

**Ecological Momentary Assessment: A Novel Method to Predict Physical Functioning in
Schizophrenia Patients**

Abstract

Schizophrenia patients often generate self-reports of their activities and work that diverge from objective information. It is suggested that these participants may not base their reports on their daily experiences. In this study, ecological momentary assessment (EMA) was used to sample daily activities in schizophrenia and determine whether EMA responses were associated with self and observer-reported work skills and everyday activities as measured by Specific Level of Functioning (SLOF) scales. 112 participants were sampled 3 times a day for 30 days. Each survey asked where and with whom they were, what they were doing, and if they were experiencing mood changes or active psychotic symptoms. Participants and observers completed the SLOF scale at study end. Repeated measure statistical modeling was used to determine associations. Being home or alone was associated with self-reports of productive functioning in activities and work skills. Patients with paranoia self-reported their everyday activities as better than those without paranoia even when controlling for other predictors. They also overestimated their functioning when compared to observer reports. Patients who heard voices at least once were more likely to overestimate their work abilities, as did patients who reported delusions. Those with sadness or depression were more likely to underestimate their functioning. Schizophrenia was marked by a disconnect between momentary experiences and self-reports. Positive schizophrenia symptoms are associated with overestimating activities but not work skills. This study showed that schizophrenia patients have high introspective bias, but EMA methods can be used to provide a richer picture of the patient's daily functioning.

Introduction

Purpose

The purpose of this study was to determine whether reports from a novel evaluation tool, Ecological Momentary Assessment (EMA), are associated with patient self-reported and observer-reported work skills and independence in everyday functioning at 30 days.

Background

Schizophrenia is a chronic mental disorder that is characterized by delusions, disorganized speech, auditory and visual hallucinations, lack of motivation, and trouble thinking. Each year 1.5 million people worldwide are diagnosed with the disorder (American Psychiatric Association). While medical and psychological treatments for schizophrenia have improved, it still remains the leading cause of mental disability worldwide (Charlson et al., 2018).

Finding new treatments for schizophrenia requires careful attention to whether or not these treatments improve a patient's day to day functioning and necessitates valid functional measures. Scientists in the field agree that current functional assessment methods do not accurately capture daily functioning behaviors of patients with schizophrenia (Ben-Zeev et al., 2012). This is partly due to the fact that many survey questions rely on the schizophrenia patient to self-report. The accuracy of assessments relying on self report depends on the person's ability to accurately evaluate their personal performance, frame of mind, and emotional stability at the time of survey completion. This characteristic of self report surveys is often referred to as introspective accuracy (Harvey et al., 2018) and is of particular concern in individuals with mental illness.

Individuals with schizophrenia, on average, have a skewed sense of their abilities compared to non-schizophrenic individuals, either overestimating or underestimating their functioning. This phenomenon is referred to as introspective bias (Silberstein and Harvey, 2019). Introspective bias affects a patient's self-assessment of cognitive abilities, functional abilities, social cognition, and social outcomes. A high level of confidence biases to overestimating actual performance on self reports and worse performance on objective social cognitive and neurocognitive tests (Jones et al., 2020; Gould et al., 2015). Depression is also associated with introspective bias, as schizophrenia patients without depression have a greater difference between their self-ranking and their actual performance on cognitive tests while schizophrenia patients with depression are more accurate in their introspective assessment (Harvey et al., 2018).

Due to the patients' introspective bias, self-reported overall assessment of cognitive functioning is often impaired. In order to address the possibility of introspective bias, psychologists have developed a potentially more accurate way to study schizophrenia patients in their day-to-day lives. Known as the Ecological Momentary Assessment (EMA), patients electronically report on their physical and social functioning three times a day for thirty days. The daily report is why EMA could potentially be useful, as clinicians cannot check in everyday but EMA can, allowing clinicians insight into what really is going on with their patients. Validation of EMA data with mobile phone global positioning satellite (GPS) sensors has been accomplished recently, allowing for an objective evaluation of each person's location (at home or elsewhere) while completing the EMA. GPS data found that individuals with schizophrenia spend more time at home, travel shorter distances overall, and tend to stay closer to home. There was substantial concurrence between EMA reports and GPS data (Depp et al., 2019).

