Relationship between social cognition, general cognition, and risk for suicide in individuals with a psychotic disorder

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ABSTRACT

Objective: Cognitive alterations putatively contribute to the risk for suicide in individuals with psychosis. Yet, a comprehensive assessment of social- and general-cognitive abilities in a large sample is lacking.
Methods: Seven-hundred-fifteen individuals diagnosed with a psychotic disorder performed tasks of facial emotion recognition, Theory of Mind, and general cognitive functioning (sustained attention, set-shifting, IQ-tests and verbal learning) as part of the Genetic-Risk-and-Outcome-of-Psychosis (GROUP) study. Presence of past suicide attempt/s and/or current suicidal ideation was reported by 261 individuals and 454 individuals reported no suicide attempt or ideation. We used general linear models to investigate group differences in task performance. All analysis were controlled for age, sex, education, and psychotic symptom severity.
Results: Individuals with suicide attempt and/or ideation showed better performance on the facial emotion recognition task and lower performance on tasks of sustained attention and verbal learning, compared to individuals without suicide attempt and/or ideation, without a clear effect of attempt or ideation. Theory of Mind performance was also better for individuals with suicide attempt and/or ideation, with largest differences between individuals who reported both attempts and ideation compared to individuals without suicide attempt and/or ideation. No effect of suicide attempt and/or ideation was found on misperception of facial emotions, IQ and set-shifting. Overall, effect sizes were small.
Conclusion: Higher sensitivity to social-emotional cues together with weakened attentional control and learning capacity was observed in individuals with psychosis and suicide attempt and/or ideation. This may suggest that insufficient capacity for regulating perceived social stress contributes to suicidal thoughts and behavior.

1. Introduction

Psychotic disorders are related to an increased risk for suicidal behavior. Suicidal thoughts are present in 20–60% of individuals with schizophrenia (Addington et al., 2006; Carlborg et al., 2014) and around 5–13% of individuals with schizophrenia die by suicide (Caldwell and Gottesman, 1990; Hor and Taylor, 2010; Pompili et al., 2005). Clinically,

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past attempts and current ideation are risk factors for death by suicide that may act synergistically, though not every individual with ideation or past attempt/s will end their life by suicide (O'Connor and Kirtley, 2018). Although suicide may be prevented in patients diagnosed with schizophrenia by direct psychotherapeutic (Tarrier et al., 2014) and/or pharmacological interventions (Meltzer et al., 2003), the prediction of who is at risk for suicide and thus would profit from targeted intervention remains a challenge. Therefore, identification of markers and moderators of suicidal risk are needed.

So far, several models have been introduced to incorporate markers for suicidal ideation and behavior, and cognition has been identified as a reoccurring risk factor. In their 'integrated motivational – volitional model of suicidal behavior' (IMV model (O'Connor and Kirtley, 2018)) O'Connor and Kirtley (2018) suggest that abnormalities in social cognition as well as general cognition can elicit a feeling of entrapment or no perspective for escape or rescue which are strong risk factors for suicidal ideation (O'Connor and Kirtley, 2018). According to the neurocognitive model of suicidal behavior (Jollant et al., 2011), this relation can be explained by an altered interpretation of external cues with a greater focus on negative emotions. Recently the importance of neurocognitive abilities as well as social cognition in individuals with suicidal risk have also been incorporated in a model specifically for individuals with psychotic symptoms (Yates et al., 2019). Concluding there is a need to investigate cognitive abilities in suicidal individuals and psychosis.

Social- and general cognitive functioning have been put forward as potential moderators of suicidal risk (Jollant et al., 2011; O'Connor and Nock, 2014). Indeed, social cognition has been associated with suicidal ideation and behavior in psychotic individuals in the domains of emotion recognition and Theory of Mind (ToM; i.e. the ability to recognize other people's mental states and the inference on someone else's thoughts of another person's mental states (Bora et al., 2006)). Higher accuracy in identifying negative facial emotions has been observed in individuals with schizophrenia and suicidal ideation compared to individuals with schizophrenia without suicidal ideation (Depp et al., 2018). Furthermore, past suicidal behavior and current ideation have been linked to misinterpreting neutral as angry faces, albeit on trend level (Villa et al., 2018b). Impairments in ToM have also been observed in individuals with a history of suicide attempt/s and schizophrenia (Canal-Rivero et al., 2017; Duñó et al., 2009) and was found to be predictive of future suicidal behavior in individuals with first-episode psychosis (Canal-Rivero et al., 2017). To date, studies only investigated ToM in individuals with psychosis and a history of at least one suicide attempt in the past, while ToM abnormalities might already be present in patients with suicidal ideation and contribute to the likelihood to act on these thoughts. Considering that individuals with current suicidal ideation and a history of suicidal behavior show both the intention and capability to attempt suicide (by overcoming the natural fear of death) (O'Connor and Nock, 2014; Van Orden et al., 2010), they can be considered at high risk for future suicidal behavior (Van Orden et al., 2008). We therefore expect individuals with both ideation and past attempt (s) to show highest agreement with current findings (greater focus on negative facial emotions and more difficulties in ToM).

General cognitive performance has also been linked to suicidal risk in psychosis. Higher Intelligence Quotient (IQ; De Hert et al., 2001; Delaney et al., 2012), verbal learning (Kim et al., 2003; Nangle et al., 2006; Villa et al., 2018a), working memory, and attentional performance (Kim et al., 2003; Nangle et al., 2006) have been suggested as risk factors for suicidal ideation (Delaney et al., 2012; Villa et al., 2018a) and attempt (De Hert et al., 2001; Delaney et al., 2012; Nangle et al., 2006; Villa et al., 2018a). One hypothesis is that better cognitive performance links to better clinical insight (Leonhardt et al., 2019), which poses an independent risk factor for suicide in psychosis (Barrett et al., 2011). It has further been suggested that higher cognitive performance increases the ability to plan and implement a suicide attempt (Nangle et al., 2006). On the other hand, lower cognitive performance could lead to an impaired capacity of finding solutions in an unbearable situation (Jollant et al., 2011). Therefore, higher and lower cognitive performance could both considered to be risk factors for suicidal behavior (Jollant et al., 2011). Lower IQ and problem-solving skills have indeed been observed in patients with a history of suicide attempt (s) (Duñó et al., 2009), though not consistently (Barrett et al., 2011; Delaney et al., 2012; Nangle et al., 2006; Potkin et al., 2003; Villa et al., 2018a; Zoghbi et al., 2014), suggesting that general cognitive functioning is not a risk factor for suicide in psychosis. So far, little research has been done in individuals diagnosed with a psychotic disorder with current suicidal ideation, and no comparison has been made between individuals with current ideation and a history of suicidal behavior on cognitive and social cognitive outcome. Examining the social and general cognitive risk factors for suicide would add to the existing literature and may yield clues for aiding the development of novel treatment approaches.

