Schizophrenia Research: Cognition 26 (2021) 100202

Contents lists available at ScienceDirect

Schizophrenia Research: Cognition

journal homepage: www.elsevier.com/locate/scog

Research Paper

Daily Ecological Momentary Assessments of happy and sad moods in people with schizophrenia and bipolar disorders: What do participants who are never sad think about their activities and abilities?

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ARTICLE INFO

Keywords:
Schizophrenia
Bipolar disorder
Sadness
Disability
Activity
Ecological Momentary Assessment

ABSTRACT

Objectives: People with schizophrenia have challenges in their self-assessments of everyday functioning and those who report no sadness also tend to overestimate their everyday functional abilities. While previous studies were cross-sectional, this study related longitudinal assessments of sadness to self-reports of abilities in domains of everyday functioning and cognitive abilities.
Methods: 71 people with bipolar illness (BPI) were compared to 102 people with schizophrenia (SCZ). Participants were sampled 3 times per day for 30 days with a smartphone-based Ecological Momentary Assessment (EMA) survey. Each survey asked where they were, with whom they were, what they were doing, and if they were sad. Performance based assessments of executive functioning, social competence, and everyday activities were collected after the EMA period, at which time the participants and observers were asked to provide ratings of three different domains of everyday functioning and neurocognitive ability.
Results: 18% of participants with SCZ reported that they were never sad on any one of the 90 EMA surveys. Reports of never being sad were associated with overestimated functioning compared to observers and SCZ participants who reported that they were never sad were more commonly home and alone than both SCZ participants who reported occasional sadness and participants with BPI. These participants reported being significantly happier than all people in the study.
Implications: Reporting that you were never sad was associated with overestimation of everyday functioning and cognitive abilities. Although participants who were never sad did not perform more poorly on objective measures than those were occasionally sad, their self-assessed functioning was significantly elevated. These data suggest that negative symptoms constructs such as reduced emotional experience need to consider reduced ability to subjectively evaluate emotional experience as a feature of negative symptoms.

1. Introduction

People with schizophrenia commonly experience reduced everyday functioning because of their illness, with studies finding that more than 70% are challenged with living independently and finding employment (Lee et al., 2015; Leung et al., 2008; Twamley et al., 2002). Similarly, a 2016 study in Israel found that only 5.8% of patients who had multiple hospitalizations for schizophrenia earned minimum wage or above, as opposed to 56% of the country's general population (Davidson et al., 2016). Accordingly, as recognition has grown of the importance of disability in schizophrenia (Farkas, 2007; Frese et al., 2009), treatment has shifted to focus on functional recovery.

Research has consistently shown that people with schizophrenia often lack self-awareness across a number of domains including clinical

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https://doi.org/10.1016/j.scog.2021.100202
Received 28 March 2021; Received in revised form 28 May 2021; Accepted 7 June 2021

insight, or awareness of one's illness and the needs for its treatment (Amador et al., 1993); cognitive insight, or the ability to re-evaluate beliefs and draw new conclusions and readjust attitudes (Beck et al., 2008); and introspective accuracy (IA) (Harvey and Pinkham, 2015), or the awareness of one's own neurocognitive (Gould et al., 2015), social cognitive (Silberstein and Harvey, 2019), and functional abilities (Beck et al., 2008; Gould et al., 2015). Previous studies estimate that at least 50% and up to as many as 93% of people with schizophrenia experience lack of clinical insight during their disease course (Amador et al., 1993; Wilson et al., 1986). Those who experience impaired clinical insight are, by definition, less aware of the effects of their illness, and, perhaps unsurprisingly, are less likely to engage in appropriate treatment (Arango and Amador, 2011; Cuffel et al., 1996; Olfson et al., 2006) and have worse clinical outcomes and higher re-hospitalization rates (Kurtz and Tolman, 2010; Schwartz, 1998; Smith et al., 2004). Further, IA also shows strong links to functioning with misestimation of abilities in domains of cognition (Gould et al., 2015) and social cognition (Silberstein and Harvey, 2019) relating more strongly to poor functional outcomes than performance scores on objective tests of these abilities.

These impairments in self-assessment are pervasive. Participants with SCZ who had never worked full-time reported that their work skills were equivalent to, and their ability to perform everyday activities were superior to, participants who were currently employed full time (Gould et al., 2013), despite performing notably more poorly on measures of neurocognition (effect size = 1.0 SD). Durand et al. (2021) reported that participants with schizophrenia generated self-reports of their everyday social functioning that were completely uncorrelated with 30 days (90 assessments) of Ecological Momentary Assessment (EMA) data regarding where they were and who they were with; being home and alone was associated with self-reports of significantly better everyday functioning than participants who were away from home with others.

