



Autism symptoms, depression, and active social avoidance in schizophrenia: Association with self-reports and informant assessments of everyday functioning

Philip D. Harvey^{a,b,*}, Elizabeth Deckler^a, Mackenzie T. Jones^a, L. Fredrik Jarskog^c, David L. Penn^{d,e}, Amy E. Pinkham^{f,g}

^a Department of Psychiatry and Behavioral Sciences, University of Miami Miller School of Medicine, Miami, FL, USA

^b Research Service, Miami VA Healthcare System, USA

^c Department of Psychiatry, University of North Carolina, Chapel Hill, NC, USA

^d Department of Psychology, University of North Carolina, Chapel Hill, NC, USA

^e School of Psychology, Australian Catholic University, Melbourne, VIC, Australia

^f School of Behavioral and Brain Sciences, The University of Texas at Dallas, Richardson, TX, USA

^g Department of Psychiatry, University of Texas Southwestern Medical School, Dallas, TX, USA

ABSTRACT

Autistic traits are a feature of schizophrenia and has been found to impair social functioning and social cognition. Other influences on social outcomes in schizophrenia include depression and social avoidance. However, challenges in self-assessment of abilities and functioning (i.e., introspective accuracy) and self-assessment bias also contribute to disability. Depression has been studied for its association with introspective accuracy and bias, but autistic traits have not. Participants were 177 patients with schizophrenia who self-reported their everyday functioning and social cognitive ability as well as their depression. All were rated with the PANSS and a separate rater generated all-sources ratings of everyday functioning and social cognitive ability. Correlations between self-reported everyday functioning and social cognitive ability, ratings of everyday functioning and social cognitive ability, and the discrepancies between those ratings were examined for correlations with depression, autistic features and social avoidance. Accuracy was defined by the absolute value of the difference between self-reports and all-sources ratings and bias was defined by the direction of discrepancy (positive vs. negative). There was a statistically significant difference between sources on every measure. Bias was not directional on average, but patients with the lowest levels of depression overestimated their abilities on every measure and those with the highest depression underestimated. Autistic traits were associated with impairments in everyday functioning and underestimation of those impairments, while social avoidance was associated with impaired social functioning and accurate self-assessment. Features of schizophrenia have differential implications for impaired functioning and self-assessment, with autistic features and low levels of depression associated with consistent self-assessment biases.

1. Introduction

The concept of autism originated with Bleuler's description of a pattern of social isolation, inappropriate social behavior, and inability to connect with others. Later conceptions of autism spectrum disorders (ASD) focused on the developmental condition that was defined by Kanner and has persisted with various definitions until the present. At the same time, autistic features in schizophrenia have remained a focus of attention, albeit often under the label of negative symptoms (Kästner et al., 2015; Sheitman et al. 2004). Recent studies have; specifically examined autistic traits defined with Autism-specific rating scales in people with; schizophrenia (Barlatti et al., 2019), as well as developing and validating autism subscales that; can be extracted from other rating such as the PANSS (Deste et al., 2018; Kästner et al., 2015). Individuals with autism spectrum disorders have a number of cognitive and social

cognitive deficits. Among these deficits are impairments in theory of mind tasks, which measure the ability of a person to take the perspective of others (Baron-Cohen et al., 2001). These same deficits have been suggested to underlie social limitations seen in people with schizophrenia, with impaired performance on tests of social cognition found to predict social functioning deficits (Fett et al., 2014; Kalin et al., 2015). Several comparative studies have examined similarities and differences in social cognitive performance across schizophrenia and ASD populations (Eack et al., 2013; Fernandes et al., 2018; Sasson et al., 2011.)

Accurate self-assessment of one's own skills and abilities is another critical ability for interpersonal functioning. It is important for planning and executing attempts to interact with others. This process of self-assessment of skills and abilities has broadly been called introspective accuracy (IA; Silberstein and Harvey, 2019). Impaired introspective

* Corresponding author. Miller School of Medicine, University of Miami, 1120 NW 14th Street, Suite 1450, Miami, FL, 33136, USA.
E-mail address: philipdharvey1@cs.com (P.D. Harvey).

accuracy can be associated with “Introspective bias”, where individuals show a tendency to either overestimate or underestimate their functioning.

