. Alexithymia

Toronto Alexithymia Scale (TAS-20) (Bagby et al., 1994) is a self-report scale comprising 20 items rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The TAS-20 is a reliable

Table 2
The relationship between alexithymia and symptoms severity (n = 60).

	Positive Total	Negative Hall (P3)	Disorganization Del (P1)	Excitement	Emotional discomfort	PANSS total	History of psychotic symptoms		
TAS-20 total score	−0.014	0.216	−0.055	−0.060	−0.106	−0.127	0.182	−0.062	0.303*
DIF	0.139	0.290*	0.109	0.081	−0.061	−0.139	0.358	0.090	0.350*
EXT	−0.112	0.098	−0.125	−0.166	−0.127	0.065	−0.078	−0.147	0.015
DES	−0.168	0.049	−0.193	−0.096	−0.090	−0.169	0.030	0.212	−0.212

TAS-20, alexithymia Toronto scale; DIF, difficulties in feelings identification: EXT, Ex.
Bold values are significant after Bonferroni correction for multiple comparisons.
* $p < 0.05$.

Table 3
The relationship between alexithymia and neurocognition ($n = 60$).

	CTT 1	CTT 2	Forward digit span	Backward digit span	Block design	D2 attention test	CVLT
TAS-20 total score	0.015	0.013	−0.081	−0.129	−0.212	−0.180	−0.008
DIF	−0.062	−0.065	0.000	0.021	−0.045	−0.061	0.132
EXT	0.102	0.084	−0.310*	−0.133	−0.320*	−0.334**	−0.162
DES	0.027	0.048	−0.006	−0.223**	−0.156	−0.081	−0.032

TAS-20, alexithymia Toronto scale; DIF, difficulties in feelings identification; EXT, externally oriented thinking style; DES, difficulties in describing feelings; CTT, color trial test.
Bold values are significant after Bonferroni correction for multiple comparisons.
* $p < 0.05$.
** $p < 0.01$.

and valid measure of emotion processing in adults which includes a total score and three subscales: Difficulty Identifying Feelings (DIF) (e.g., 'I am often confused about emotions I am feeling'), Difficulty Describing Feelings (DDF) (e.g., 'It is difficult for me to find the right words for my feelings'), and Externally Oriented Thinking (e.g., 'I prefer to talking to people about their daily activities rather than their feelings').The TAS-20 cut-off score for alexithymia is greater than 61 (scores equal or less than 51 – non-alexithymia; scores 51–60 – possible alexithymia). Three-factor structure of the TAS-20 was confirmed in schizophrenia spectrum patients (Heshmati et al., 2011). Cronbach's alpha for total scores in this sample was 0.64.

2.3. Statistics

All analyses were carried out in SPSS 24. Descriptive analyses were performed in the first step; then we checked gender differences on the measured variables with *t*-tests for independent groups. Relationships between target variables were investigated with two-tailed Pearson's correlation analyses ($p < 0.05$)Given the fact of multiple correlations, additionally, to non-corrected p-values, we provided also Bonferroni corrected results. Finally, in addition to correlational analyses, we performed an analysis of regression on the relationships between TAS-20 and the DACOBS controlling for age, neurocognition and symptoms severity. In order to provide readable results, we focused on the DACOBS total score and TAS-20 dimensions that were significantly related to cognitive biases.

3. Results

3.1. Clinical characteristics

A substantial proportion of the patients had no positive symptoms at the time of the study. A total of 38 of patients had delusions (P1 > = 3), and 23 patients experienced hallucinations (P3 > = 3). Of note, the severity of symptoms among the patients reporting hallucinations or delusions varied from slight to moderate; however, all patients had a lifetime history of delusions or hallucinations as indicated by the MINI 5.0. According to the TAS-20 cut off scores for alexithymia criteria (TAS-20 total scores equal or above 61) based on empirical studies (Bagby et al., 1994; Taylor, 1984), 11 patients were considered as alexithymic. Simultaneously, 31 patients fulfilled less conservative criteria (TAS-20 total scores equal or above 52 indicating possible alexithymia). For detailed clinical and demographic characteristics, see Table 1.