In both healthy individuals and people with schizophrenia, the direction of introspective inaccuracies, or introspective bias (IB), varies as a function of mood state. Healthy individuals routinely overestimate their abilities (Kruger and Dunning, 1999); this positive IB can be corrected by inducing a mildly depressed mood or offering negative feedback (Alloy and Abramson, 1979; Soderstrom et al., 2011). Similarly, a study based on the Clinical Antipsychotic Trials of Intervention Effectiveness [CATIE] trial revealed that people with schizophrenia who reported extremely low sadness levels described themselves as "pleased" or "delighted" with their lives, manifesting clear positive IBs (Siu et al., 2015), and were more likely to discontinue treatment and perform poorly on tests of executive functioning than those who reported higher levels of sadness. Similarly, in two previous studies with non-overlapping samples of people with schizophrenia and healthy controls (Harvey et al., 2019a; Harvey et al., 2017), responding to surveys with reports of moderately sad moods was associated with generation of self-assessments congruent with observer ratings, while low and high levels of self-reported sadness were associated with congruent IBs (e.g., low sadness with overestimation and high sadness with underestimation).

While previous analyses have consistently reported that people with schizophrenia who report minimal sadness tend to lack IA and overestimate their functioning, these analyses have all relied on cross-sectional data. It is therefore unknown whether these relationships reflect a single day sampling bias and a tendency to make global judgments because of momentary moods or attitudes, or a true longitudinal failure to report any sad moods. To address this issue, we examined daily reports of sadness collected three times per day over a 30-day period in a sample of people with schizophrenia and related these reports of sadness to performance-based capacity assessments, self-reports of functioning, ratings of functioning generated by observers, and the same test of executive functioning used in the CATIE study.

In this study (Durand et al., 2021; Harvey et al., 2021), we collected daily EMA reports of moods, as well as data regarding whether the participants were home, alone, or both home and alone, as well as end of study self-reports and observer ratings of everyday functional outcomes and cognitive abilities. Participants with bipolar disorder and schizophrenia were examined in the study and our analyses focused on participants with schizophrenia who never reported any sad moods versus those who reported that they were occasionally sad. We hypothesized that participants who reported the complete absence of any sadness daily every day for 30 days would manifest a positive IB in terms of self-reporting their everyday functioning and overestimating their competence compared to observers. We also expected, consistent with previous studies of social cognition (Jones et al., 2019) and neurocognition (Perez et al., 2020), that participants who overestimated their competence would be poorer performers on performance-based measures of everyday functioning and cognitive functioning. We also expected these participants to self-report better functioning, but to appear to observers to, at the very least, function no better than occasionally sad participants in domains of social functioning, vocational performance, and the ability to perform everyday activities.

2. Methods

2.1. Overview of methods

Participants had a brief office visit at the beginning of the study. They received diagnostic and clinical assessments and then began the 30-day EMA period described below. At the end of the EMA period, a follow-up visit took place, with a repeat of the baseline clinical assessments and a detailed performance-based assessment of neurocognition, social cognition, and functional capacity. Participants also self-reported on their everyday functioning and their social and neurocognitive abilities. The assessment time frame for all self-report and observer ratings of functioning were "the last month", which is convergent with the 30-day EMA period. These analyses report on a subset of data from this very detailed assessment.

2.2. Participants

Participants in this study met DSM-V criteria for schizophrenia, schizoaffective disorder, or bipolar disorder (I or II), with or without current or previous psychotic symptoms. Recruitment occurred at three sites: The University of Miami Miller School of Medicine (UM), The University of California San Diego (UCSD), and The University of Texas at Dallas (UTD). UM participants were recruited at Jackson Memorial Hospital-University of Miami Medical Center and the Miami Veteran Affairs (VA) Medical Center. UCSD patients were recruited from the UCSD Outpatient Psychiatric Services clinic, the San Diego VA Medical Center, a large public mental health clinic, other local community clinics, and via word of mouth. UTD participants were recruited from Metrocare Services, a non-profit mental health services organization, and other local clinics. The study was approved by the Institutional Review Board (IRB) at UTD and endorsed by the local IRB at each site. Diagnostic information was collected by trained interviewers using the Mini International Neuropsychiatric Interview (MINI) and the psychosis module of the Structured Clinical Interview for DSM Disorders-5 (SCID-5); a consensus procedure was utilized to generate final diagnosis. All participants provided decisional capacity to consent and signed informed consent after receiving a complete description of the study. We also collected information on whether the participant was financially responsible for their residence and whether they had been unemployed for at least one year.

