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Publication Date

2022-04-01

DOI

10.1016/j.psychres.2022.114487

Peer reviewed



Published in final edited form as:

Psychiatry Res. 2022 April ; 310: 114487. doi:10.1016/j.psychres.2022.114487.

Momentary Severity of Psychotic Symptoms Predicts Overestimation of Competence in domains of Everyday Activities and Work in Schizophrenia: An Ecological Momentary Assessment Study

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Abstract

Objectives—Schizophrenia participants generate self-reports of their competencies that differ from objective information. They may base their reports on momentary moods or experiences rather than objective data. Theories of delusion formation implicate overconfidence during self-assessment as a cause.

Methods—Ecological momentary assessment (EMA) was used to sample activities and experiences in 101 participants with schizophrenia up to 3 times a day for 30 days. Each survey asked where and with whom they were, what they were doing, and moods and psychotic symptoms they were experiencing. Self-reports and observer ratings of competence in work and everyday activities were collected.

Results—Being home was associated with self-reports of better functioning in activities and work skills ($p < .001$) and being alone correlated with better self-reported functioning in activities

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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.

($p < .001$). Participants who reported more occurrences of hearing voices, paranoid ideation, and other psychotic symptoms reported their functioning as better ($p < .001$).

Implications—Schizophrenia was marked by a disconnect between momentary activities and self-assessments. Being home more was associated with better self-reported functioning on tasks that are only performed away from home. Psychotic symptoms were associated with overestimation, consistent with previous theories positing that overconfidence and suspension of plausibility assessment may be associated with psychotic experiences.

Keywords

Ecological Momentary Assessment; Schizophrenia; Delusions; Self-Assessment; Insight

1. Introduction

The current search for impactful treatments for schizophrenia requires a focus on whether treatments improve a participant's day to day functioning. There is consensus that current functional assessment methods do not accurately capture daily functioning behaviors of participants with schizophrenia (Bowie et al., 2007; Leifker et al., 2010; Ben-Zeev et al., 2012). One reason is the widespread reliance on participants with schizophrenia's self-report of activities, competencies, and symptoms, with substantial evidence that these reports do not relate substantially to milestone achievements (Gould et al., 2013), concurrent clinician assessments (Durand et al., 2015), or even momentary data collected regarding social behaviors and directly related to subsequent self-reports of social outcomes (Durand et al., 2021). Bridging the gap between accurate momentary reports and biased global judgments is a major goal of functional outcomes assessment research, particularly if a quantitative competence judgment is the goal. Convergence between performance-based assessments of competence and validated experience measures and self-assessment of performance are often referred to as "introspective accuracy" (IA; Harvey and Pinkham, 2015).

Individuals with schizophrenia, on average, manifest response biases when evaluating their abilities, commonly overestimating, or underestimating their functioning. This phenomenon is referred to as introspective bias (IB) (Silberstein and Harvey, 2019). Introspective bias applies to participant's self-assessment of cognitive abilities, functional abilities, social cognition, and social outcome and has been shown to be related to wide-ranging impacts on performance and functioning. A high level of confidence in self-reports evaluating performance with has been found to be correlated with worse performance on performance-based social cognitive and neurocognitive tests (Jones et al., 2020; Perez et al., 2020), as well as to correlate with reduced levels of achievement of functional milestones (Gould et al., 2013) and worse every day social functioning (Durand et al., 2021). Current moods are also associated with introspective bias, as participants with schizophrenia who report minimal levels of sadness, both on clinical rating scales (Harvey et al., 2017; Siu et al., 2014) and in daily EMA assessments of mood (Jones et al., 2021) commonly have a positive introspective bias that spans everyday functioning and global assessments of their cognitive abilities.

EMA assessments wherein participants report on their functioning as well as having their locations monitored with mobile phone global positioning satellite (GPS) sensors has been accomplished recently. There was substantial concurrence between EMA reports of activities and GPS data regarding geolocation (Depp et al., 2019; Raugh et al., 2021) and combining GPS and other passively collected information with EMA paging data increases the convergence between clinical negative symptoms ratings and EMA information (Raugh et al., 2020). We recently reported on the convergence between GPS location information and mood states, showing that the combination of these two strategies can evaluate how people feel when leaving home and returning (Parrish, et al., 2020), with an eye toward developing personalized intervention strategies focusing on the reasons for staying home and avoiding social contact.