In the current study we aimed to investigate the relation between social and general cognitive functioning and suicide attempt and/or ideation in a large sample of patients with psychotic disorders. We expected patients with past suicidal behavior and/or current ideation to show lower performance on social cognitive tasks and better performance on general cognitive tasks than patients without suicidal ideation nor suicidal behavior.

2. Methods

2.1. Sample

In this study we used data of the baseline measurement of the "Genetic Risk and Outcome of Psychosis" (GROUP)-study. We additionally used data from the three-year follow-up measurement to explore whether general and social cognitive performance was predictive of future suicidal ideation and future suicide attempt/s. Studying correlates of past attempts or suicidal ideation was not the main objective of the GROUP study, and therefore the present report concerns secondary analyses. The GROUP-study is an ongoing naturalistic longitudinal study for individuals with a psychotic disorder ($n = 1120$), their healthy siblings and parents ($n = 1976$) who were identified through clinicians working in selected mental health centers in the Netherlands and Belgium, and a healthy control group ($n = 590$). The inclusion criteria for all individuals with a psychotic disorder were: (1) age from 16 to 50, (2) good command of the Dutch language, and (3) being able and willing to give written informed consent, and (4) a diagnosis conform the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV). The full procedure of the study has been described elsewhere (Korver et al., 2012). For the current study we only selected individuals diagnosed with a psychotic disorder (see Table 1). No information on suicidal ideation nor suicidal behavior was available for the relatives and healthy controls.

2.2. Clinical measures

Presence of psychotic behavior (current and past) was assessed through the Comprehensive Assessment of History and Symptoms (CASH) (Andreasen et al., 1987); at three study sites) concluding into a classification conform the DSM-IV (American Psychiatric Association, 2010). The presence and severity of symptoms of a psychotic disorder during the last week (Kay et al., 1988) was measured with the semi-structured Positive and Negative Syndrome Scale (PANSS (Kay et al., 1988)). It covers three dimensions of symptomatology: positive symptoms (7 items), negative symptoms (7 items) and general psychopathology (16 items).

2.2.1. Measures of suicidal ideation and suicidal behavior

Past suicidal behavior was assessed with a single item asking participants whether they ever attempted suicide (yes/no; see Appendix). In addition, questions were asked about the number of suicide attempts,

Table 1
Sample characteristics for suicide attempt and/or ideation and the four groups (levels of suicide attempt and/or ideation).

Variable	Suicide attempt and/or ideation Two Groups				Levels of suicide attempt and/or ideation Four Groups					
	Yes Mean (SD)	No Mean (SD)	Test Statistic	p Value	SA+SI+ Mean (SD)	SA+SI− Mean (SD)	SA−SI+ Mean (SD)	SA−SI− Mean (SD)	Test Statistic	p Value
N	261	454			49	149	63	454		
%	36.5%	63.5%			6.9%	20.8%	8.8%	63.5%		
Age	26.9 ±7.5	27.4 (7.3)	$F_{(1,714)} = 0.6$	0.45	25.4 (7.3)	27.7 (7.7)	26.1 (6.9)	27.4 (7.3)	$F_{(3,711)} = 1.7$	0.16
Sex	186 male (71.3%)	332 male (74.1%)	$X^2(1) = 5.9$	0.60	38 male (77.6%)	98 male (65.8%)	50 male (79.4%)	332 male (73.1%)	$X^2(3) = 5.6$	0.13
Education										
No Education	1.1%	0.9%	$X^2(5) = 2.1$	0.84	0.0%	2.0%	0.0%	0.9%	$X^2(15) = 21.6$	0.12
Primary School	16.1%	13.7%			24.5%	14.1%	14.3%	13.7%		
Secondary school	37.5%	37.7%			51.0%	32.2%	39.7%	37.7%		
High school	21.5%	23.1%			6.1%	23.5%	28.6%	23.1%		
Vocational Education	21.1%	20.5%			18.4%	24.2%	15.9%	20.5%		
University	2.7%	4.2%			0.0%	4.0%	1.6%	4.2%		
Medication										
No antipsychotics	0.0%	1.2%	$X^2(2) = 3.2$	0.21	0.0%	0.0%	0.0%	1.3%	$X^2(6) = 4.6$	0.60
Atypical antipsychotics	76.6%	77.3%			78.0%	74.1%	81.8%	77.1 %		
Typical antipsychotics	23.4%	21.5%			22.0%	25.9%	18.2%	21.6%		
Other Medication										
Mood-stabilizers	8.8%	8.9%	$X^2(2) = 1.3$	0.53	8.2%	9.4%	7.9%	8.2%	$X^2(6) = 4.4$	0.62
Anti-depressants	30.3%	22.1%			42.9%	28.9%	23.8%	20.3%		
Benzodiazepines	1.1%	1.1%			4.1%	0.7%	0.0%	1.1%		
Diagnosis										
Schizophrenia	72.4%	69.3%	$X^2(5) = 5.0$	0.41	68.1%	71.8%	77.0%	69.3%	$X^2(15) = 10.3$	0.80
Schizoaffective disorder	12.4%	10.5%			17.0%	13.4%	6.6%	10.5%		
Psychotic disorder	9.2%	11.5%			8.5%	8.5%	11.5%	11.5%		
Bipolar disorder	0.8%	1.4%			2.1%	0.7%	0.0%	1.4%		
Brief psychotic disorder	0.8%	2.8%			0.0%	0.7%	1.6%	2.8%		
Other psychotic disorders	4.4%	4.4%			4.3%	4.9%	3.3%	4.4%		
PANSS[1]										
Positive symptoms	14.2 ± 5.9	12.3 ± 5.2	$F_{(1,701)} = 20.1$	**<0.001**	16.7 ±6.7	12.8 ± 5.3	15.6 ± 5.6	12.3 ± 5.2	$F_{(3,698)} = 15.2$	**<0.001**
Negative symptoms	14.8 ± 6.4	13.7 ± 5.8	$F_{(1,697)} = 5.6$	**0.02**	15.6 ± 6.3	13.4 ± 5.8	17.7 ± 6.7	13.7 ± 5.8	$F_{(3,694)} = 10.0$	**<0.001**
Psychopathology	27.5 ± 8.8	24.8 ± 7.1	$F_{(1,685)} =19.1$	**<0.001**	32.3 ± 9.7	24.7 ± 7.6	30.6 ± 8.4	24.8 ± 7.1	$F_{(3,682)} = 23.0$	**<0.001**
Total	56.5 ±17.8	50.7 ± 15.4	$F_{(1,662)} =19.1$	**<0.001**	65.1 ± 19.2	50.8 ± 15.7	63.5 ± 16.7	50.7 ± 15.4	$F_{(3,662)} = 21.0$	**<0.001**