It has been suggested that about 50% of people with schizophrenia have significant introspective bias, with these biases approximately evenly distributed between over and underestimation (Gould et al., 2015; Silberstein et al., 2018). Introspective bias has been seen across multiple domains, including neurocognition (Gould et al., 2015), social cognition (Silberstein et al., 2018), everyday functioning (Durand et al., 2015), and the momentary assessment of accuracy in test performance (Jones et al., *in press*).

The origin of disparities between self-assessment and the opinions of informants has remained elusive. Harvey et al. (2017) found that people with schizophrenia generated global self-assessments of everyday functioning that were consistent with their current level of depression. Having very low reported levels of current depression was associated with having a positive introspective bias, consistent with earlier large-scale studies (Siu et al., 2015). In a follow-up study (Harvey et al., *in press a*), people with schizophrenia experiencing very low levels of depression once again demonstrated a much more optimistic perspective on their abilities and functioning than those with higher levels of depression. The results suggested that people with schizophrenia may rely on current mood states to form global self-assessments of functioning, but the research did not conclusively identify the cause of deficits in introspective accuracy and whether a relationship between introspective accuracy and current mood state will result in a specific direction of introspective bias.

In that same study, schizophrenia patients with negative symptoms of reduced emotional experience generated assessments of their social functioning that were consistent with informant ratings. Thus, reduced emotional experience was associated with intact introspective accuracy in social domains, despite the fact that these symptoms were correlated with reduced social activity. Informant ratings of social cognitive abilities were not related to the severity of reduced emotional experience, consistent with our previous finding that reduced emotional experience was minimally correlated with performance on tests of social cognitive skills (Harvey et al., *in press, b*).

Previous studies have suggested that overconfidence in social cognitive abilities may be associated with deficits in social functioning, perhaps through impacts on introspective accuracy. Pinkham et al. (*in press a*) reported that confidence ratings while performing social cognitive tests was the strongest single correlate of impairments in informant rated everyday functioning in the SCOPE study. Jones et al. (*in press*) found that patients with schizophrenia who stated that they were 100% confident that they were correct on all 21 items of a social cognitive test (13% of the sample) performed more poorly on that test than those patients who were less confident in their performance. Interestingly, the highly overconfident patients also had lower scores on self-reported depression than other patients. They were also rated by informants as having both poorer social cognitive abilities and poorer social outcomes.

Another potential correlate of reduced introspective accuracy is the presence of autistic traits. Because individuals with these traits can show strong social disconnection, as well as limitations in evaluating the social appropriateness of their behaviors (e.g., mannerisms and posturing), they may also be expected to have limitations in their socially relevant introspective accuracy. There is a considerable body of literature on self-assessment in ASD, typically phrased in the context of “metacognition”. For instance, awareness of the quality of performance in both neurocognitive (Grainger et al., 2014) and social cognitive (McMahon et al., 2016) domains have been reported to be impaired in individuals with ASD. We expand the study of self-assessment and autism to schizophrenia and hypothesize that autistic traits in individuals with schizophrenia could contribute to the discrepancy between observer-rated and self-reported assessments of social functioning.

In this study we contrast the correlations of autistic traits on self-assessment challenges and contrast those relationships to those seen between self-assessment and depression. In so doing, we return to our strategy of dividing patients into subgroups based on the severity of depression. In our previous studies, the subgroup of patients who had the most highly positive introspective bias also self-reported very low levels of depression (Harvey et al., 2017; Siu et al., 2015). Although the schizophrenia patients with the most severe depression were not previously found to underestimate their functioning compared to informant ratings, patients with bipolar depression clearly do (Harvey and Pinkham, 2015). By dividing patients into subgroups based on meaningful levels of depression, we can specifically evaluate the features of patients with very low scores as well as relatively high scores. These two extremes in scores may have different implications for both introspective accuracy and introspective bias, as previous studies in healthy people have often suggested that mid-range depression scores are associated with greater accuracy in self-assessment (Alloy and Abramson, 1979; Moore and Fresco, 2012).