In this study, EMA paging was used to examine the momentary correlates of self-reported and observer-reported global capabilities in daily activities and work in a sample of participants with schizophrenia. By collecting EMA information on social context, location, activities, mood states and symptoms, we captured an objective stream of information that was obtained prospectively and prior to the collection of self-reports and observer reports of functioning. We had previously reported on self-reported everyday social functioning and self-reported social cognitive abilities in this sample, finding that there was essentially zero correlation between up to 90 ratings of where the participants were and who they were with and self-reported social functioning (Durand et al., 2021). Further, we found that participants who were more commonly home and alone reported that they had better social functioning and social cognitive abilities than ratings generated by observers. Further, participants in the study who were more commonly away from home in the presence of another person rated themselves as less socially competent than those participants who were home and alone. In summary, we observed both failure to consider momentary experiences when generating global self-assessments as well as an introspective bias toward self-reporting better functioning in the subgroup of participants who were more commonly home and alone.

In this report, we approach two new topics. First, we relate the occurrence of momentary psychotic symptoms to global assessments of functioning, with a specific focus on everyday activities and work functioning. Continuing to consider also social context, we examined the number of surveys responded to while home and alone and related these to self-reports and observer reports of important activities measured with our everyday functioning rating scale, many of which cannot realistically be performed while at home (e.g., transportation, shopping). We limited our analyses to our participants with schizophrenia because of the lower prevalence of psychosis in our bipolar participants. We tested several hypotheses. First, we expected that higher prevalence and severity of momentary psychotic symptoms would be associated with overestimation of functioning, consistent with models of delusion formation that suggest that failure to consider objective information and overestimating competencies are associated with paranoid symptoms (Moritz et al., 2014; 2015). We also expected that there would be minimal correlation between leaving home on a regular basis with self-reports of competence in performing activities that can only be performed away from home such as transportation and shopping and engagement in work, while also expecting a positive introspective bias in individuals who were commonly home and alone.

Thus, we expected that momentary information on activities would minimally influence global self-reports of functioning at the end of the assessment period.

Methods

2.1 Overview of methods

The methods for this overall study have been described previously (Durand et al., 2021). At the beginning of the study, participants received clinical and diagnostic assessments. Then, they began the 30-day EMA period. After the 30 days, the participants visited for a follow-up where a repeated clinical assessment was done, as well as a performance-based assessment of functioning. Participants also completed a variety of self-reports regarding their everyday functioning and other relevant abilities at the end of study assessment.

2.2 Participants

Participants who met DSM-V criteria for Schizophrenia or schizoaffective disorder, were enrolled in in this study. Participants were recruited at three different 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). The study was approved by each University's respective Institutional Review Board, and all participants provided written informed consent. Diagnostic information was collected by trained interviewers using the Mini International Neuropsychiatric Interview (MINI). More information on the diagnostic process is presented in previous papers and demographic information is in supplemental table 1.

2.3 Exclusion Criteria

Participants were excluded if they met the following criteria: (1) history of or current medical or neurological disorders that may affect brain functioning, (2) history of or current intellectual disability, which includes developmental disorder according to the DSM-V criteria, (3) presence of substance use disorder not in remission for at least 6 months, (4) visual or hearing impairments that interfere with assessment, and (5) unable to read or write English.

2.4 Study Assessments

2.4.1 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. A trained rater administered the measure to participants to obtain a self-report of functioning. Each item was rated from 1-5, with higher scores reflecting better functioning. Two subscales in SLOF (activities and work skills) were used as the dependent outcomes of interest in this study. In the activities subscale, participants were asked to rate their level of independence in performing various skills such as household chores, use of public transportation, using the telephone, handling personal finances, basic reading, and writing, travelling from home every day without getting lost, use of medical and community resources, managing their own medications, and shopping. The activities score ranged from 11 to 55, with higher scores reflecting greater independence. The work skills scores ranged from 6 to 30 and asked about skills that are needed to be successfully

employed. High contact informants were asked to fill out an identical survey and used their knowledge of the participant to rate the functioning of the participants. A consensus judgment was derived by a research coordinator taking the reports of the patient, and the informant and using it, combined with their observations of the participant, to generate ratings.