2.3. Exclusion criteria

Exclusion criteria included: (1) history of or current medical or neurological disorders that may affect brain function (e.g., CNS tumors, seizures, prolonged loss of consciousness), (2) history of or current intellectual disability (IQ < 70) or pervasive developmental disorder as defined in the DSM-5, (3) substance use disorder without remission of at least 6 months, (4) visual or hearing impairments that interfere with assessment, and (5) lack of English proficiency. Participants were also ineligible if they had medication changes or dose changes >20% in the past 6 weeks or had been hospitalized in the past 6 weeks.

2.4. *Assessments of functioning*

2.4.1. *Metacognitive Wisconsin Card Sorting Test*

This test was similar to one developed by Koren et al. (2004) was utilized to assess performance-based executive functioning. There were 64 sorts to be performed. After each sort, to measure IA, the participant was asked "Did you get it correct?" and answered with a yes/no response. Then the participants were asked to provide a confidence judgment as to their confidence in the correctness of their yes/no accuracy judgment. Participants were provided feedback about their response on a yes/no basis. The dependent variables for this test were the number of correct sorts out of 64, as the WCST full results are being published elsewhere.

2.4.2. *UCSD Performance-Based Skills Assessment-Brief (UPSA-B)*

We used the same abbreviated version of the UPSA that has been commonly used as a shorter but still valid assessment of functional capacity (Mausbach et al., 2007). The UPSA-B was designed to assess the ability to perform everyday tasks needed for independent community functioning by evaluating two areas: communication and finance. Raw scores from each subtest are transformed to yield comparable scores (ranging from 0 to 50) for each and a summary score ranging from 0 to 100. Higher scores reflect better performance.

2.4.3. *Social Skills Performance Assessment (SSPA)*

The SSPA is a widely used performance-based assessment (Patterson et al., 2001). It includes two scenes, one that involves the participants introducing themselves to a new neighbor and one that involves the participants requesting their landlord to fix a leak after the landlord had previously agreed to fix the leak but had never completed the task. Audio-recordings of SSPA interviews conducted at all sites were sent to a central expert rater who rated all the audio-recordings without having any other information about the participants. There is an additional item, appearance, which was not rated due to the audio-only data format. All variables are rated on a 5-point scale, and we used the total score for analyses.

2.4.4. *Specific Levels of Functioning (SLOF)*

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 observer- or self-rated assessment of functioning. In this study we focused on work skills, everyday activities, and interpersonal functioning. We did not examine the social acceptability and self-care subscales. A trained rater administered the measure to participants to obtain self-reports of functioning. In line with past use of this scale in several studies, observers completed the scale as if it were a questionnaire (Harvey et al., 2011; Pinkham et al., 2018). Each item was rated from 1 to 5, with higher scores reflecting better functioning.

2.4.5. *Cognitive Assessment Interview (CAI)*

We had patients and observers rate the Cognitive Assessment Interview (CAI; Ventura et al., 2013). This is a 10-item instrument that asks the person making the judgments to rate the severity of impairments in a variety of cognitive domains. These domains are aimed at the dimensions of cognitive impairment typically studied in schizophrenia. Ratings are generated for each subscale and overall cognitive functioning is rated along a 0–100 scale based on the GAF. For the purposes of theses analyses, we used the global scores from the observer and self-reported scores. The patient was asked the questions in a standard interview format. Observers were simply asked to complete the form using the same instructions that the interviewer provided to the patients.

2.5. *Assessments of symptoms*

2.5.1. *Depression symptoms*

We used a common clinician rated depression assessment, the Montgomery-Asberg Depression rating scale (MADRS; Montgomery and Asberg, 1979). MADRS ratings were generated the day before the first EMA survey. Raters were trained to adequate reliability (ICCs>0.80) on this assessment.

2.5.2. *Schizophrenia-related symptoms*

Severity of symptoms was evaluated with the Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987), which was administered in its entirety by trained raters and on the same day as the MADRS. These raters had extensive experience in other studies of participants with severe mental illness and were trained to high reliability (ICC > 0.80) by the study PI (Pinkham). The PANSS consists of 30 items and each item was scored on a 7-point Likert scale ranging from 1 to 7.