An additional feature of this study was the use of all-sources judgments of functioning generated by raters. In our data collection efforts, we were not always able to obtain high contact, clinician informants. In order to have an informant-rated assessment of functioning for all patients, we used our previous procedures (e.g., Keefe et al., 2006) to generate an all sources rating based on all available informant information, regardless of informant qualifications. As a result, we had trained interviewers generate their own ratings of everyday functioning on the basis of interviews with the patients and information from all available informants, including those other than mental health professionals. These ratings allowed us to examine the entire database rather than be limited to the 60% of cases for whom we were able to obtain a high-contact informant rating.

Our hypotheses were that:

- 1). Introspective bias would be associated with depression, particularly at very low levels of severity wherein there will be overly optimistic perspectives on everyday functioning
- 2). Autistic traits would be correlated with both impairments in social functioning and the ability to self-evaluate functioning, both in domains of real-world functioning and social cognitive ability
- 3). Impairments in introspective accuracy and introspective bias would also be associated with poorer everyday social functioning as determined by all-sources ratings of outcomes.

2. Method

2.1. Participants

The final phase of the SCOPE study (Pinkham et al., 2018a) involved data collection from three locations: The University of Miami Miller School of Medicine (UM), The University of Texas at Dallas (UTD), and The University of North Carolina at Chapel Hill (UNC). UM patients were recruited from Jackson Memorial Hospital-University of Miami Medical Center and the Miami VA Medical Center. UTD patients who took part in the study came from Metrocare Services, a non-profit organization. UNC patients were identified at the Clinical Research Unit (CRU) in Raleigh, NC and the Schizophrenia Treatment and Evaluation Program (STEP) in Carrboro, NC.

Eligibility for the study was determined by a DSM-IV diagnosis of schizophrenia or schizoaffective disorder. Patients underwent a clinical interview utilizing the MINI International Neuropsychiatric Inventory (Sheehan et al., 1998) and the SCID Psychosis and Substance Abuse Modules (First et al., 2002). Another requirement was that patients had been on a consistent medication schedule for at least six weeks with no changes in the dosage of their medication in the past two weeks.

2.2. Exclusion criteria

Characteristics that excluded study participants included: 1) current or history of disorders, medical or neurological, that can impact brain function, 2) history of intellectual disability (defined as IQ < 70 by DSM-IV criteria) or of extensive developmental disorder, 3) sensory impediments including hearing and/or visual (e.g. glaucoma, blindness, vision uncorrectable to 20/40), 4) a lack of proficiency in English, 5) a history of substance abuse in the past month, other than caffeine or nicotine, and 6) substance dependence that has not been in remission for at least the past six months.

2.3. Measures

Clinical Symptoms Assessment. The Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987) was used to assess negative symptoms in study participants. Trained raters administered the entire scale and were not informed of any plans for analysis of subscales or item subsets.

Autism Score. The PANSS Autism Severity Score (PAUSS) is composed of the PANSS items that correspond to autistic traits. These items include measures of blunted affect (N1), poor rapport (N3), passive social withdrawal (N4), difficulties in abstract thinking (N5), lack of spontaneity and flow of conversation (N6), stereotyped thinking (N7), mannerisms (G5), and preoccupation (G15). This scale was developed and validated in people with schizophrenia by Kästner et al. (2015).