2.4.2 EMA Procedures.—A Samsung smartphone with Android OS was used to deliver the EMA surveys. Patients could use their own phone or one that was provided by the investigators. 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. All responses were time-stamped. EMA surveys were check-box questions asking about experiences and behaviors since the previous survey. The messages were delivered at random intervals separated by at least 2 hours but were adjusted to accommodate each participant's sleep and wake schedule. Responses were allowed up to 1 hour after the message was delivered.

The first question in each EMA survey asked participants whether they were home or away, and the second asked whether they were alone or with someone else, and if so, with whom? A customized survey followed, tailored to activities that could be performed at home, with or without another person, or away from home. The first assessment of the day set the timeframe as “today” and the subsequent two surveys asked about “Since the last survey”. At each timepoint, participants were asked to report their mood (sad, happy, relaxed, anxious), and positive symptoms of schizophrenia (hearing voices, special powers, receiving messages, mind reading [including having one's mind read and reading others' minds], and paranoid feelings. We previously published data on this sample indicating that EMA based ratings of psychosis were both well-correlated with clinical ratings of psychopathology generated with the Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987) ratings captured close in time to the EMA surveys and that there was no reactive effect of EMA surveys, with EMA psychosis items remaining stable over up to 90 surveys over 30 days (Harvey et al., 2021). All symptoms were reported on a 1-7 scale, with higher scores representing worse severity. Here we focus on the occurrence of psychotic symptoms, as we have reported on mood states previously (Jones et al., 2021). We aggregated and averaged the severity of the three delusions other than paranoia, so that we had three psychosis variables: paranoia, hearing voices, and other delusions that were collected across all EMA surveys.

2.5 Data Analyses

Hierarchical modeling analyses were performed using the SPSS edition 28 Generalized Linear Models (GLM) module (IBM, 2021). There were two crucial dependent variables: Self-reported work functioning and self-reported everyday activities. We also evaluated subgroups (Accurate estimators, overestimators and under-estimators) based on convergence of participants' self-reports with the consensus generated ratings. These three subgroups, like those originally defined by Bowie et al. (2007), were based on participants self-ratings compared to the consensus ratings. Accurate estimators were designated as being within 0.75 standard deviations (SD) in either direction on the composite of the consensus rating,

overestimators rated their functional skills greater than 0.75 SD over the rating, and underestimators rated their functional skills at least 0.75 SD less than the consensus ratings.

The critical predictor variables were the number of surveys answered at home, alone, and the home x alone interaction term, and the mean severity of the psychosis items across the surveys. Hierarchical Linear Modeling (HLM) models were used to predict the self-reported everyday functioning variables using independent variables listed above. Study day (1-30) and time of day (1-3) was entered as the repeated factors, with subject entered as a random intercept. Sex and age were entered as fixed covariates. The experiences of psychotic symptoms were collected at each survey, as were responses based on social context (home or away; Alone vs. with someone). For each model, the omnibus test to determine that the fitted model improved on the intercept only model was used. The significance of each variable in the context of the overall model was reported.

3. Results

As we have reported on these participants previously, the demographic information is presented in supplemental table 1. There were a total of 6,814 survey responses from people with schizophrenia that had analyzable data, with adherence to surveys at 75%.

During the 90 potential timepoints captured by EMA, 30% of the surveys reported the presence of hallucinations, 39% reported paranoid ideation and 31% reported one of the other psychotic symptoms. 51% of the participants overestimated and 28% underestimated their competence in performing everyday activities compared to the consensus judgments and 59% of the participants overestimated and 27% underestimated their work skills. Table 1 presents the scores for everyday functioning and work skills as reported by the participants and the consensus rating. As can be seen in the table, there were no overall differences between observer reports and self-reports for everyday activities but participants with schizophrenia overestimated their work skills ($p < .001$). Participants were home for 64% of the surveys and alone for 54% of the surveys. As can be seen in the table, mean severity scores for the psychotic symptoms were relatively low, but all 7 severity levels were represented across the surveys for each of these symptoms.

Table 2 presents the results of the multi-level modeling of self-reported everyday activities and work skills, including the adjusted means for the significant effects. As can be seen in the table, both analyses found significant omnibus effects. Significant covariate effects of age, (both $X^2 > 7.70$, both $p < .001$), but not sex (both $X^2 < 1.74$, both $p > .18$) were found. For self-reported activities, being home, being alone, and being home alone all were associated with reports of significantly **better** performance of everyday activities. Being home more commonly was also associated with significantly **higher** self-reported work functioning. Follow-up contrasts found that being home alone was associated with significantly higher self-reported functioning in everyday activities than being away from home while alone. For work functioning, the largest overestimation difference was between being home and alone and away from home with someone.