2.5.3. *Negative symptom models*

Khan et al. (2017) generated a two-factor model of negative symptoms measured by the PANSS, identifying dimensions of expressive deficits and experiential deficits. This model is clinically relevant as the reduced emotional experience factor has been shown to predict variance in everyday functioning in several different samples (Harvey et al., 2017; Strassnig et al., 2018) and to respond to pharmacological treatment (Harvey et al., 2019b). The items in the *PANSS Reduced Emotional Experience* factor are: Emotional Withdrawal (N2), Passive/Apathetic Social Withdrawal (N4) and Active Social Avoidance (G16). We also calculated the continuous score proxy for the deficit syndrome (PDS; Goetz et al., 2007), which is defined as the sum of the Anxiety, Guilt Feelings, Depressive Mood and Hostility items subtracted from the score for Blunted Affect item. With our small sample size, we used this score as a continuous variable rather than characterizing our patients as positive or negative on a deficit syndrome indicator.

2.5.4. *All-sources observer ratings*

In this study, observers generated ratings based on all sources of information other than the EMA data. In our previous studies that recruited at these sites (Harvey et al., 2011; Pinkham et al., 2016, 2018), we discovered that we were only able to obtain a high-quality informant (high contact clinician; caregiver who lived with the participant) for about 75% of potential participants. Rather than reject cases without such an informant, we used a previously described all sources observer rating procedure (Harvey et al., 2019a). Raters who interviewed the participants on the SLOF and the CAI also had access to informant reports for these two rating scales (when available) as well as clinical assessment data. Raters were instructed to make their ratings based on what they thought was the correct rating, regardless of the source of information, and to consider information from their own observations of the participant when generating their ratings.

2.6. *EMA procedures*

A Samsung smartphone with Android OS was used to deliver EMA surveys. The device was provided by the investigators to participants. Participants received text messages with weblinks to EMA surveys 3 times daily for 30 days, with data instantly uploaded to a cloud-based data capture system. The signals occurred at stratified random intervals that varied from day to day within, on average, 2.0-hour windows starting at approximately 9:00 AM and ending at 9:00 PM each day. The first and last daily assessment times were adjusted to accommodate each participant's typical sleep and wake schedules. All responses were time-stamped and were only allowed within a 1-hour period following the signal, although participants had the option of silencing alarms for 30-minute intervals (e.g., driving, naps, classes). An in-person training session (typically <20 min) was provided on how to operate and charge the device and respond to surveys, including the meaning of all questions and response choices. We selected this one-hour window prior to the start of this study in contrast to other intervals (e.g., 15 min) because of our findings in previous studies that participants commonly engaged in only one activity in the past hour (Strassnig et al., 2021) and were also either home or away for the entire past hour in 85% of the surveys returned (Granholm et al., 2020; Parrish et al., 2020). Thus, the longer window was aimed at augmentation of adherence.

EMA surveys were check-box questions asking about behaviors performed since the previous survey. The first question asked about the participant's location, with the following options: at my home, at home of family, at home of friends, at work, at outpatient medical visit, in hospital, at community center, in public business/store, in vehicle, outside walking, in class/educational setting, inside other, and outside other. Then participants were queried about who they were with. Options for this question included, alone, spouse or partner, friends, other family members, pets, healthcare providers, other known people, and unknown people. The subsequent screen then asked what the participant was doing, with response options including an array of different activities ranging from working for pay, cleaning the house, watching television, or doing "nothing". Being with a pet, but not a human, was considered "alone". Mood questions included "sad", "happy", "relaxed", "anxious", and "energized". We also surveyed hallucinations, paranoid ideas, receiving messages, mind reading and having special powers at these same surveys and reported on them previously (Harvey et al., 2021). All reported moods were scaled with a 1–7 range, with higher values indicating greater intensity. Participants were paid $1.00 for each survey answered, $25.00 for the baseline assessment, and $50.00 for the endpoint assessment.

2.7. Data analyses

For our analytic strategy, we first identified all of the participants with schizophrenia who answered all of their sadness surveys with a score of 1 or 2. We then compared this group of schizophrenia participants who reported no sadness at any of their surveys to the participants with SCZ who did not meet that criteria and the entire sample of bipolar patients on self-reported and observer ratings of everyday functioning (SLOF) and cognitive performance (CAI), as well as the clinical symptoms and performance on the WCST, SSPA, and the UPSA-B. These three groups were compared with a one-way Analysis of variance for each dependent variable and Student-Newman-Keuls follow-up tests. To capture bias in self reports, the observer ratings are presented as difference scores from the self-reports, with high scores reflecting participants over-estimating their functioning compared to the observer ratings. We also compared the participants on lifetime functional milestones, including current unemployment and current financial responsibility for their residence using Chi-square tests.