In this study, EMA strategies were used to examine self-reported and informant-reported daily physical functioning and work outcomes in a sample of participants with schizophrenia. By collecting EMA information on who one is with, where they are located, what they are doing, and how they are feeling and relating that information to informant rated physical functioning and work outcomes, it may be possible to identify the origins of the mis-estimation of functioning (introspective bias) seen so often in schizophrenia patients. Furthermore, this study was designed to determine to what extent EMA reports correlate with a patient's self report on independence on everyday activities at study end (one time assessment) and how observer/informants rate patients at 30 days.

Hypothesis

If EMA reports are used to evaluate schizophrenia patients' every day activity and work functioning, then they will more closely be associated with trained observer one time evaluation of patient daily functioning, but not patients' own self report of functioning at 30 days.

Methods

Material List

A de-identified database was created of survey results evaluating demographics, mood, physical, cognitive, and social functioning of schizophrenic patients. EMA data collected, three times a day for 30 days, was also linked to this database. Subjects were recruited from 3 university psychiatric clinics.

Independent Variables

Daily activity, age, gender, ethnicity, education, positive or negative symptoms of schizophrenia, location, mood, whether alone or with someone during each EMA report, and severity of depression

Dependent Variable

Four models were developed: 1) Schizophrenia patient's one time, at 30 day, self report of everyday functioning; 2) Informant's/trained observer's 30 day report of everyday functioning (without prior knowledge of EMA reports); 3) Participant's 30 day self report of work skills; 4) Informant's/trained observer's 30 day report of work skills (without prior knowledge of EMA reports)

Participants

Participants who met DSM-V criteria for Schizophrenia, any subtype, or Schizoaffective Disorder, with or without current or previous psychotic symptoms participated 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).

Inclusion/Exclusion Criteria

Inclusion Criteria: (1) Schizophrenia, any subtype, or Schizoaffective Disorder, with or without current or previous psychotic symptoms, (2) clinically stable for a minimum of 6 weeks, on a stable medication regimen for a minimum of 6 weeks with no dose changes for a minimum of 2 weeks.

Exclusion criteria: (1) history of or current medical or neurological disorders that may affect brain functioning, (2) history of or current intellectual disability, which includes anyone with an IQ under 70, or developmental disorder according to the DSM-5 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.

Study Surveys

The Montgomery-Asberg Depression rating scale (MADRS) was used to evaluate for depression. MADRS ratings were generated the day before the first EMA survey and immediately after the 30-day EMA sampling period.

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. A trained rater administered the measure to patients 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 everyday without getting lost, use of medical and community resources, managing their own medications, and shopping. The score ranged from 11 to 55, with higher scores reflecting greater independence. The work skills subscale ranged from 6 to 30 and asked about skills that are needed to be successfully employed. Informants were asked to fill out an identical survey but used their one-time observations of the participant to rate the subject. The informants/observers did not have access to EMA results at the time of completing SLOF surveys.

Participant demographics were determined by asking subjects to report their age, ethnicity, race, and highest level of education.

EMA Procedures

A Samsung smartphone with Android OS was used to deliver EMA surveys. The device 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 behaviors performed since the previous survey. Questions asked about the participants location (home vs. away), whether the participant was alone or with someone. If with someone, they were next asked with whom. Participants were asked about different activities they had completed during the day ranging from working for pay, cleaning the house, watching television, or doing “nothing”. At each timepoint, participants were asked to report their mood (sad, happy, anxious),

and positive symptoms of schizophrenia (hearing voices, super powers, paranoid feelings). All symptoms were reported on a 1-7 scale, with higher scores representing worse severity.

Data Analyses

Data analysis was performed using the SPSS edition 26 Generalized Linear Models (GLM) module (IBM, 2020). Four mixed model repeated measures analysis of variance (MMRM) models were used to predict the dependent variables using independent variables listed above. Study day (1-30) and survey position within that day (1-3) was entered as the repeated factors and diagnosis and other independent variables as the between subjects factors. 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.

Results

During the 90 timepoints captured by EMA, 8% reported having special powers, 15% reported hearing voices, and 27% had paranoid feelings at least once during 30 days of observation. 51% overestimated and 28% underestimated their everyday functionality; 59% overestimated and 27% underestimated their work skills. In GLM models, there was a statistically significant association between being home or alone and overestimating productive functioning in everyday activities. Patients with significant paranoid ideation self-reported their everyday activities as considerably better than those without paranoia even when controlling for other predictors. However, when compared with observer reports, they were overestimating their functioning in everyday activities. Patients who heard voices at least once during the 30-day EMA analysis were more likely to overestimate their work abilities compared to observers; this relationship

also held true for patients who reported more delusions (reading minds, super powers). Those who reported high levels of sadness or depression on a daily basis were more likely to underestimate their everyday functioning and working ability. When compared to those subjects who underestimated their physical functioning, subjects who overestimated their functioning had a higher mean paranoid score during their 30-day EMA assessment.