Active Social Avoidance. Among negative symptoms, reduced emotional experience seems more important for the prediction of everyday disability than reduced emotional expression (Harvey et al., 2017; Strauss et al., 2012, 2013). Although we had previously examined negative symptom subsets of reduced emotional experience and reduced emotional expression in this dataset (Harvey et al., in press b; Strassnig et al., 2018), we chose to use item G16, active social avoidance, as the predictor variable for the analyses in this study. In our previous studies, a single PANSS item from the reduced emotional experience item set, active social avoidance, was the most important predictor of social dysfunction (Robertson et al., 2014; Kalin et al., 2015; Harvey et al., in press a). Because the other reduced emotional experience items overlap with the PAUSS, we examined the correlates of active social avoidance alone for this study.

Self-reported Depression. Patients completed the Beck Depression Inventory, second edition (BDI-2; Beck, Steer and Brown, 1996). The BDI-2 is self-reported and severity scores range from 0 to 63.

Clinical Rating of Depression. The PANSS depression item, G6, was used to examine the convergence of clinical ratings with self-reported depression. This item was used to validate self reports on the BDI-2.

Social cognitive ability was assessed with the Observable Social Cognition Rating Scale (OSCARS). Both informants and patients completed the OSCARS (Healey et al., 2015), an 8-item interview based assessment of social cognition. Each question on the OSCARS is made up of a question probing a domain of social cognition (attribution style, cognitive rigidity, theory of mind, emotional perception, and jumping to conclusions). For each item, study participants ranked their abilities using a 7-point scale, with higher rankings translating to greater impairment. A final question assessed the impression of global social cognitive impairment and used a scale with 10 points, with higher scores reflecting more impairment. The internal consistency of the OSCARS was found to be .80 in participants in the development study (Healey et al., 2015). The global informant ratings on the OSCARS were found to contribute 15% of the variance in a performance-based assessment of social cognition in a second study (Silberstein et al., 2018). The 15% variance is very similar to the previously reported (Pinkham et al., 2018a) proportion of shared variance between informant ratings of everyday functioning and this same social cognition test battery.

Real-World Functioning was rated with the 31-item version of the Specific Levels Of Functioning (SLOF; Schneider and Struening, 1983). The SLOF is an informant- or self-rated assessment of functioning. We

examined three functioning subscales: everyday activities, vocational functioning, and interpersonal functioning. A trained rater administered the measure to patients to obtain a self-report of functioning. In line with past use of this scale in several studies, informants completed the scale as if it were a questionnaire (Bowie et al., 2006; Harvey et al., 2011; Pinkham et al., 2016). Each item was rated from 1 to 5, with higher scores reflecting better functioning.

2.4. Procedure

Informed consent was obtained for all participants at the first study visit using an IRB approved consent form. The PANSS assessment and a diagnostic assessment were administered during this visit by raters who were trained to reliability using established procedures at each study site. Then participants completed interview-based and performance based social cognitive and functional outcome measures. The informants were blind to any self-reported, performance-based, or clinically rated data on the study participants.

2.5. All-sources SLOF and OSCARS ratings

Raters who interviewed the patients on the SLOF and the OSCARS also had access to informant reports for these two rating scales. There were 177 patients with community informants, of whom 53 were mental health clinicians. Raters were instructed to generate their ratings on the basis of what they thought was the correct rating, regardless of the informant who provided the information and to consider information from the own observations of the patient (but not performance-based scores) when generating their ratings.

2.6. Data analyses

The dependent variables used in the study were the all-sources ratings of the global social cognition item from the OSCARS and the SLOF subscales, and self-reports of these same variables. We created subgroups of patients based on the severity of self-reported depression, in line with our previous study, wherein BDI scores of 0–8, 9–20, and greater than 20 defined the groups. To index introspective accuracy, the differences between self-ratings and all-sources ratings were calculated and an absolute value was used for each case for each variable. Thus, the larger the score, regardless of direction, the more discrepant it was compared to the all-sources rating. Introspective bias was indexed by the difference scores between all-sources and patient ratings. For both the SLOF and the OSCARS, we calculated the differences such that higher discrepancy scores reflected the patients rating their performance as better than the all-sources judgment. First, we tested the significance of the difference of the introspective accuracy absolute value scores from 0 using single sample *t*-test, compared each of them to zero to take the bidirectional nature of introspective accuracy in self-assessment into consideration. Second, we used one-way analysis of variance (ANOVA) to compare the introspective accuracy and introspective bias scores from the SLOF and the OSCARS across the three depression groups. Pearson correlations were utilized to measure the relative relationships between active social avoidance and PAUSS severity scores the introspective accuracy and introspective bias scores. Finally, regression models were used to examine the differential contributions of introspective accuracy, depression, autism severity, and active social avoidance to all-sources ratings of SLOF everyday functioning.