3.2. Group characteristics and alexithymia

There were no group differences on alexithymia between male and female patients ($t = 0.81$, $p > 0.05$). Furthermore, alexithymia was not significantly related to either age ($r = 0.10$), education, clinical characteristics such as the number of hospitalizations ($r = 0.15$), medication dosage ($r = 0.14$), or length of the illness ($r = 0.18$).

With regard to the severity of recent symptoms, we found no significant relation between alexithymia and composite scores for positive ($r = -0.01$) and negative ($r = -0.06$) symptoms as well as total scores for PANSS ($r = -0.06$). Only the severity of emotional discomfort was moderately related to the identification of emotion subscales of the TAS-20 ($r = 0.36$). At the same time, a more detailed analysis revealed that the TAS-20 subscale of identification of emotion was related to the severity of hallucinations ($r = 0.29$) but not to delusions ($r = 0.11$). Please note that none of the TAS-20 subscales was related to any individual negative symptoms (PANSS negative symptoms items). Finally, we found that the total scores of the TAS-20 ($r = 0.30$) and the subscale of difficulties in identification of feelings were significantly related to a lifetime history of psychotic symptoms ($r = 0.35$).

3.3. Basic cognitive functions and alexithymia

Only the externally oriented thinking style was significantly related to neurocognitive functioning. More specifically, we found that three tests were related to this alexithymia domain, i.e., Forward Digit Span ($r = -0.31$), Block Design ($r = -0.32$), and D2 ($r = -0.33$). Simultaneously, the Backward Digit Span was related to Difficulties in Describing Feelings at the level of statistical tendency ($r = -0.22$, $p = 0.09$). The results are presented in Table 3.

3.4. Cognitive biases and alexithymia

JTC, as measured with the Fish Task, was not related to alexithymia. The specific source-monitoring error, namely misrecognition of imagined actions as being performed, was significantly related only to externally oriented thinking style ($r = 0.35$). Contrarily, we found several significant correlations between self-reported cognitive biases and dimensions of alexithymia. A subscale of the TAS-20 - Difficulties in Feelings Identification - was linked to all of the cognitive biases (r ranging from 0.26 for Attention to Threat to 0.47 for Subjective Cognitive Complaints). At the same time, Beliefs Inflexibility was related to all dimensions of the TAS-20 (*r* ranging from 0.23 for Difficulties in Describing Feelings to 0.39 for Externally Oriented Thinking Style), thus suggesting the broadest relationships between lack of cognitive flexibility and the construct of alexithymia. Finally, Safety Behaviors were also related to all dimensions of alexithymia (*r* ranging from 0.23 for Difficulties in Describing Feelings to 0.49 for the TAS-20 total score). See Table 4 for the results.

3.5. Cognitive biases and alexithymia controlling for age, neurocognition and symptoms

Additional regression analysis revealed that the relationship between alexithymia and cognitive biases (DACOBS total score) remained significant after controlling for age, neurocognition and symptoms severity ($\beta = 0.631$, $p < 0.001$), $R^2 = 0.19$. Similarly, the relationship between Difficulties in Feelings Identification and cognitive biases (the DACOBS total score) remained significant after controlling for age,

Table 4
The relationship between alexithymia and cognitive biases ($n = 60$).

	Jumping to conclusions	Beliefs Inflexibility	Attention to threat	External Attributions	Social Cognition Deficits	Subjective Cognitive Complaints	Safety Behaviors	DACOBS total	JTC 60/40	JTC 80/20	Imagined as Performed	Performed as imagined
TAS-20 total score	−0.165	**0.383****	0.277*	0.256*	0.363**	**0.374****	**0.493*****	**0.407****	0.112	0.054	0.180	−0.114
DIF	−0.164	0.275*	0.256*	0.292*	0.337**	**0.475****	**0.418****	**0.392****	0.177	0.158	0.000	−0.043
EXT	−0.134	**0.392****	0.181	0.191	0.163	0.163	0.233	0.249	0.014	−0.175	0.348**	−0.069
DES	−0.117	0.225	0.180	0.081	0.314*	0.149	**0.369****	0.237	0.038	0.036	0.096	−0.143

Bold values are significant after Bonferroni correction for multiple comparisons.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

neurocognition and symptoms severity ($\beta = 0.52$, $p < 0.05$), $R^2 = 0.32$. Neurocognition and symptoms severity were not related to alexithymia in the model ($p > 0.05$).