Tables

Table 1: Participant Characteristics

Characteristic	All Participants N = 112
Age, Mean +/- SD	42±10
Gender, Male, n (%)	50 (45)
IQ Level, Mean ± SD	98±12
Ethnicity, Not Hispanic/Latino n (%)	83 (74)
Race, n (%)	
White	53 (47)
Black	42 (38)
Other	17 (15)

Education, n (%)	
Junior High	2 (1.8)
Some High School	14 (12.5)
Graduated From High School	32 (28.6)
Graduated from 4 year College	24 (21.4)
Master's or PhD	5 (4.5)
SLOF, Self report at 30 days	
Activities, Mean $\pm$ SD (range 11-55, higher scores reflect better functioning)	50.3 $\pm$ 7.5
Work Skills, Mean $\pm$ SD (range 6-30, higher scores reflect better functioning)	24.8 $\pm$ 4.9

Table 2: Characteristics of Participants Who Overestimated Everyday Activity

Characteristic	Over estimators (N=50)
Age, mean $\pm$ SD	44 $\pm$ 10
Gender, male, n (%)	22 (44)
Ethnicity, Hispanic, n (%)	11 (22)
EMA: Ever heard voices, n (%)	11 (22)
EMA: Paranoid thoughts, n (%)	17 (34)
EMA: Delusions	14 (28)
EMA: Sadness, mean $\pm$ SD, (range 1-7, higher scores indicate worse sadness)	2.6 $\pm$ 1.5