Missing EMA data were addressed with maximum likelihood procedures. We used hierarchical linear modeling (HLM) analyses to relate sadness status across the entire survey period to the socially relevant outcomes of being home or away and alone vs. with someone over the 30-day survey period.

Analyses were performed with the SPSS version 26 (IBM, 2020) general linear models and generalized linear model programs. For the HLM analyses we entered a random subject intercept and reported only GLM analyses wherein the overall model solution exceeded the omnibus criterion for improving on intercept only effects.

3. Results

Descriptive information on the participants with bipolar disorder (BPI; n = 71) and schizophrenia (SCZ; n = 102) is presented in Table 1, divided by sadness status. There were 19 participants with schizophrenia (19%) who reported that they were never sad across up to 90 surveys; these participants did demonstrate the presence of other moods including happiness. Only 3 bipolar participants would have met these criteria; we did not exclude them from the bipolar sample. There was a total of 11,907 EMA surveys with non-missing data for being home, being alone, and the mood items for cases with both SLOF and CAI self-report and observer ratings, with 7110 from SCZ and 4797 from BPI. Adherence to surveys was 78% for participants with SCZ and 75% for participants with BPI. The never sad participants with SCZ responded to 79% of the surveys and the sometimes-sad participants responded to 77%.

BPI participants had more education and higher WRAT scores than the SCZ participants and were more likely to be Caucasian. The SCZ

Table 1
Descriptive and demographic information on participants.

	Schizophrenia				Bipolar Illness (n = 71)			
	Never sad (n = 19)		Sometimes sad (n = 83)		M	SD	F	p
	M	SD	M	SD				
Age	42.47	10.38	41.87	10.51	39.22	11.75	1.34	.27
Years of education	12.76_a	1.58	12.48_a	2.47	14.22_b	2.64	10.10	<.001
Mothers education	12.71	3.32	12.59	3.66	13.67	3.67	1.67	.19
WRAT-3 - Standard score	98.16_a	10.96	94.79_a	12.00	102.13_b	11.70	7.39	.001

	Schizophrenia				Bipolar Illness (n = 71)			
	Never sad (n = 19)		Sometimes sad (n = 83)		M	SD	X^2	p
	M	SD	M	SD				
Sex (% female)	26		54		69		12.51	.002
Racial status (%)								
Caucasian	26		33		53		19.66	.03
African American	58		52		25			
Asian	0		3		3			
Indigenous	5		1		1			
Other, multiple, unknown	11		11		12			
Ethnic status (%)								
Hispanic	21		24		29		0.72	.70

Note. Means with different subscripts differ by p < .05 according to the Student-Newman-Keuls Test.
60 cases from UCSD, 41 cases from Miami, and 72 cases from UT Dallas.

participants who were never sad were more likely to be male than the other two participant samples.

Table 2 presents the proportion of cases who lived independently and were unemployed for at least the last 12 months as well as means and standard deviations for the observer reported and self-reported social functioning and cognition variables. Also presented are scores on the performance based WCST, SSPA, and UPSA-B variables. There were no differences in the proportion of participants across the three groups who were financially responsible for their residences or who had been employed in the past 12 months. For WCST correct responses, there was an overall group difference and the Tukey follow-up tests indicated that the BPI participants outperformed both groups of SCZ participants, who did not differ. Similar findings were found for the UPSA-B and SSPA, wherein the BPI participants outperformed both groups of SCZ participants, who did not differ. For self-reported work skills, the never sad SCZ participants reported that they had the best work skills compared to the other two groups, who did not differ, while for interpersonal functioning, the never sad SCZ participants reported that they had better interpersonal skills than the sometimes-sad SCZ participants, with no other differences significant. For overestimation of functioning compared to observer ratings, there were significant group differences for overestimation of interpersonal functioning and work skills, with the never sad participants in both cases having higher scores overestimating their abilities compared to both the sometimes sad and BPI participants.

Self-reported cognitive functioning on the CAI was significantly higher in the never sad and BPI participants compared to the sometime sad SCZ participants. The overestimation scores for the CAI were also highest in the never sad group and significantly greater than the other two groups, who did not differ.