3. Results

Table 1 presents demographic information on this sample of patients. The time 1 to time 2 correlation was $r = 0.69$ for the PAUSS and $r = 0.83$ for the BDI. The internal consistency of the PAUSS at the time 1 assessment was .73 and there was only 1 item, difficulty in abstract

Table 1
Demographic and symptomatic features of the sample of patients with schizophrenia.

N		177
Sex:	% Male	54%
Racial Background:	% Caucasian	58%
	% African American	35%
Ethnicity:	% Latino	13%
Employment:	% employed (Full and part)	19%
Residence:	% living Independently	64%
	M	SD
Age	40.5	11.5
Years of Education	13.1	2.5
Active Social Avoidance	2.2	1.3
Autism Score	12.8	5.3
BDI Total Score	15.2	12.5

Note. There are 9 items in the PANSS autism score. Mean item score, therefore, is 1.4.

thinking, whose deletion would have improved the coefficient markedly (to 0.77). There was a positive correlation between PANSS item G6 (Depression) and total BDI Score ($r = 0.63$).

Scores for everyday functioning, as well as overall scores for introspective accuracy and introspective bias, are presented in Table 2. As can be seen in the table, all of the variables had a statistically significant introspective accuracy discrepancy from 0. The introspective bias scores were essentially normally distributed, with ranges that were symmetrical around the mean, which was close to 0. Thus, there is a global effect of impaired introspective accuracy, but the introspective bias scores for the group as a whole do not suggest a global shift in one direction or the other.

Data testing our hypothesis regarding the association of low levels of depression and self-assessment of functioning are presented in Table 3. This table presents self-reported and all-sources ratings on the SLOF and the OSCARS, as well as scores for the PAUSS and Active Social Avoidance, as a function of depression severity. Of these patients with complete data, 61 had BDI scores of 8 or less, 59 had scores of 9–20, and 58 had scores of 21 or more. There were no differences between depression groups in all-sources ratings of everyday activities or vocational functioning, while there was a significant difference in all-sources ratings of social cognitive impairment (assessed with OSCARS) and interpersonal functioning. Increased severity of depression was associated with more severe clinical ratings of PANSS active social avoidance but not with autism symptoms. For self-reported functioning, there was a significant overall group difference for every variable and the group with the lowest depression scores uniformly reported less impairment in everyday functioning and social cognitive ability than the most depressed group. Some differences between the lowest and middle severity depression groups were also found to be statistically significant.

In addition, there were significant group-related differences on every introspective bias score. For everyday activities, low and moderate levels of depression were associated with scores consistent with all-sources ratings, with the most depressed group underestimating

Table 2
Everyday functioning, introspective accuracy, and introspective bias scores in the overall sample.

	All-sources Score		IB (Difference Score)		IB Range		IA (Difference Score Absolute Value)		Statistical tests of IA	
	M	SD	M	SD	Low	High	M	SD	t (Versus 0)	p
Interpersonal Functioning	3.37	0.88	0.18	0.94	–3.00	3.00	0.73	0.62	15.43	.001
Everyday Activities	4.51	0.55	-.15	0.89	–4.00	2.00	0.55	0.71	10.25	.001
Vocational Functioning	4.02	0.66	-.03	0.98	–3.00	3.00	0.71	0.61	13.86	.001
OSCARS	4.23	1.69	-.25	2.59	–6.00	6.00	2.13	1.49	21.05	.001

Note. The self-report score is the sum of the All-sources score and the IB difference score.

their performance. For interpersonal functioning, the groups with low and moderate levels of depression appeared to overestimate their functioning while the most severe group self-reported their functioning consistent with the all-sources ratings. For vocational functioning, the three groups differed, with the lowest group overestimating their functioning, the highest group underestimating their functioning, and the moderate group consistent with all-sources. For the OSCARS, the pattern was similar, with the lowest group overestimating their functioning, the highest group underestimating their functioning, and the moderate group consistent with all-sources ratings.