Note. The sample sizes per group are based on the maximum available data.
The post hoc scores revealed significant differences between the groups on PANSS positive symptoms (SA+SI+ > SA+SI−, $p < .001$; SA+SI+ > SA−SI−, $p = .004$) on PANSS negative symptoms (SI+SA− > SA+SI−; SI+SA− > SA−SI−; both $ps < .001$) and on PANSS psychopathology symptoms (SA+SI+ > SA+SI− and SA+SI+ > SA−SI−, both $ps < .001$; SI+SA− > SA+SI−, SI+SA− > SA−SI−, both $ps < .001$).

severity and intention (see Table 2 and Appendix). On the three-year follow-up subjects were asked if they attempted suicide during the past three years. On the baseline measurement, suicidal ideation was measured with one item of the Camberwell Assessment of Need Short Appraisal Schedule (CANSAS (Phelan et al., 1995)). The interview-item addressed whether someone poses a risk for themselves through

Table 2
Characteristics of the suicide attempts.

	SA+SI+	SA+SI−	t-Test	χ2
Number of attempts	(n = 49) 2.0 (1–14)	(n = 146) 1.8 (1–15)	0.8	
After/Before onset of the psychotic episode	(n = 49) 34/15	(n = 149) 113/36		0.1
Severity	(n = 47)	(n = 146)		0.7
Mild	28	96		
Moderate	15	41		
Severe	4	9		
Intention	(n = 47)	(n = 145)		0.4
Mild	10	45		
Moderate	23	56		
Severe	14	44		

Note. χ2 = Pearson Chi-Square test.
Severity SA: Mild = no or little damage Moderate = little damage, Severe = severe damage.
Intention of SA: Mild = did not want to die, Moderate = wanted to die but was uncertain about it, Severe = wanted to die. Sample sizes vary from 47–49 for individuals with SA+SI + and from 145–146 for individuals with SA+SI.

asking if one had thoughts about self-directed injurious behavior or did already harm oneself, during the past three months (see Appendix for more information). Based on this item, we created a variable for suicidal ideation scored as SI- (no suicidal ideation) or SI+ (suicide risk is covered or the patient indicated suicidal plans in the past month or put oneself in danger). For the three-year follow-up suicidal ideation was defined by a score higher than one on the item about suicidal ideation in the past two weeks from the Calgary Depression Scale for Schizophrenia (CDSS; see appendix; the CANSAS was not conducted on the three-year follow-up).

For the current study we categorized the groups for the baseline measures as follows:

1) Individuals with suicide attempt/s and/or suicidal ideation; including the following levels:

a) Individuals with at least one suicide attempt in the past and current suicidal ideation (SA + SI+);
b) Individuals with at least one suicide attempt in the past without current suicidal ideation (SA + SI-);
c) Individuals without a suicide attempt in the past but with current suicidal ideation (SA-SI+).

2) d.) with neither a suicide attempt nor current suicidal ideation (SA-SI-).

For the follow-up analyses the following groups were compared: 1. Individuals with and without suicidal ideation (SI/noSI) and 2.

Individuals with and without a suicide attempt (SA/noSA) in the past three years.

2.3. Cognitive measures

Three social cognitive and seven general cognitive tasks were used in the analysis of the current paper.

Facial recognition was measured with the Degraded Facial Affect Recognition Task (DFAR (Van't Wout et al., 2004)), by instructing individuals to indicate emotional expressions (neutral, happy, fearful and angry) of 64 facial pictures at 70% intensity, i.e. slightly degraded (Maat et al., 2015; Van't Wout et al., 2004). In order to rule out the effect of a general facial recognition inability on the DFAR task, the Benton Facial Recognition Task (Benton et al., 1983; Duchaine and Weidenfeld, 2003) was administered, and used as a covariate. The Hinting Task (Corcoran et al., 1995) was used to measure ToM and assesses an individual's ability to indicate real intentions from implicit messages in ten short stories containing interaction between two protagonists. At the end of every interaction, a short hint about the implicit message was given by one of the protagonists.

For general cognition the following tasks were used: the Continuous Performance Task-HQ (CPT-HQ, (Nuechterlein and Dawson, 1984)) to measure sustained attention and vigilance. Set-shifting abilities were measured with the Response Shifting Task (RST; Bilder et al., 1992)). Four subtests of the validated Dutch Wechsler Adult Intelligence Scale, version III (WAIS-III; Uterwijk, 2000; Wechsler, 1997) were taken together to create an indicator for general IQ (Blyler et al., 2000). Verbal learning was assessed with a word learning task (WLT) consisting of three 15-word trials (Brand and Jolles, 1985). Detailed information about the tasks and outcome scores can be found in the Appendix.

2.4. Statistical analysis

Statistical analyses were performed using Statistical Package for Social Science (SPSS) software, Version 23.0 R 7.0 of the GROUP database was used for the analyses. Outlier analyses of the dependent variables were conducted with Cook's distance; a score higher than one was used as a cut-off score for outliers (Field, 2013). Assumptions of normality were checked using probability-plots (QQ) and tests for normality. Differences between the two (with and without SA and/or SI) and four groups (SA + SI+, SA + SI-, SA-SI+, SA-SI-) regarding demographics, medication (antipsychotics and other psychopharmaca), diagnosis, and symptoms of psychosis explored with one-way ANOVA and χ2 tests. We performed all analysis with the following covariates: age, sex, and education and the total PANSS score. The total PANSS score was added owing to the potential effect of the psychotic symptoms on facial affect recognition abilities (Addington et al., 2006; Dyck et al., 2010), ToM (Stanford et al., 2011; Chung et al., 2008), and cognitive abilities (Hofer et al., 2005).