Table 3 presents the means and standard deviations for the 4 mood items other than sadness, as well as a calculated variable which is the difference of happiness and sadness, with higher scores reflecting relatively more happiness than sadness. Also presented are on the MADRS for all participants and scores for reduced emotional experience, and the deficit syndrome proxy score for the two groups of participants with SCZ. For all EMA mood ratings and for the calculated difference of happiness and sadness, the never sad SCZ participants reported more happiness, more energy, more relaxation, and less anxiety than the other two groups, who did not differ. Despite these higher ratings, the standard deviations for all the mood variables other than sadness were very similar across the three participant groups, suggesting that even the never sad participants used the full range of the rating scale (other than for sadness). Depression rated with MADRS was higher in both the bipolar and sometimes sad schizophrenia participants. For the two negative symptoms variables, the never-sad schizophrenia participants had more severe scores on both reduced emotional experience and the proxy for the deficit syndrome.

Table 4 presents the results of the MMRM analyses of sadness status over the repeated assessments over 30 days for prediction of being home or being alone as well as engaging in only one activity in the past hour. The overall omnibus effect was significant, and there were no significant effects of day. For both being home and being alone, there was a significant effect of sadness status. The BPI participants were alone less than the two samples of SCZ participants, who did not differ. BPI participants did not differ from SCZ participants who were sometimes sad, but both groups were home less than the SCZ participants who were never sad. For one activity in the past hour, both SCZ groups were more likely to have engaged in only one activity in the past hour than the BPI participants.

4. Discussion

Participants with schizophrenia who reported never feeling sad over up to 90 EMA surveys over a 30-day had several distinguishing features. They exhibited statistically significant positive introspective bias in the domains of work skills, interpersonal functioning, and cognitive performance compared to participants with schizophrenia who reported sometimes feeling sad and participants with bipolar disorder. In particular, the never sad group reported that they had the strongest work skills, and they overestimated their skills the most compared to the observer ratings. Similarly, the same never sad SCZ participants rated their interpersonal skills as superior to the sometimes-sad SCZ participants. Both indices of negative symptoms were elevated in the never sad group. This same sample of SCZ participants who were never sad rated their own cognitive function as significantly better than the SCZ participants who were sometimes sad and not significantly different from the BPD participants, with these reports also reflecting a significant positive introspective bias overestimation compared to observer ratings. Performance on the WCST, the UPSA-B, and the SSPA was significantly more impaired in both SCZ groups than the BPD group and not significantly different across the two subgroups. In terms of milestones, never-sad participants were no more likely to be employed than the other participants. Thus, the observer ratings for competence in various elements of everyday functioning on the part of the never-sad participants

Table 2
Differences among the Schizophrenia Participants who reported No Sadness Vs. Occasional Sadness and Participants with Bipolar Disorder.

	SCZ Never sad	SCZ Sometimes sad		$X^2(2)$	p
Responsible for residence (%)	61	74	69	1.36	.51
Employed for at least one year (%)	33	34	49	3.73	.15

	SCZ Never sad		SCZ Sometimes sad		Bipolar disorder		F	p
	M	SD	M	SD	M	SD		
WCST correct responses	32.00_{ab}	12.68	30.36_{a}	11.41	36.96_{b}	11.77	5.90	.003
UPSA-B total score	69.48_{ab}	15.39	67.60_{a}	14.92	76.11_{b}	12.70	6.75	.002
Social Skills Performance Assessment	3.78_{a}	0.51	3.70_{a}	0.46	4.05_{b}	0.42	8.19	<.001
Specific levels of functioning: Self-reported								
Activities	53.12	3.24	48.84	8.52	50.50	8.31	2.23	.111
Work skills	28.65_{a}	1.62	23.90_{b}	5.20	24.77_{b}	4.89	6.77	.001
Interpersonal functioning	28.12_{a}	5.73	23.41_{b}	6.72	24.35_{b}	6.38	3.69	.027
Specific levels of functioning: Overestimation compared to observer ratings								
Activities	2.69	4.07	0.00	7.56	−1.08	7.51	1.71	.19
Work skills	4.87_{a}	3.44	1.51_{b}	5.09	0.27_{b}	3.60	6.80	.002
Interpersonal functioning	4.88_{a}	4.54	0.79_{b}	5.89	-0.31_{b}	5.55	5.24	.006
Cognitive assessment inventory								
Self-reported	80.00_{a}	12.40	68.20_{b}	16.88	75.51_{ab}	14.40	6.31	.002
Overestimation compared to observer ratings	14.81_{a}	13.07	7.05_{b}	15.01	3.00_{b}	11.00	4.24	.016

Means with different subscripts differ by $p < .05$ according to the Student-Newman-Keuls Test.