Figures

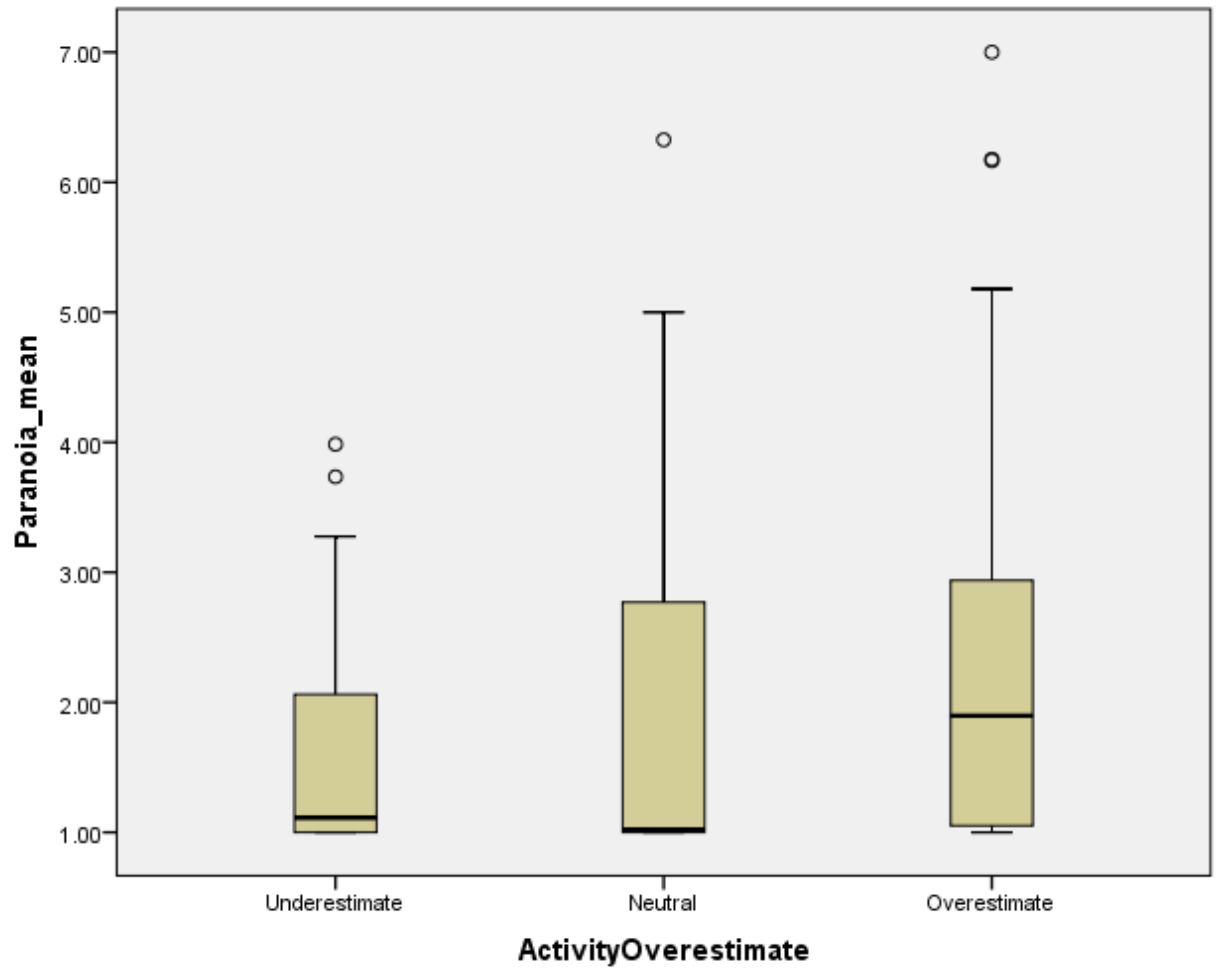


Figure 1: Mean paranoid score in participants who overestimated, agreed with observers, or underestimated their independence in performing everyday activities