4. Discussion

The main purpose of this study was to examine the relationships between basic neurocognitive functioning, cognitive biases, and alexithymia in schizophrenia. Neurocognitive functioning and cognitive biases, as suggested by studies on their relations to symptoms or outcome, are considered as two related (e.g., Garcia et al., 2012), but distinct groups of cognitive processes. We expected that these two kinds of cognitive processes have different relationships with alexithymia. However, in light of the limited number of studies on cognitive correlates of alexithymia in schizophrenia, our study was exploratory and with no specific hypotheses on which cognitive biases of neurocognitive functions are specifically related to alexithymia. We expected positive correlations between cognitive biases and alexithymia, and negative correlations between neuropsychological tests and alexithymia. Furthermore, the relationship between symptoms and alexithymia remains understudied in schizophrenia. Thus we were interested in exploring the relationship between alexithymia, the severity of recent and history of past psychotic symptoms.

In line with some previous studies (Fogley et al., 2014), we observed no relationship between the severity of general positive and negative symptom dimensions or general symptoms measured with the PANSS. Our analysis revealed, however, that alexithymia was linked to the severity of hallucinations. Simultaneously, basic demographic characteristics (age, education, and gender), and individual negative symptoms were not related to alexithymia. Previous studies conducted in the general population showed that alexithymia is related to increased risk of psychotic experiences (Larøi et al., 2008), including hallucinatory-like experiences (van't Wout et al., 2004) suggesting the linkage between hallucination-proneness and lack of emotion self-awareness. Our results are in line with a prior study which showed that a decreased level of emotional awareness is related to the severity of hallucinations in schizophrenia patients (Serper and Berenbaum, 2008). Furthermore, our findings on the positive relationship between emotional discomfort and alexithymia corroborate with results obtained by Fogley et al. (2014).

Further studies may benefit from investigating the relationship between specific psychotic symptoms, i.e., delusions and hallucinations, rather than general dimensions (e.g., positive symptoms). Indeed, cognitive models of psychotic symptoms (Garety et al., 2001) emphasize that although delusions and hallucinations may share some cognitive and emotional underpinnings, both symptoms also have specific cognitive and emotional roots. Finally, considering the presence of symptoms in the broader time frame may also be beneficial, as was suggested by our results which showed that patients with a history of more severe psychotic symptoms, as indicated by the MINI interview, had a higher intensity of general alexithymia and difficulties in identification of feelings in particular.

The main aim of our study was to investigate the cognitive mechanisms of alexithymia in schizophrenia, as these remain unclear. To date only limited studies have focused on the role of neurocognitive functions as measured with neuropsychological tests. In the context of schizophrenia, to the best of our knowledge, only one study provided data on the complex relationship between alexithymia and neurocognition. Fogley et al. (2014), by using a standardized neurocognitive battery, namely Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS), found that deficits in processing speed, working memory, and abstract thinking were related to difficulties in the identification of feelings and externally related thinking, whereas no relations to difficulties in describing feelings were found. Our results partially confirmed the findings of a prior study, namely, that only the externally oriented thinking subscale of the TAS-

20 was related to basic cognitive functions including working memory, attention, and spatial visualization ability. Simultaneously, we found no relationships between difficulties in identification of feelings and most of the neurocognitive domains, with the exception of attention (errors of omission). These findings on the relationship between neurocognition and the subcomponents of the TAS-20 can be considered in the broader context of studies conducted in other groups of patients or the general population, which show rather inconsistent findings. In particular, the relationship between difficulties in identification of feelings and neurocognitive functioning seems inconclusive, e.g., contrary to a prior study on schizophrenia patients (Fogley et al., 2014) and in line with our recent study, Santorelli and Ready (2015) found no relation between neurocognitive functioning and difficulties in identification of feelings among the non-clinical sample. Similar results were presented in a study by Bogdanova et al. (2010) on asymptomatic HIV-positive patients. Our results are thus in line with findings showing that neurocognitive deficits are related to externally oriented thinking. However, further investigations in this field are required.