For the tests measuring social and general cognition we conducted a series of analysis of covariance (ANCOVA/MANCOVA/RM-ANCOVA where appropriate) with SA and/or SI and levels of SA and/or SI (1.SA + SI+, 2.SA + SI-, 3.SA-SI+, 4.SA-SI-) as respective independent variables and the test scores as dependent variables (see Appendix for more details). To correct for general facial recognition abilities, scores of the Benton facial recognition task were used as an extra covariate in the DFAR-model. In addition, for the follow-up measures, four logistic regression models were performed with 1. SA and 2. SI as the dependent variable and the following predictors for the social cognitive models: age, sex (categorical with one dummy variable), education (categorical with five dummy variables), PANSS total, DFAR (neutral, happy, fearful, angry), DFAR biased (happy_neutral, fearful_neutral, angry_neutral), Benton and the Hinting Task. For the general cognitive models, the following predictors were used: age, sex (categorical with one dummy variable), education (categorical with five dummy variables), PANSS

total, CPT-HQ, RST, the four WAIS subtests and the WLT (immediate recall and delayed recall). See appendix for more details.

To investigate potential confounding effects of the severity of symptoms and diagnosis, we repeated the analyses without correction for PANSS total scores, and additionally ran the analyses including corrections for PANSS positive symptoms scores, PANSS negative symptoms scores and after omission of individuals with bipolar and schizoaffective disorders (see appendix).

Significance levels were set at an alpha of 0.05.

3. Results

3.1. Sample

As a consequence of missing data, the current study sample for analysis of the social and general cognition, data ranged from $n = 593$ to $n = 715$ individuals from the full GROUP sample. In 261 individuals out of 715, presence of suicide attempt and/or suicidal ideation was reported. Sample characteristic are shown in Table 1 and characteristics of suicide attempts can be found in Table 2. Individuals with SA and/or SI did show higher scores on the PANSS positive, negative and general psychopathology scale than individuals without SA and/or SI (with highest scores for SA + SI+ on the PANSS positive and psychopathology subscales and highest scores for SA-SI+ on the PANSS negative subscale). No differences were found for age, sex, education level, psychotropic drugs, or diagnosis. The demographics and sample characteristics are shown in Table 1. Characteristics of the three-year follow-up sample can be found in Table 4.

3.1.1. Social cognition

For the DFAR there was a main effect for SA and/or SI (yes/no) (see Table 3), however no SA and/or SI × emotional valence interaction was observed (F(2.7306.7) = 0.9, $p = .41$, $\eta^2 = 0.002$). Explorative post-hoc tests per emotion showed higher scores for recognizing fearful faces in individuals with SA and/or SI ($p = 0.046$, $\eta^2 = 0.007$; see Fig. 1), with no significant differences for other emotions ($ps > 0.05$). No effect was observed for SA and/or SI (yes/no) on misperception of emotional faces (seeing a happy, fearful or angry face when a neutral face was shown; see Table 3). There was no main effect for levels of SA and/or SI (SA + SI+, SA + SI-, SI + SA-, SA-SI-) on emotion recognition or misperception of emotional faces (see Table 3).

A main effect of SA and/or SI and a main effect for levels of SA and/or SI (see Table 3) were observed on ToM. Specifically, individuals with SA and/or SI showed higher scores on the Hinting Task (see Table 3 and Fig. 2A). For levels of SA and/or SI (see Table 3 and Fig. 2B), a simple contrast revealed higher scores for the SA+SI+ group compared to the SA-SI- group ($p = .02$; $\eta^2 = 0.007$). At the follow-up, social cognition did not predict a future SA ($\chi^2(16) = 22.8$, $p = .12$, Nagelkerke's $R^2 = 10.3\%$), nor future SI ($\chi^2(16) = 14.7$, $p = .58$, Nagelkerke's $R^2 = 4.9\%$). See Table 4 for all results of the individual predictors.

3.1.2. General cognition

On the CPT-HQ task differences were found for SA and/or SI: individuals with SA and/or SI had lower scores compared to individuals without SA and/or SI (see Table 3 and Fig. 3). For levels of SA and/or SI the results were not significant. Presence and levels of SA and/or SI were not associated with RST differences nor with the four subtests of the WAIS (see Table 3). On the WLT a main effect was found for SA and/or SI for the immediate recall with lower scores for individuals with SA and/or SI (see Table 3 and Fig. 3); no effect was found for the delayed recall condition. For levels of SA and/or SI no differences were found on the immediate or the delayed recall condition. Further, there was no learning effect between the first three repetitions and SA and/or SI (F (1.9, 1260.3) = 0.6, $p = .51$, $\eta^2 = 0.001$) or levels of SA and/or SI (F (5.81260.2) = 0.5, $p = .81$, $\eta^2 = 0.002$). Prediction for SI and SA at the follow-up indicated, that cognitive tests did not predict a future SA

Table 3
Group differences for levels of suicidality on the social and general cognition tasks.