Table 3
Mood reports and social context among the schizophrenia participants who reported no vs. occasional sadness and participants with bipolar disorder.

	SCZ Never sad		SCZ Sometimes sad		Bipolar disorder		F	p
	M	SD	M	SD	M	SD		
Happy	5.29	1.72	4.00	1.48	3.94	1.23	7.39	.001
Anxious	1.92	1.05	3.21	1.52	3.36	1.42	7.82	.001
Relaxed	5.18	1.44	4.02	1.35	3.96	1.10	7.45	.001
Energized	4.74	1.83	3.60	1.40	3.36	1.16	7.81	.001
More happy than sad	3.73	2.12	0.73	2.94	1.29	2.46	7.73	.001

All contrasts reveal that the never sad participants differed from the other two groups at p < .01 or less

	SCZ Never sad		SCZ Sometimes sad		Bipolar disorder		F	p
	M	SD	M	SD	M	SD		
Baseline MADRS	3.73_a	6.30	10.63_b	10.36	12.83_b	11.39	5.71	.004
Baseline reduced emotional experience	6.86	3.17	4.84	2.19			11.07	<.001
Baseline proxy for the deficit Syndrome (PDS)	−4.47	3.59	−8.42	4.50			13.69	<.001

Means with different subscripts differ by p < .05 according to the Student-Newman-Keuls Test; scores closer to 0 reflect more deficit symptoms for the PDS.

Table 4
Association of sadness status on being home, alone and engaging in only one activity.

	Home			Alone		
	X^2	df	p	X^2	df	p
Omnibus test	309.97	33	<.001	152.94	33	<.001
Day	27.69	29	.54	21.97	29	.82
Sadness status	66.69	2	<.001	91.98	2	<.001

	Only one thing		
	X^2	df	p
Omnibus test	154.64	91	<.001
Day	28.45	29	.52
Sadness status	32.91	2	<.001

Proportion of surveys	EM proportions for home, alone, and only activity by sadness status		
	Never sad	Sometimes sad	BPI
Home	0.69_a	0.64_b	0.64_b
Alone	0.49_a	0.46_a	0.40_b
One activity	0.70_a	0.71_a	0.66_b

Means with different subscripts differ by p < .05 according to the Student-Newman-Keuls Test.

are more congruent with their milestone achievements than their self-reported capabilities.

Perhaps most strikingly, this IB was not present in the sometimes-sad SCZ participants whose self-reports of functioning converged closely with observer ratings. In this study, the IB displayed by SCZ patients who reported never being sad over a 30-day period is consistent with the IB previously observed in studies where SCZ patients reported no sadness on a singular assessment (Harvey et al., 2019a; Harvey et al., 2017; Siu et al., 2015). Our findings that some patients with SCZ overestimate their functioning in various domains while displaying no objective differences in performances expand a growing body of evidence (Durand et al., 2021; Gould et al., 2015; Gould et al., 2013) that patients with schizophrenia struggle with impairments in self-assessment of functioning and that one of the markers of this process is the level of self-reported sadness. Excess bias toward socially desirable responding is not the likely cause of these reports of no sadness: never-sad participants endorsed equivalent numbers of surveys compared to the sometimes-sad participants that reported the occurrence of hallucinations and 4 different delusions.

One plausible mechanism for positive IB is an inability to momentarily monitor performance or activity streams, as evidenced by previous findings of poor performance on the metacognitive WCST which tests participants' ability to monitor and regulate their own performance based on feedback (Gould et al., 2015; Koren et al., 2004; Tercero et al., in press). In the Tercero et al. study, the participants with SCZ performed poorly on the test and generated global estimates of their performance based only on their momentary performance judgments, while the participants with BPI, while overestimating on a trial x trial basis, generated global judgments of their performance that were strongly congruent with their actual task performance. General failure to monitor environmental events may also contribute to positive IBs. In this same sample of participants, Durand et al. (2021) recently reported that the results of the 90 EMA surveys addressing social context (home vs. away and alone vs. with someone) were uncorrelated with self-reports of both social functioning and subjective social cognitive ability. Specifically, the participants who were most commonly home and alone reported better social functioning and better social cognitive abilities than participants who were more commonly away from home and in the company of others.