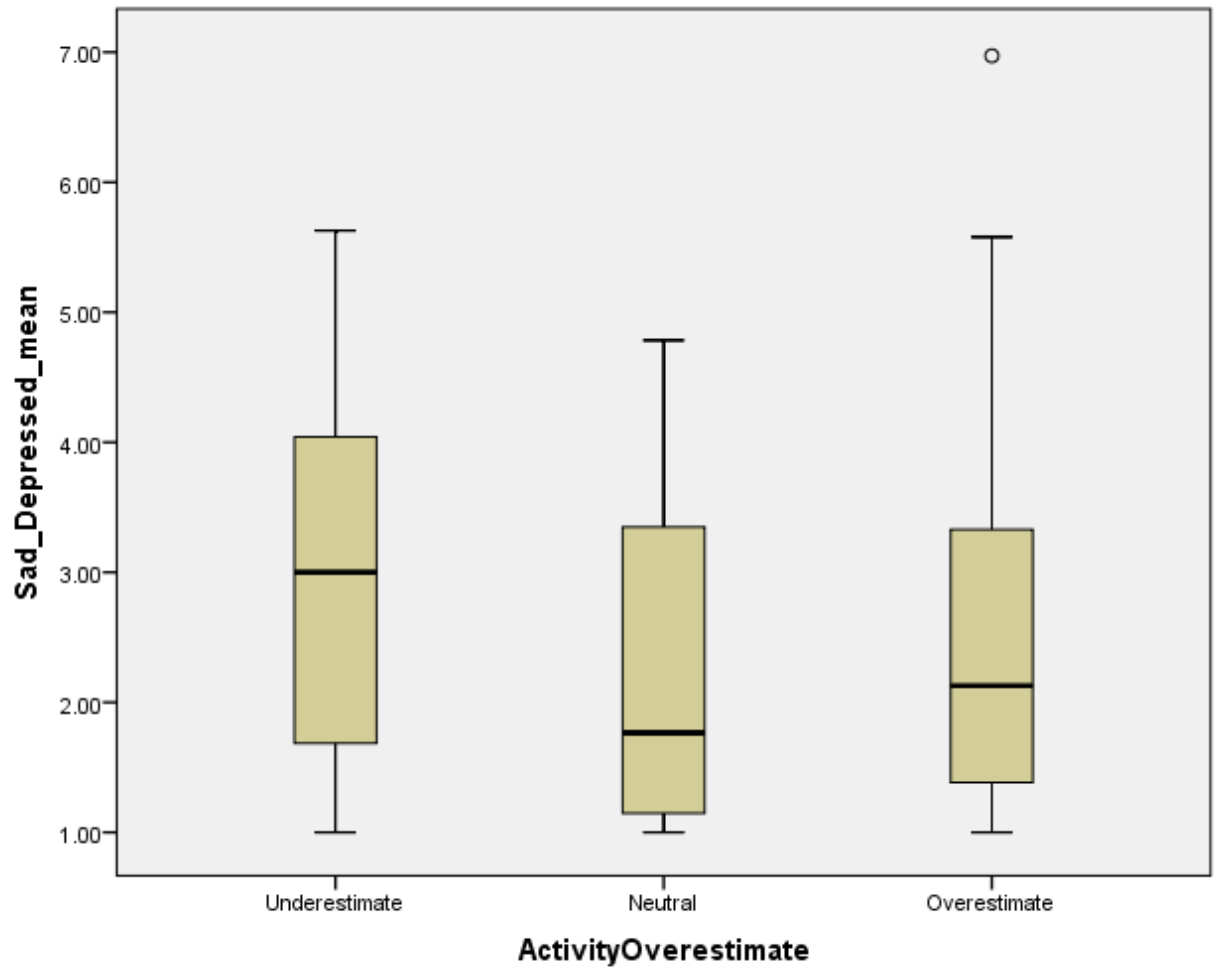


Figure 2: Mean sadness score in participants who overestimated, agreed with observers, or underestimated their independence in performing everyday activities

Discussion

Conclusions

The hypothesis was supported, as reports of positive schizophrenia symptoms on EMA correlated with the observer's one time assessment of worse functioning in everyday activities and may be an early marker of functioning that can be followed to evaluate treatment effectiveness. Schizophrenia is marked by a disconnect between momentary experiences and

self-reports. Positive schizophrenia symptoms such as paranoia are associated with overestimating daily activities but not work skills. Participants with daily sadness and depression were more likely to underestimate their work abilities and every day activities. Overall greater accuracy in self-reported work activities may be due to the more concrete nature of work activities. EMA provides a richer picture of the social, physical and work functioning of schizophrenia patients.

Limitations

There was a lack of diversity in study participants, specifically in race, ethnicity, and education levels. More diversity is needed to better generalize the results. There is no gold standard for evaluating the severity of schizophrenia and at present the observations of a trained professional or a close family member are used as the best option and were used as the standard in this study as well. In the future, biological markers developed to evaluate severity may be a more objective standard.

Error Analysis

All models were statistically significant and improved upon the null hypothesis of no association between independent and dependent variables. Given the nature of study done, observational study with subjective measurements (asking participants and informants to self report or observe behavior at a snapshot of time), there is the possibility of recall bias or introspective bias (as is actually discussed in this paper).

Applications

While it is not perfect, EMA may be a useful tool to help provide a better picture of everyday functioning in schizophrenia patients. This study showed that schizophrenia patients have high introspective bias, but EMA methods may allow therapists to determine trends in worsening functioning in real time, much earlier than regularly scheduled therapy visits and modify medications to help improve outcome.

Future Research

This study highlights that being alone at home while being engaged in passive activities and reporting daily paranoid symptoms are likely to impact a patient's ability to accurately report on their activities when a snapshot survey is taken at a clinical visit (introspective accuracy is decreased). Depression is prevalent in schizophrenia patients and will also lead to introspective bias. Future studies need to be done to see how EMA reports by patients compare to EMA reports by family observers and whether both tools can be used to evaluate severity of disease. Future research is also needed to evaluate the impact of various therapies on EMA reports of activity and mood and whether this would improve introspective accuracy.

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Appendix

Specific Levels of Functioning Scale

Informant Questionnaire

Instructions: Circle the number that best describes _____'s *typical* level of functioning on each item below. If you are not sure about a certain rating, please give your best guess.

Mark only one number for each item. Be sure to mark all items.

Social Functioning

1. Interpersonal Relationships

Item	Rating
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	Highly Typical of This Person	Generally Typical of This Person	Somewhat Typical of This Person	Generally Untypical of This Person	Highly Untypical of This Person
1. Accepts contact with others (does not withdraw or turn away)	5	4	3	2	1
2. Initiates contact with others	5	4	3	2	1
3. Communicates effectively (speech and gestures are understandable and to the point)	5	4	3	2	1
4. Engages in activities without prompting	5	4	3	2	1
5. Participates in groups	5	4	3	2	1
6. Forms and maintains friendships	5	4	3	2	1
7. Asks for help when needed	5	4	3	2	1

2. Work Skills

Item	Rating				
	Highly Typical of This Person	Generally Typical of This Person	Somewhat Typical of This Person	Generally Untypical of This Person	Highly Untypical of This Person
1. Has employable skills	5	4	3	2	1
2. Works with minimal supervision	5	4	3	2	1
3. Is able to sustain work effort (not easily distracted, can work under stress)	5	4	3	2	1
4. Appears at appointments on time	5	4	3	2	1
5. Follows verbal instructions accurately	5	4	3	2	1
6. Completes assigned tasks	5	4	3	2	1