Variable	Suicide attempt and/or ideation Two Groups					Levels of suicide attempt and/or ideation Four Groups						
	Yes Mean (SD)	No Mean (SD)	F(df)	p	η^{21}	SA+SI+ Mean ± SD	SA+SI− Mean ± SD	SA−SI+ Mean ± SD	SI−SA− Mean ± SD	F(df)	p	η^{21}
Social cognition												
DFAR	(n = 219)	(n = 374)				(n = 41)	(n = 136)	(n = 58)	(n = 411)			
			F(1,586) = 4.1	**0.04**	0.007					F(3,588)=1.4	0.26	0.009
Neutral	77.4 ± 16.6	77.6 ± 18.1				79.9 ± 16.3	77.0 ± 15.8	76.7 ± 18.5	77.6 ± 18.1			
Happy	87.1 ± 12.7	86.9 ± 12.1				86.7 ± 9.6	87.1 ± 13.4	87.3 ± 12.9	86.9 ± 12.1			
Fearful	49.9 ± 18.7	46.7 ± 20.2				47.1 ± 19.7	50.3 ± 18.0	50.8 ± 19.8	46.7 ± 20.2			
Angry	63.6 ± 20.8	62.4 ± 21.3				64.3 ± 19.4	63.4 ± 21.1	63.5 ± 21.5	62.4 ± 21.3			
DFAR Bias												
HappyNeutral[2]	1.7 ± 1.8	1.6 ± 1.8	F(1,585) = .03	0.87	<0.01	1.2 ± 1.4	1.6 ± 1.60	1.8 ± 1.6	1.6 ± 1.8	F(3,588) = 0.5	0.71	0.002
FearfulNeural[3]	0.9 ± 1.7	0.7 ± 1.4				1.0 ±1.5	0.8 ±1.6	0.8 ± 1.9	0.7 ± 1.4			
AngryNeutral[4]	1.2 ± 1.4	1.2 ± 1.6				1.0 ± 1.4	1.3 ± 1.5	1.1 ± 1.4	1.2 ± 1.6			
Benton	(n = 241)	(n = 404)				(n= 47)	(n= 149)	(n= 61)	(n= 440)			
	22.5 ± 2.4	22.8 ± 2.3	F(1,639) = 0.8	0.38	0.001	22.0 ± 2.3	22.6 ± 2.4	22.5 ± 2.6	22.8 ± 2.3	F(3,637) = 0.3	0.81	0.002
Hinting Task	(n = 242)	(n = 408)				(n= 47)	(n= 149)	(n= 62)	(n= 443)			
	17.6 ± 2.8	17.4 ± 3.0	F(1,644) = 4.4	**0.04**	0.007	17.8 ± 2.5	17.6 ± 2.6	17.2 ± 3.2	17.4 ± 3.0	F(1,642) = 3.2	**0.02**	0.015
General cognition												
CPT-HQ	(n = 218)	(n = 379)				(n = 42)	(n = 134)	(n = 57)	(n = 412)			
Accuracy	97.6 ± 6.3	98.8 ± 2.6	F(1,591) = 6.4	**0.01**	0.01	96.9 ± 8.0	98.0 ± 5.2	97.7 ± 6.4	98.8 ± 2.6	F(3,590) = 2.3	0.07	0.012
RST	(n = 213)	(n = 364)	F(1,571) = 1.8	0.19	0.003	(n = 39)	(n = 121)	(n = 53)	(n = 364)	F(3,569) = 0.6	0.60	0.003
	1.3 ± 4.5	1.9 ± 6.5				1.1 ± 3.2	1.3 ± 4.2	1.6 ± 5.7	1.9 ± 6.5			
WAIS	(n = 241)	(n = 413)				(n = 45)	(n = 140)	(n = 56)	(n = 413)			
Calculation	11.8 ± 4.7	11.9 ± 4.7	F(1,648) = 25.0	0.24	0.002	10.9 ± 4.5	11.8 ± 4.8	12.8 ± 4.5	11.9 ± 4.7	F(3,646) = 2.2	0.09	0.010
Block design	39.6 ± 17.4	40.2 ± 16.8	F(1,648) =84.9	0.57	0.001	37.3 ± 18.8	39.6 ± 16.7	40.4 ± 16.8	40.2 ± 16.8	F(3,646) = 0.6	0.65	0.003
Information	16.5 ± 5.4	16.3 ± 5.5	F(1,648) = 64.1	0.10	0.004	14.8 ± 5.0	16.6 ± 5.5	17.6 ± 5.3	16.3 ± 5.5	F(3,646) = 2.3	0.08	0.010
Symbol Substitution	64.4 ± 16.7	65.3 ± 16.0	F(1,648) = 9.0	0.84	<0.001	61.1 ± 17.1	65.1 ± 16.6	64.1 ± 16.7	65.3 ± 16.0	F(3,646) = 0.1	0.96	<0.001
WLT	(n = 239)	(n = 409)				(n = 43)	(n = 141)	(n = 55)	(n = 409)			
Immediate recall	22.1 ± 6.1	23.5 ± 6.2	F(1,642) = 4.6	**0.03**	0.007	22.5 ± 6.3	22.2 ± 5.9	21.4 ± 6.4	23.5 ± 6.2	F(3,640) = 2.3	0.08	0.011
Delayed recall	7.3 ± 2.8	7.8 ± 2.9	F(1,642) = 2.1	0.15	0.003	7.1 ± 2.9	7.4 ± 2.7	7.3 ± 3.0	7.8 ± 2.9	F(3,640) = 0.8	0.49	0.004

Note. Mean values are not corrected for the covariates. Statistics included the following covariates: age, sex, education and the total PANSS score.

[1] Eta Squared.
[2] HappyNeutral = seeing a happy face, when a neutral face was shown.
[3] FearfulNeutral = seeing a fearful face, when a neutral face was shown.
[4] AngryNeutral = seeing an angry face, when a neutral face was shown.

($\chi^2(16) = 24.2, p = .09$, Nagelkerke's $R^2 = 12.0\%$) nor future SI ($\chi^2(16) = 11.6, p = .77$, Nagelkerke's $R^2 = 4.2\%$). For SA only sex (being male) was a significant predictor in the general cognition model ($p = .02$). See Table 4 for all results of the individual predictors.

4. Discussion

The aim of the present study was to investigate the relationship between social cognitive functioning, general cognitive functioning and suicide attempt/s and suicidal ideation in individuals with psychosis. To this end, we analyzed data from 715 individuals with a psychotic disorder for whom data was available regarding SA and/or SI (presence/absence of past attempts and current ideation) and social cognitive and general cognitive test performance from the baseline measurement of

Fig. 1. Percentage correct of the DFAR task per emotions for individuals with and without suicidality. *Note.* Mean values are corrected for age, sex, education and PANSS total score. Error bars indicate standard errors. *significant at the level $p < .05$.

the GROUP cohort study (Korver et al., 2012). Results were twofold: on the one hand we found higher scores for detecting facial expressions and Theory of Mind performance in individuals with presence of SA and/or SI, most notably for fearful faces, whereas on the other hand sustained attention and verbal learning abilities were slightly lower in patients with SA and/or SI compared to no SA and/or SI. Group differences in ToM were most pronounced between patients without SA and/or SI and patients with both past attempts and current ideation, whereas for facial emotion recognition, vigilance and verbal learning, no clear effect of current suicidal ideation and/or past suicide attempt was observed. No association was observed between presence of SA and/or SI and misperception of facial expressions, IQ sub-tests, nor set-shifting. These results suggest that individuals with a psychotic disorder with suicidal ideation and/or behavior in the past may have increased capabilities to detect (negative) social cues together with lower attentional and verbal learning capabilities. However, since effect sizes were (very) small, this conclusion should be treated with caution, and replications of this study are needed to verify our results. Social and general cognition could not predict future SA nor SI.