For introspective accuracy, there were depression group differences for two variables: vocational functioning and the OSCARS. For vocational functioning, the most depressed group showed the largest absolute introspective accuracy discrepancy. For the OSCARS, however, the results were different. The patients with the lowest level of depression had the greatest introspective accuracy impairment, followed by the group with the most depression, followed by the moderate group.

In order to test our hypotheses regarding autism severity and impairments in self-assessment and everyday functioning, we correlated the severity of autism symptoms and active social avoidance with all-sources ratings of everyday functioning and social cognition, as well as introspective accuracy and introspective bias scores. These correlations are presented in Table 4. As can be seen in the table, more severe autism symptoms were associated with all-sources ratings of greater severity of impairment in interpersonal functioning and social cognition indexed by OSCARS scores. Further, autism symptoms were correlated with a positive introspective bias for interpersonal functioning, vocational functioning, and total scores on the SLOF. Active social avoidance was associated with lower scores on the all-sources SLOF interpersonal subscale, as well as a positive introspective bias for everyday activities.

In a final analysis, we examined the differential importance of autistic features, depression, introspective accuracy, and active social avoidance for the prediction of all-sources ratings of interpersonal functioning. We used a stepwise regression model and four predictors: total BDI scores, active social avoidance, PAUSS scores, and the introspective accuracy score for interpersonal functioning. Since the introspective bias variable is derived without transformation from all-sources ratings of interpersonal functioning it overlaps with introspective accuracy scores and we did not include that variable in the model. The overall analysis was significant, $F(4,171) = 28.28$, $p < .001$. Active social avoidance entered the equation first, accounting for 27% of the variance, $t = 7.99$, $p < .001$, followed by autism, adding 5% of the variance, $t = 3.70$, $p < .001$, followed by impairments in introspective accuracy, accounting for 4% of the variance, $t = 3.26$, $p < .001$, followed by depression, accounting for a final 4% of the variance, $t = 3.24$, $p < .001$, leading to a total variance accounted for of 40%. Thus, all of our predictor variables independently predicted real-world social functioning.

4. Discussion

When using all-sources ratings of functioning obtained from multiple sources of information in a sample of people with schizophrenia, the severity of depressive symptoms were associated greater inaccuracy

Table 3
Scores on Self-reported and All-Sources rated Everyday Functioning, Social Cognitive Ability, and PANSS Autism and Active social avoidance Variables.