Contrary to basic neurocognitive functioning, we found broad and complex relationships between dimensions of alexithymia and the different cognitive biases that are involved in schizophrenia. In general, our results suggest that different cognitive biases as assessed with the self-report measure established more relations to dimensions of alexithymia when compared to cognitive biases assessed with performance-based measures of jumping to conclusions and source monitoring. However, these results may be explained by differences in the assessment (self-report vs. performance-based) only partially; for instance, similar results showing no relationships between jumping to conclusions and alexithymia were obtained from both the performance-based Fish Task and self-report questionnaire subscale. On the other hand, externally oriented thinking style was related to a specific source monitoring bias, i.e., to misattribution of imagined action as being performed (imagery– reality confusion), but not to the self-report assessment of external attribution bias. It is worth noting that the relationship between externally oriented thinking style and source monitoring was not affected by a general tendency to give false positive responses (e.g., new items recognized as old ones), as alexithymia was not related to false recognition of new items as previously perceived. This result might reflect that deficits in imagery capacity are related to alexithymia (Campos et al., 2000) and likely lead to focusing one's attention on primarily external objects. However, this explanation needs further investigation, as not all studies confirmed the linkage between alexithymia and imagery deficiency (Czernecka and Szymura, 2008).

The results on the remaining self-reported cognitive biases suggested that the general level of alexithymia and difficulties in identification of feelings, in particular, are related to external attribution bias and attention to threat. We also found that beliefs inflexibility, in particular, established the most extensive relations with alexithymia, with a significant correlation coefficient for all alexithymia dimensions (a statistical tendency for a description of feelings). Importantly, we also found that the dimensions of alexithymia were significantly related to subjective difficulties in social cognition, which is consistent with previous studies showing that emotion recognition and theory of mind are related to alexithymia (Moriguchi et al., 2006); however, studies that contradict these findings also exist (Koelkebeck et al., 2010). Interestingly, contrary to an objective measure of neurocognitive functioning, the results suggested that subjective cognitive and social cognition complaints were related to difficulties in identification of feelings, but not to externally oriented cognitive style. This might suggest that alexithymia, at least when it comes to difficulties in identification of feelings, is related to beliefs about cognitive abilities rather than the performance itself. Additional regression analyses revealed that the relationships between alexithymia and cognitive biases were not affected by neurocognition or symptoms severity. Further research may benefit from exploring whether meta-cognitive awareness of performance deficits rather than the deficits themselves may be a better predictor of emotion identification and description in schizophrenia.

Our results may have important theoretical and clinical implications for understanding emotion dysregulation in schizophrenia. Cognitive abilities are an important factor in recognizing emotional states (Taylor et al., 1999; Wingbermühle et al., 2012). In particular, or even exclusively, neurocognitive deficits may play a role in attentional disengagement from internal sensations, as suggested by their relationship to the higher degree of externally oriented cognitive style (Fogley et al., 2014). In consequence, important interoceptive signals that are crucial for awareness of emotional states (Herbert et al., 2011) become less available to the patient. At the same time, emotional awareness may be hampered by inadequate cognitive regulatory processes (i.e., cognitive biases) related to stimuli appraisals (Gross and Jazaieri, 2014); for instance, the tendency for external attributions may prevent patients from reflecting on their own mental/emotional states.

Moreover, a better understanding of emotional states requires the ability to consider different points of view on the situation or stimuli and efficient social cognition. Our results suggest that patients with a higher degree of alexithymia tend to have higher deficits in these domains, at least at a subjective level. It is worth noting, in line with observations that alexithymia is related to avoidance-oriented coping strategy (Panayiotou et al., 2015; Parker et al., 1998), that our results suggest that patients who tend to engage safety behaviors (mostly avoidance) tend to have higher alexithymia.