An important issue raised by these data is the role of emotional experience and other negative symptoms. The participants who were never sad had multiple objective indicators of avolition, in that they were most commonly home and alone and commonly engaged in only one activity since the last survey. While these behaviors are not remarkably different from the SCZ participants who were occasionally sad, the never sad participants endorsed being particularly happy, relaxed and energized, and having very low levels of anxiety compared to the other participants. The construct of reduced emotional experience is therefore challenging to apply to these participants, because they are reporting considerable happiness and relaxation in the context of objective behavior suggesting minimal social contact or productive activity. Clearly this subsample could be characterized as having reduced emotional reactivity, which could very well reflect reduced experience combined with an IB toward the report of positive moods. Future research on this population could address more objective biomarker data on potential correlates of these self-reported moods, as previously presented by Raugh et al. (2020) and Strauss et al. (2020).

A viable possibility for being happier while also being home and alone comes from the results of another recent on a completely different sample (Parrish et al., 2020). In that study, participants with schizophrenia were sadder and more anxious when leaving and remaining out of their homes, least sad and anxious when staying home, and experienced reduced sadness and anxiety when on the way home. Thus, reporting greater happiness and less sadness while home and alone may be a feature of social anxiety, as staying home may offer avoidance of others and reduced anxious symptoms, as well as avoidance of other social and functional challenges.

The work presented here, as with any study, has limitations. There were only 19 never sad participants, which is a small sample but is close to the proportion of participants in a completely independent study (Jones et al., 2019), who reported that they were 100% confident that they were 100% correct on all 21 trials of a social cognition test. Like these results, these very confident participants performed at an accuracy level of 57% compared to 67% for the sample, were the worst overall performers, and had the lowest self-reported depression scores of the entire sample. Additionally, the never sad ratings do not appear to be a result of simply answering surveys with the same selection for each question each time; these participants reported higher ratings of happiness, energy, and relaxation than the other groups and the variance of these other moods did not differ from the other two participant groups. Further, participants were not fully adherent with sampling, and it is possible that missing surveys occurred during activities out of the home and in the company of others, leading to collected data skewed toward being home and alone. Obviating this concern were the lack of adherence difference between the three subgroups and the fact that that the participants with the top 20% adherence in this study (3 or fewer missed surveys) answered 35% of the surveys while away from home and those whose adherence was lowest (40 or more missed surveys) answered 40% of their surveys while away from home. Additionally, there was not a healthy control (HC) group in this study. However, the EMA results regarding social context and activities or the participants with SCZ in this study were very similar to those seen in participants in previous comparative studies with HC (Granholm et al., 2020; Rauch et al., 2020; Strassnig et al., 2021; Strauss et al., 2020).

5. Conclusions

Congruent with the results of previous cross-sectional studies, SCZ participants who report that they are never sad report that they are more capable in multiple domains than participants who are occasionally sad. Further, these reports of greater competence are accompanied by, at least, no evidence of greater competence than occasionally sad and BPI participants. Although there is considerable behavioral evidence of avolition on the part of the never-sad group, they reported considerable positive moods although being rated as having more deficit symptoms and reduced emotional experience. We suggest that this is still reflective of reduced emotional experience, in that these participants apparently do not react to daily events with even minimal shifts in their mood state. Further, as these participants are experiencing the lowest level of social and activity-based reinforcement, this lack of emotional reactivity may be understood in the context of low sensitivity to reward or motivation for engagement, or as elevations in social anxiety.

CRediT authorship contribution statement

Drs. Ackerman, Harvey, Depp, Moore, and Pinkham designed the study. Ms. Jones ran the specific analyses in this paper along with Dr. Harvey. They co-wrote the first draft of the paper. All of the other authors have edited the paper and approve of its submission.

Declaration of competing interest

Dr. Raeanne C. Moore is a co-founder of KeyWise AI, Inc. and a consultant for NeuroUX. Dr. Harvey has received consulting fees or travel reimbursements from Alkermes, Bio Excel, Boehringer Ingelheim, Intra-Cellular Therapies, Minerva Pharma, Otsuka America, Regeneron, Roche Pharma, and Sunovion Pharma. He receives royalties from the Brief Assessment of Cognition in Schizophrenia and the MATRICS Consensus Battery. He has a research grant from Takeda and from the Stanley Medical Research Foundation. He is chief scientific officer of iFunction, Inc. Dr. Pinkham has served as a consultant for Roche Pharma. The other authors have no potential Biomedical Conflicts of Interest.

Acknowledgements

This research was supported by NIMH grant RO1MH112620 to Dr. Pinkham. The NIMH had no role in the preparation of this paper. The data in this study are being deposited in the NIMH RDOC repository. 6 Months after data lock they will be available for public access. In the interim, the authors are happy to share the data that underlie this paper.

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