	BDI < 9		BDI 9-20				BDI > 20		
	M	SD	M	SD	M	SD	M	SD	
BDI Total Score	3.54	2.84	14.04	3.55	31.00	8.11			
	M	SD	M	SD	M	SD	F	p	Differences
Interpersonal Functioning									
Self-reported	4.01	0.77	3.64	0.78	3.03	0.96	20.56	.001	L > M > H
All-sources Rated	3.67	0.76	3.30	0.89	3.13	0.77	8.87	.001	L > M > H
Difference (IB)	0.34	1.05	0.34	0.85	-1.10	0.86	4.06	.019	L = M > H
Absolute Value (IA)	0.85	0.66	0.72	0.58	0.60	0.61	2.30	.10	
Everyday Activities									
Self-reported	4.62	0.86	4.42	0.77	4.05	0.92	4.94	.001	L = M > H
All-sources Rated	4.68	0.53	4.44	0.64	4.49	0.53	2.74	.26	
Difference (IB)	-0.06	0.83	0.02	0.86	-0.44	0.93	3.90	.022	L = M > H
Absolute Value (IA)	0.41	0.65	0.55	0.66	0.70	0.80	2.42	.091	
Vocational Functioning									
Self-reported	4.34	0.65	4.08	0.59	3.58	1.05	14.56	.001	L > M > H
All-sources Rated	4.00	0.74	3.99	0.64	3.93	0.70	0.21	.81	
Difference (IB)	0.34	0.87	0.09	0.82	-0.41	1.13	7.54	.001	L > M > H
Absolute Value (IA)	0.65	0.72	0.58	0.59	0.90	0.80	3.80	.025	L = M < H
OSCARs									
Self-reported	3.40	2.13	4.52	2.20	5.81	2.50	20.89	.001	L > M > H
All-sources Rated	3.76	1.51	4.38	1.68	4.71	1.89	6.19	.002	L > M = H
Difference (IB)	0.36	2.81	-1.14	2.25	-1.10	2.43	6.00	.003	L = M > H
Absolute Value (IA)	2.43	1.44	1.77	1.37	2.14	1.59	3.71	.026	L > H > M
Autism Subscale	12.42	5.15	13.37	6.00	11.77	4.59	1.55	.21	
Active Social Avoidance	1.69	0.97	2.32	1.33	2.65	1.59	10.75	.001	L < M = H

Table 4
Correlations between All-sources rated Everyday Functioning, Introspective Accuracy, Introspective Bias and PANSS Autism and Active social avoidance Variables.

	Autism	Active Social Avoidance
Interpersonal Functioning		
All-sources Rating	-.40***	-.48***
Introspective Accuracy	0.14	0.08
Introspective Bias	0.17*	-.03
Everyday Activities		
All-sources Rating	-.10	-.04
Introspective Accuracy	-.07	0.03
Introspective Bias	-.01	0.19*
Vocational Functioning		
All-sources Rating	-.12	-.02
Introspective Accuracy	-.03	0.02
Introspective Bias	0.18*	0.12
OSCARs		
All-sources Rating	0.17*	-.09
Introspective Accuracy	-.05	0.05
Introspective Bias	0.22*	0.12

Note. Higher IA scores reflect more discrepancy between patient and All-sources ratings. IB scores vary depending on whether Bias is positive (higher than All-sources) or negative (Lower than All-sources).

and increased bias in self-assessments of functioning. The groups with the highest and lowest severity of depression demonstrated the greatest introspective biases. Further, autistic traits were associated, as expected, with impairments in all-sources rated interpersonal functioning and social cognitive abilities, as well as tendencies toward over-estimation of social functioning and social cognitive ability. This was consistent with the research on metacognition in autism cited above (Grainger et al., 2014; McMahon et al., 2016). All-sources rated

interpersonal functioning had a 40% variance overlap with several different predictors, including autistic traits and self-assessments, none of which were rated by the same rater. In evaluating these findings in terms of their importance for “depressive realism”, the results appear to vary somewhat depending on the domain of self-assessment, but are generally consistent with the idea that mild levels of depression are consistently associated with the least biased self-assessment. People with schizophrenia who had very low levels of depression consistently rated their functioning as the best of all of the groups, which was confirmed by all-sources ratings only for interpersonal functioning. Even in this domain, the least depressed subgroup still overestimated their functioning compared to all-sources ratings, while the most depressed subgroup rated themselves as functioning on a level that was relatively consistent with their all-sources ratings. However, interpersonal functioning was the only functional domain where greater depression severity overall was associated with ratings of poorer functioning. Further, the path to impairments in interpersonal functioning also includes active social avoidance, which was also associated with the severity of depression across groups. Patients with the lowest levels of depressive symptom severity overestimated their functioning in domains of social cognitive skills and vocational functioning.