Since the overestimators constituted 50% or more of the sample in both functional domains, we examined whether the accurate and underestimating two groups differed on any of the critical predictor variables. Using t-tests, we compared the means across all EMA samples for hallucinations, paranoia, and other psychotic symptoms across accurate self-assessors and underestimates for both work and everyday activities. We found that none of these t-tests were significant, all $t < .60$, all $p > .28$. Thus, we created two groups, overestimators and all others and compared them in both functional domains in similar HLM analyses using home, alone, and mood and psychotic symptoms as predictors. The results of these analyses are presented in table 3. As can be seen in the table, the participants who overestimated their competence in everyday activities were different from the other participants in terms of being **home more**, **alone more**, and reporting more psychotic symptoms across indices of psychosis. For participants who overestimated their work performance, being home more and all indices of psychosis were increased in the participants who overestimated their work performance. Thus, the only difference in findings for self-assessment of work performance compared to self-assessment of everyday functioning was that being alone was not associated with overestimation.

4. Discussion

More than half of participants with schizophrenia overestimate their competence by 0.75 SD compared to observer ratings. This overestimation is similar in prevalence across the two different domains of everyday functioning. Symptomatic correlates of overestimation include more severe delusions and hallucinations compared to participants who do not overestimate. Similarly, being more commonly at home was associated with overestimation in both domains, with being alone more commonly also found to be associated with overestimation of capabilities in everyday activities.

The tendencies toward overestimation are correlated with the momentary presence of psychotic symptoms. These findings are consistent with previous studies suggesting that people with schizophrenia are found to be more confident about their decisions, correct or not, than healthy people (Jones et al., 2019; Moritz et al., 2006; 2014; Perez et al., 2020). They are also consistent with data from the current study finding that participants with schizophrenia did not incorporate feedback regarding their performance into global estimates of the quality of their performance on the Wisconsin Card sorting test (Tercero et al., 2021). While participants with bipolar disorder overestimated the accuracy of their performance on a momentary basis, their global judgments about the performance on the task were most strongly related to their actual sorting performed, as indexed by the trial x trial feedback they received.

Perhaps the most striking disconnect between self-reports and the longitudinal course of everyday activities is the finding whereby participants with schizophrenia who are most commonly at home reported that they are more capable at activities that are generally performed outside the home compared to participants who were away from home for more of their surveys. Participants who did not overestimate their work skills were away from home on 18% more surveys than those who did. On the SLOF work subscale, 5/6 items are performed away from home and for activities, 5 of the activities can only be performed

away from home and 2 more could be performed at home or away. Thus, participants with schizophrenia are rating themselves as very capable of performing away from home activities while rarely leaving home.

In a sense, this endorsement of very implausible levels of competence is not that inconsistent from the suspension of disbelief (Coltheart et al., 2018) that occurs with the endorsement of bizarre delusions. The correlation found in this study between prototypical first rank delusion severity and overestimation of competence is a linkage consistent with many different theories of delusion formation (e.g., Moritz et al., 2015). If one can believe that a computer has been surgically inserted into one's brain, it is not qualitatively different to believe that one is very good at out of home activities while never leaving home.

There are several limitations in the study. Participants were not selected for or stratified by the presence of either psychotic symptoms or different levels of functioning. In our previous studies, finding a high contact clinician to be an informant was not possible in all cases so we adopted the current strategy. In several previous publications, these observer ratings of everyday functioning were correlated with performance-based measures of cognition, social cognition, and functional capacity. The present study did not include healthy controls, but previous studies that we conducted found much more limited mis-estimation of functioning and a generally negative introspective bias (Oliveri et al., 2020).