Our findings of the facial affect recognition task are not in line with those from previous papers regarding the relation between SA and/or SI and an increased attention for negative affective information. Previously, no differences for individuals with and without suicidal ideation were found (SI; Depp et al., 2018; Villa et al., 2018b), nor for individuals with past Suicide Attempt/s (SA/s) compared to no SA (Villa et al., 2018b) on a static facial affect recognition task. The tasks used by Depp et al. (2018) and Villa et al. (2018b) are comparable to the one we used in the current study, although our pictures were shown with 70% intensity. Facial expressions at this intensity might be more comparable to daily situations in which emotional expressions may be brief and not fully expressed (Van Dijke et al., 2016). Our task might

Fig. 2. Total correct scores on the Hinting Task for suicidality (yes/no) and levels of suicidality. *Note.* Mean values are corrected for age, sex, education and PANSS total score. Error bars indicate standard errors. *significant at the level p < .05.
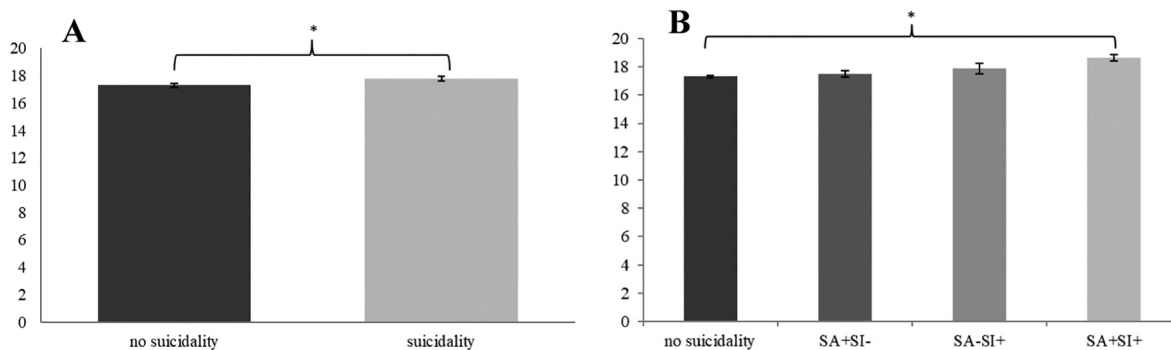
therefore be a more accurate reflection of daily inaccuracies patients with risk for suicide experience. During a dynamic task with upper-body movement and dynamic facial stimuli Depp et al. (2018) also revealed differences in detecting faces with negative affect. Their dynamic task could also be considered more ecologically valid (Velotti et al., 2015), and therefore more sensitive to reveal differences in facial expression recognition for patients with SI. While we detected higher performance for detecting faces of all valences, most pronounced for fearful faces, Depp et al. (2018) found a combination of negative states (sadness, fear, disgust and anger) to be better detected by patients with SI. The differences in sample population might have contributed to this subtle discrepancy. While Depp et al. (2018) only investigated individuals with and without SI our population comprises individuals with SI as well as SA.

We also observed slightly better ToM performances for individuals with SI and past SA(s) compared to individuals without SA and/or SI. These findings contrast with previous observations that lower ToM abilities are associated with suicide attempt/s in psychosis (Duñó et al., 2009; Canal-Rivero et al., 2017). The differences in ToM abilities might be explained by task differences. Our ToM task (Hinting Task) focused on speech interpretation, while the task used in previous research (Duñó et al., 2009; Canal-Rivero et al., 2017) focused more on vignette stories, characterized by a stronger memory component, where one needs to mentalize a setting and environment to make a correct conclusion. Their results could therefore also reflect memory and mentalizing problems. The Hinting task focuses on speech utterances and interpretation of social cues (Mallawaarachchi et al., 2019), to which individuals at risk for suicide might be more sensitive (Jollant et al., 2011). Patients at risk for suicide might focus more on the negative cues, which we also observed in the DFAR task, and might therefore show higher performance on the negative ToM stories too. However, this could not be tested. An alternative explanation of these findings is that individuals who indicated suicidal ideation and/or attempts, might be better in communicating their suicidal tendencies and where therefore revealed as suicidal in the current study, while some of the individuals in the control group were less able to communicate suicidal tendencies and therefore were left undetected. Notably, Canal-Rivero et al., 2017, in addition to the story-ToM-task, also investigated the same task we used (Hinting Task) and did not find differences in ToM performance for patients with suicidal behavior. The difference with our finding might in addition be explained by differences in the study population. While we included 261 patients with either SA or SI, Canal-Rivero et al. (2017) only included 20 patients with SA for their study.

Besides social cognition, we also investigated general cognitive abilities in patients with suicidal ideation and/or suicidal behavior and psychosis. Our findings suggest that lower performance in the domains of attention and verbal learning might contribute to suicide attempt and/or ideation. This finding is contrary to that of a number of previous studies which have suggested a link between better cognitive performance and ideation and/or suicidal behavior (De Hert et al., 2001; Delaney

et al., 2012; Kim et al., 2003; Nangle et al., 2006; Villa et al., 2018a), but in line with the findings from Duñó et al., 2009 who reported lower scores for individuals with a suicide attempt on cognitive domains. The inconsistency between the results may suggest a U-shaped function, implying that improved as well as impaired general cognitive performance can contribute to a risk for suicide in patients with psychosis. Impairments in attention could compromise directing attention to other sources than the automatic, internally generated negative states and emotions, and lower verbal learning abilities can lead to difficulties finding solutions in stressful situations. During a suicidal crisis, these inabilities may enlarge the feeling of being trapped, a risk factor for suicide (O'Connor and Kirtley, 2018). Inabilities in attention and verbal learning have also been found in patients with mood disorder (Richard-Devantoy et al., 2014). For future work it would be of interest to compare cognitive performance in patients with suicidal ideation and suicidal behavior across different types of psychopathology.