Those with the highest levels of depression manifested a negative introspective bias for everyday activities, work outcomes, and social cognitive abilities. There are several limitations in this study. We did not specifically select patients on the basis of the severity of any symptom type or social cognitive deficit. In samples with more severe autism symptoms, it would appear likely that the correlations would be larger and might expand to include impairments in introspective accuracy in addition to the consistent impairments in introspective bias seen. A more comprehensive assessment of autism symptoms might also yield higher severity scores than the PANSS. Depression severity was greater than the severity of either active social avoidance or the severity of autism symptoms. The mean scores on the BDI appear similar to our previous paper (Harvey et al., 2017) with a non-overlapping sample

($n = 406$; $M = 15.6$ vs 15.2 in this study.) Finally, active social avoidance was measured with a single item, which may reduce its predictive utility and it may be very challenging to recruit patients with more than moderate levels of active social avoidance into research studies.

When focusing on introspective accuracy alone, the most and least depressed patients had the largest impairments in introspective accuracy, while more severe depression was associated with negative introspective bias and less severe depression with positive introspective bias. Thus, somewhat similar impairments in IA can be associated with completely different directional introspective bias. Interestingly, active social avoidance was not correlated at all with impairments in introspective accuracy. Introspective bias, but not accuracy, was consistently correlated with autism symptoms. Further, regression analyses suggest that autism and active social avoidance, as well as depression severity and introspective accuracy, independently contribute to impairments in everyday social functioning.

A clear question for further research is the nature of the causal relationship between introspective accuracy and introspective bias. Equivalently plausible current possibilities include the argument that:

- 1) Poor introspective accuracy can be a function of introspective bias, because if one consistently mis-estimates their competence in a single direction across one or more functional domains, leading to positive or negative introspective bias, then introspective accuracy must be greater than 0. This argument is supported by results such as our previous findings that a substantial proportion of schizophrenia patients stated that they were correct 100% of the time when making task performance judgments (Jones et al., in press) and other research on excessively positive biases in self-assessment (Moritz et al., 2006, 2014; 2015).

The alternative argument is that:

- 2) Introspective bias is a product of poor introspective accuracy, with the direction of introspective bias determined by dispositional differences between individuals. If one does not know their competence, (i.e., manifests deficits in introspective accuracy) for any reason, and they are asked to make a judgment, this decision will be based on factors other than their actual competence. Candidate biases include the current prevailing mood state, negative biases, or environmental factors (being isolated v. with others; Depp et al., 2016).

This hypothesis is consistent with the current results for both OSCARS scores and self-assessment of vocational functioning. It is also supported by our previous findings (Pinkham et al., 2018b) implicating a specific brain region, the right rostro-lateral frontal cortex, in introspective accuracy. Patients with schizophrenia, compared to healthy people, failed to activate that critical brain region while assessing the accuracy of their emotion recognition judgments. For healthy people, regional activation correlated positively with accuracy of judgments. For patients, the correlation was not significant, although the patients who did activate the region had better real-world functional outcomes based on completely independent ratings. Answering the question of the causal and longitudinal relationship between introspective accuracy and introspective bias will require a momentary assessment approach, examining concurrent introspective accuracy, biasing factors such as mood state and environmental factors, and relating both to introspective bias. This approach can test the Poor Introspective Accuracy → Biasing Factors Introspective Bias Model while comparing that model to the Consistent Introspective Bias → Poor Introspective Accuracy Model.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpsychires.2019.05.010>.

Conflicts of interest

Dr. Harvey has received consulting fees or travel reimbursements from Alkermes, Boehringer Ingelheim, Intra-Cellular Therapies, Jazz Pharma, Minerva Pharma, Otsuka America, Roche Pharma, Sanofi Pharma, Sunovion Pharma, Takeda Pharma, and Teva during the past year. He receives royalties from the Brief Assessment of Cognition in Schizophrenia. He is chief scientific officer of i-Function, Inc. He has a research grant from Takeda and from the Stanley Medical Research Foundation. Dr. Pinkham has served as a consultant to Roche Pharma. Jarskog has received research grant funding from NIH, Auspex/Teva, Boehringer-Ingelheim and Otsuka. The other authors have no reportable biomedical activities.

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