From a clinical perspective, our findings provide the rationale for combining cognitive and emotional factors in therapeutic interventions for patients with schizophrenia or psychosis in general (Freeman and Garety, 2003). For instance, low-intensity training programs, as well as the CBT for psychosis, have been shown to efficiently ameliorate cognitive biases and symptoms (Fiszdon et al., 2017; Kowalski et al., 2017; Waller et al., 2015). Promising results have also been derived from interventions focusing of self-awareness (meta-cognition) in schizophrenia (Inchausti et al., 2017; Ottavi et al., 2014); however, their impact on emotional regulation strategies and alexithymia is to date unknown. Some studies have shown that emotional regulation of patients with schizophrenia increases in experimentally evoked cognitive reappraisal (Grezellschak et al., 2017, 2015). Future studies may address how cognitive biases interact with alexithymia and cognitive appraisals in the context of exposition to stressful life events. Furtheremore, future clinical trials may be informative for clinical practive by considering emotion self-awareness (e.g., alexithymia) as one of the clinical outcomes of the CBT or meta-cognitive therapies for schizophrenia.

Before concluding, some shortcomings of our study should be discussed. The main aim of the study was to investigate cognitive correlates of alexithymia in schizophrenia. Hence, by definition, a cross-sectional and correlational design of the study naturally precludes any causal inferences. Although causality is often bidirectional in psychiatry, leading to circular causality models (e.g., Young, 2015), future longitudinal studies are required to better understand the causal relations between the investigated factors. We provided results from conservative correction for multiple comparisons (Bonferroni). However, as there is no clear recommendations of how and when to use corrections for multiple comparisons, as well as the fact that corrected results are prone to type II errors (Nakagawa, 2004), we decided to base our interpretations on uncorrected statistics. Higher sample size may allow increasing statistical power and additional investigations of the potential role of different trajectories of schizophrenia course and their relation to alexithymia. Furthermore, as suggested by some authors (Kooiman et al., 2002), additional scales for measuring alexithymia may be advisable in order to validate the results and provide assessment for other aspects of alexithymia that is not captured by TAS-20. Furthermore, self-report assessment of self-awareness deficits in schizophrenia might be a limitation and thus other behavioral measures may be beneficial for in future studies. Although our results gave some

support for the linkage between hallucination severity and alexithymia, because alexithymia is treated as a trait factor, one may expect that the construct is a better predictor for dynamics of changes of symptoms or other states rather than for a static point of their severity. Thus, future studies may investigate whether alexithymia predicts dynamic changes in symptoms or cognitive biases contrary to static assessment (for a discussion, see: Nelson et al., 2017). Furthermore, findings from a very recent study suggested that measures of alexithymia are sensitive to social desirability, thus this factor may be of importance (Fogley et al., 2014). We did not investigate the combination between cognitive biases and alexithymia in the context of social functioning, which is related to alexithymia and cognitive regulatory strategies in high clinical risk for psychosis (Kimhy et al., 2016). It should be also note that relatively more significant correlations between self-reported cognitive biases and alexithymia, as compared to less linkage to performance-based measures, might reflect different aspects of cognitive biases captures by these two types of measures as well as differences how patients react to these measures (e.g., patients have a tendency to overestimate their theory of mind abilities in self-report scales, Bonfils et al., 2017). Finally, our results suggest the importance of the relationship between alexithymia and history of psychotic symptoms. However, the measure we used was retrospective and did not provide detailed data on duration, frequency, and severity of past symptoms. Future studies may benefit from investigating in more depth a history of past symptoms of schizophrenia.

To sum up, our findings suggest that there is a relationship between alexithymia and both severe reality distortions (hallucinations) and a lifetime history of psychotic symptoms in schizophrenia. In particular, difficulties in identification of feelings are important in this context. The main analyses revealed that, compared to exclusive relations between neurocognitive deficits and externally oriented thinking style, different cognitive biases established complex relations to various aspects of alexithymia. In general, our results suggest, in line with theoretical models and some previous empirical evidence, that a combination of cognitive biases and alexithymia may play a role in emotional regulation in schizophrenia.

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Contribution

ŁG designed the study, performed the analyses, interpreted the results, and wrote the manuscript. MK coordinated the recruitment, assessed patients, prepared the dataset for analysis, and edited the final version of the manuscript.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2018.12.023.

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