Correcting results for severity of positive, negative and total symptoms scores and omitting individuals fulfilling diagnosis for bipolar and schizoaffective disorders did not largely change the effects of suicidal ideation and attempt on the cognitive task performance (see appendix) when corrected for PANSS total. However, performance on social cognitive tasks (facial affect recognition and ToM) when corrected for PANSS total, differed from uncorrected results and when corrected for positive symptoms or for negative symptoms and slightly after omission of individuals with a bipolar disorder and schizo-affective disorder (see appendix). This suggests that presence of suicide attempts or ideation is associated with cognitive performance, and that severity of overall positive, negative or total symptom severity are potentially also related to social cognitive performance and may therefore obscure the effects of suicidal ideation and attempt. For social cognitive measures, presence of suicide attempts and/or ideation was found to be only related to task performance when severity of total psychopathology was corrected for. This may suggest that at least part of the variance explained by suicide is shared with symptom severity, suggesting that the part of the suicidal risk mediated by social cognitive functioning could potentially be mitigated by moderating overall symptom severity. This of course needs validation in longitudinal designs were state vs. trait effects can be partialled out.

The current study has some limitations. First, the GROUP project was not set up to answer to questions of the current study and therefore the current study only contains secondary analyses which should be interpreted with caution. Related to this, some methodological limitations should be mentioned. The study was limited by the absence of a survey instrument designed for assessing suicidal ideation. Measuring suicidal ideation only with one item based on a short interview might not be sufficient to get a clear picture of current suicidal thoughts. Nevertheless, the CANSAS is a valid and reliable instrument (Phelan et al., 1995) and the item was further assessed by a clinician or researcher, which confirms the clinical relevance of this item as a risk factor for suicide. Second, owing to the secondary analysis conducted, the study was

Table 4
Follow-up analyses for social and general cognition and future SI and SA.

Variable	Suicide Attempt							Suicidal Ideation						
	Yes Mean (SD)	No Mean (SD)	B[5]	S.E.	Wald's χ²	Beta[6]	P	Yes Mean (SD)	No Mean (SD)	B[5]	S.E	Wald's χ²	Beta[6]	p
Predictor variables: Social cognition														
Constant	(n = 54)	(n = 333)	−23.26	9103.34	<0.01	<0.01	1.0	(n = 180)	(n = 205)	−0.87	2.44	0.1	0.42	0.72
DFAR														
Neutral	74.9 ± 21.6	78.3 ± 16.5	0.01	0.02	0.3	1.01	0.61	78.8 ± 16.7	78.9 ± 16.7	−0.01	0.01	1.0	0.99	0.32
Happy	85.3 ± 17.3	87.2 ± 11.9	−0.01	0.01	0.7	0.99	0.42	85.6 ± 14.0	87.1 ± 12.0	−0.02	0.01	3.1	0.98	0.08
Fearful	50.5 ± 20.3	48.2 ± 20.4	0.01	0.01	0.4	1.01	0.55	50.0 ± 19.9	47.0 ± 19.7	0.01	0.01	1.9	1.01	0.17
Angry	62.7 ± 18.9	64.2 ± 21.2	−0.01	0.01	0.3	1.00	0.58	65.3 ± 20.9	62.8 ± 20.5	0.01	0.01	0.9	1.01	0.35
DFAR Bias														
HappyNeutral[2]	1.7 ± 1.7	1.6 ± 1.6	0.13	0.14	0.8	1.14	0.37	1.6 ± 1.7	1.6 ± 1.5	−0.01	0.09	0.01	0.99	0.93
FearfulNeutral[3]	1.2 ± 1.7	.7 ± 1.4	0.24	0.17	2.0	1.27	0.16	0.8 ± 1.5	0.8 ± 1.4	−0.12	0.12	1.1	0.89	0.29
AngryNeutral[4]	1.1 ± 1.6	1.1 ± 1.5	−0.08	0.12	0.5	0.92	0.49	1.3 ± 1.6	1.1 ± 1.5	−0.15	0.16	0.9	0.86	0.36
Benton	(n = 61) 22.8 ± 2.3	(n = 361) 22.8 ± 2.3	>0.01	0.05	<0.01	1.00	0.98	(n = 199) 22.7 ± 2.4	(n = 226) 22.8 ± 2.2	−0.08	0.06	1.8	0.92	0.18
Hinting Task	(n = 61) 17.93 ± 2.6	(n = 365) 17.7 ± 2.8	0.06	0.08	0.7	1.06	0.41	(n = 226) 17.9 ± 2.7	(n = 203) 17.5 ± 2.8	0.06	0.09	0.4	1.06	0.55
Age	27.6 ± 8.0	27.3 ± 7.4	−0.01	0.02	0.1	1.00	0.75	27.2 ± 7.1	27.3 ± 7.7	−0.03	0.02	2.6	0.97	1.06
Sex[6]	39/25	299/107	−0.27	0.25	1.1	0.77	0.29	177/73	158/60	0.33	0.34	0.9	1.40	0.33
Education[7]	1/10/28/9/16/0	5/44/144/109/84/20	0.01		9.6	1.01	0.09	4/24/94/61/56/11	1/21/85/56/47/8	<0.01	0.01	3.8	0.74	
PANSS total[8]	38.2 ± 13.1	38.6 ± 12.4	0.01	0.01	1.2	1.01	0.28	38.4 ± 13.0	38.2 ± 11.9	<0.01	0.01	<.01	1.00	1.0
Predictor variables: General cognition														
Constant			−16.30	9552.32	<0.01	<0.01	1.0			3.47	2.86	1.5	32.07	0.23
CPT-HQ	(n = 54)	(n = 337)						(n = 211)	(n = 184)					
Accuracy	97.5 ± 6.5	98.6 ± 3.9	−.005	0.03	2.6	0.96	0.11	98.2 ± 5.2	99.8 ± 2.9	−0.02	0.03	0.5	0.98	0.49
RST	(n = 53) 1.3 ± 3.6	(n = 326) 1.2 ± 4.4	<0.01	0.04	0.01	1.00	0.91	(n = 202) 1.1 ± 3.8	(n = 177) 1.6 ± 6.2	−0.02	0.02	1.2	0.98	0.28
WAIS	(n = 60)	(n = 365)						(n = 227)	(n = 203)					
Symbol Substitution	64.6 ± 19.4	65.6 ± 15.4	−0.01	0.01	0.9	0.99	0.36	64.3 ± 16.3	67.3 ± 15.9	−0.02	0.01	2.9	0.96	0.09
Calculation	11.8 ± 4.5	12.3 ± 4.7	−0.04	0.05	0.5	0.97	0.49	12.1 ± 4.7	12.5 ± 4.7	−0.01	0.03	0.1	0.99	0.80
Block Design	41.6 ± 16.1	40.7 ± 16.6	0.02	0.01	3.3	1.02	0.07	40.1 ± 17.0	41.4 ± 16.2	<0.01	0.01	0.04	1.00	0.84
Information	16.0 ± 5.3	17.0 ± 5.5	0.03	0.04	0.6	1.03	0.45	16.7 ± 5.1	16.9 ± 5.9	0.02	0.03	0.3	1.02	0.61
WLT	(n = 59)	(n = 364)						(n = 226)	(n = 200)					
Immediate recall	22.6 ± 6.1	23.3 ± 6.3	−0.04	0.05	0.6	0.97	0.44	22.8 ± 6.2	23.7 ± 6.6	−0.03	0.03	1.03	0.97	0.31
Delayed recall	7.5 ± 3.0	7.7 ± 2.9	0.07	0.10	0.5	1.07	0.49	7.5 ± 2.8	7.9 ± 3.1	0.03	0.06	0.3	1.04	0.57
Age			<0.01	0.02	<0.01	1.00	0.96			−0.01	0.02	0.1	0.97	0.77
Sex[6]			−0.94	0.39	5.7	0.39	**0.02**			−0.16	0.27	0.4	0.85	0.55
Education[7]					7.0		0.23					0.4		0.99
PANSS total			−0.02	0.01	0.03	1.00	0.87			<0.01	0.01	0.01	1.00	0.93