These findings are consistent with previous studies suggesting that participants with schizophrenia do not sufficiently consider objective, observable information when generating global self-reports of their competence. Finding that these overconfident reports are correlated with classical psychotic symptoms of schizophrenia is consistent with theoretical models suggesting that high levels of confidence predict endorsement of implausible experiences. Interventions aimed at shifting self-evaluation focus to externally available information, as is contained in Metacognitive training (MCT; Moritz et al., 2014), would seem to be a viable strategy for reducing self-assessment biases in this population. MCT has shown value in a variety of conditions associated with impairments in judging the veracity of individuals' impressions of their symptoms and functioning, as well as general impressions of occurrences in the external world, including delusions (Andreaou, et al., 2017) and negative symptoms of schizophrenia (Swanson et al., 2021), bipolar disorder (Haffner et al., 2018), obsessive-compulsive disorder (Miegel et al., 2020) pathological gambling (Gehlenborg et al., 2021), borderline personality disorder (Schilling, et al., 2018), and excessively negative self-evaluations in major depression (Jelinek et al., 2018). A meta-analysis has suggested considerable efficacy in treatment of delusions in schizophrenia (Liu et al., 2018), which could include ideas that one is particularly capable in performance of activities that are rarely or never attempted. These interventions focus on consideration of external information and questioning self-generating impressions, which seems to be operative in this study in terms of self-assessment of everyday functioning in reference to objective, longitudinal data.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Role of Funding Source

This research was supported by NIMH grant RO1MH112620 to Dr. Pinkham.

This research was supported by the National Institute of Mental health.

The NIMH had no role in the preparation of this paper.

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The NIMH had no role in the preparation of this paper.

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, Roche Pharma, and Sunovion Pharma. He receives royalties from the Brief Assessment of Cognition in Schizophrenia and the MATRICS Consensus Battery. He is chief scientific officer of i-Function, Inc. Dr. Pinkham has served as a consultant for Roche Pharma. The other authors have no potential Biomedical Conflicts of Interest.

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Highlights.

People with schizophrenia who were more commonly home and alone overestimated their competence in domains of everyday activities and work skills.

Momentary experiences of psychotic symptoms was also correlated with overestimation.

These data suggest that people with schizophrenia may rely on their self generated ideas to a greater extent than on objectively verifiable information.

Table 1

Self-reported Everyday Functioning Variables, Observer Ratings of Everyday Functioning, and Mean Scores on predictor Variables

Variable	Mean	SD	t	p
SLOF Activities				
Self-report	49.56	8.17	0.69	.53
Consensus Rating	49.10	4.42		
SLOF Work				
Self-report	24.57	5.17	4.03	<.001
Consensus Rating	22.48	3.66		
Mean Severity of Psychotic Symptoms reported on Surveys				
Hallucinations	1.70	1.16	30	
Paranoia	2.15	1.52	39	
All other Delusions	1.47	0.94	31	
<hr/>				
% Surveys Home	64			
% Surveys Alone	54			

Note. SLOF: Specific Levels of Functioning

Table 2

Multi-Level Modeling of Self-reported Functioning

	Activities		Work	
	X ²	p	X ²	p
Omnibus	150.13	.014	65.14	<.001
Intercept	6876.61	<.001	6110.25	<.001
Home	11.55	<.001	34.30	<.001
Alone	4.38	<.006	0.59	.44
Home x Alone	7.50	<.001	0.18	.66
EM Means				
	Activities		Work	
Home with someone	50.06		25.23	
Home Alone	51.13 ^{**}		25.41 ^{**}	
Away with Someone	49.46		24.43 ^{**}	
Away Alone	48.42 ^{**}		24.58	

^{**} Designates significant differences based on post hoc contrasts, p<.005

Table 3

Multi-Level Modeling Comparisons of Over-Estimators versus All other Participants for Everyday Activities and work

	Activities		Work	
	X ²	p	X ²	p
Omnibus	790.08	.014	497.97	<.001
Intercept	781.96	<.001	1091.94	<.001
Home	83.38	<.001	10.62	.001
Alone	53.72	<.006	.013	.91
Home x Alone	.49	.48	1.52	.22
Hallucinations	67.43	<.001	65.15	<.001
Paranoia	113.56	<.001	70.19	<.001
Other Psychotic Symptoms	223.46	<.001	201.56	<.001
EM Means				
	Overestimators	All Others	Overestimators	All Others
Home	67%	61%	73%	55%
Alone	64%	44%	55%	53%
Hallucinations	1.95	1.65	1.88	1.68
Paranoia	2.42	1.96	2.39	2.11
Other Psychosis	1.82	1.47	1.74	1.41