Note. Mean values are not corrected for the covariates. Statistics included the following covariates: age, sex, education and the total PANSS score.

[2] HappyNeutral = seeing a happy face, when a neutral face was shown.
[3] FearfulNeutral = seeing a fearful face, when a neutral face was shown.
[4] AngryNeutral = seeing an angry face, when a neutral face was shown.
[5] Standardised beta coefficient.
[6] Beta in log odds units.
[7] No education/primary school/secondary school/high school/vocational education/university.
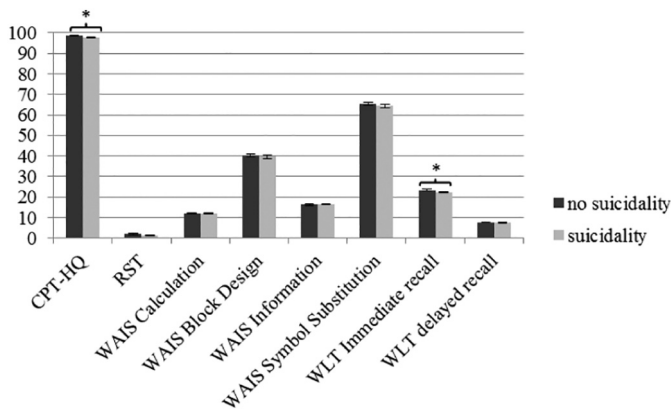[8] Male./female.

Fig. 3. Overview of the performance on the general cognition tasks for individuals with and without suicidality. *Note.* Mean values are corrected for age, sex, education and PANSS total score. Error bars indicate standard errors. *significant at the level p < .05.

limited by a certain range of social and neurocognitive test, which did restrict our measurements. The ToM abilities were e.g. not measured extensively as our task did not include an affective component. For future research it might be relevant to include a broader range of tests and to focus on positive as well as negative affect in ToM. Furthermore, when interpreting the ToM results we should bear in mind a probable ceiling effect. The Hinting Task was rightly skewed and might therefore not have measured the true extent of the individual's abilities, and showed little difference between individuals results. On the other hand, the Hinting Task was shown to have strong psychometric properties in a population with schizophrenia, and recommended for clinical trials (Pinkham et al., 2016). Third, the study was limited by the absence of a scale measuring depression. Due to the fact that depressive symptoms are risk factors for suicide they might also have an influence on the relation between suicidal ideation and behavior and social and general cognition. Nevertheless we controlled for overall severity of psychopathology. Fourth, the study did not investigate indirect effects of possible moderator/mediator variables, since several risk factors for suicide have been found to be intertwined (O'Connor and Kirtley, 2018), for future studies it would be interesting to investigate these more broadly.

5. Conclusion

Results of the current study suggest that individuals with a psychotic disorder and suicide attempt and/or ideation are slightly better in detecting emotional faces and ToM skills, in combination with slightly worse sustained attention and verbal abilities compared to individuals without suicide attempt and/or ideation. Future research should aim to further elucidate the significance of these social and non-social cognitive factors by including everyday measures of social cognition, different conceptualization of suicidal ideation, and ToM with positive and negative affect. Owing to the small effect sizes of our study (between 1 and 2% of variance in suicidal ideation and/or attempt, was explained by the neurocognitive performance) we should be cautions with recommendations for the clinical setting. Nevertheless, individual patients might benefit from including interventions targeted at improving cognitive functioning in their psychotherapeutic and/or pharmacological interventions as this might moderate their suicidal risk. Clinicians should therefore assess general cognitive performance and risk for suicidal ideation and/or attempt for the design of their treatment plan.

Data statement

In the Netherlands, due to the strict regulations and the still ongoing discussion about data availability, for the time being data can only be made available upon request. Under the General Data Protection Regulation, our data is considered pseudonymized rather than anonymized and is therefore still regarded as personal data. Given that participants have not given informed consent to have their personal data publicly shared, we are legally and ethically not allowed to publicly post our dataset. Data is therefore only available upon request via Joyce van Baaren, email j.vanbaaren@umcutrecht.nl.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.schres.2021.02.024.

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