Examining a Cognitive Model of Persecutory Ideation in the Daily Life of People With Schizophrenia: A Computerized Experience Sampling Study

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Contemporary theoretical models of paranoia suggest that negative emotions, perceptual anomalies, and recent life events are important predictors of experiencing persecutory ideation. In the current experience sampling study, these factors are examined prospectively for the first time as predictors of the occurrence of persecutory ideation, as well as persecutory belief conviction, and associated distress in real time in the context of daily life. One hundred and forty five community-dwelling participants with schizophrenia or schizoaffective disorder completed self-report assessments generated by a personal digital assistant multiple times a day for 1 week. Their responses were time lagged to allow examination of dynamic prospective relationships between variables as they occur within days. Approximately half of the participants reported having some persecutory thoughts, with a total of 378 reported occurrences of persecutory thoughts across participants during the week. Negative emotional states of anxiety and sadness were significant predictors of the occurrence of subsequent persecutory ideation, but hallucinations and recent life events were not. In a subsample of people who had multiple persecutory thoughts, anxiety was a significant predictor of belief conviction and associated distress, while sadness was only predictive of distress. The findings are consistent with recent cognitive theory that proposes a causal role for negative emotional states in the formation and maintenance of persecutory ideation and suggest that persecutory ideation may be addressed indirectly by interventions targeting anxiety and depression.

Key words: Experience Sampling Method/persecutory ideation/cognitive model/negative emotions/anxiety/schizophrenia

Introduction

Persecutory ideation is one of the most commonly reported psychiatric symptoms in individuals suffering from psycho-sis[1,2] and is associated with significant patient distress and impairment.[3] When severe, paranoid beliefs constitute the type of delusion that individuals are most likely to act upon[4] and often predict subsequent patient hospitalization.[5] In recent years, much attention has been devoted to explanatory models of persecutory ideation that can help inform and guide interventions and patient care.

Freeman and colleagues[3] proposed a multifactorial threat anticipation cognitive model of persecutory ideation that emphasizes the direct role of negative emotions in the development of paranoia. The model suggests that individuals who experience increased negative emotions (eg, anxiety, sadness) will draw from the cognitive components associated with these emotional states (eg, "I am in danger," "I am weak") when attempting to explain external life events, resulting in the formation of intense threat beliefs or persecutory ideation. The model also proposes that individuals who experience internal anomalies (eg, hallucinations) will draw from preexisting negative beliefs about the self (eg, "I am incompetent"), others (eg, "people are malicious"), and the world (eg, "the world is perilous") when subsequently trying to explain these perceptual irregularities. According to the directional structure proposed by the model, experiencing negative emotional states (ie, anxiety, depression) and internal anomalies (ie, hallucinations, perceptual irregularities) increases the likelihood of experiencing subsequent paranoid thoughts. The model provides an instrumental conceptualization of the etiology or development of persecutory beliefs but requires empirical investigation to determine its accuracy in explaining the actual occurrence of these symptoms among people with schizophrenia.[6] In addition, this theory has not been tested while controlling for other factors shown to influence psychotic symptom expression, notably substance use.[7,8]

The Experience Sampling Method (ESM)[9,10] is a research strategy that is exceptionally well suited to

examine psychological models of psychopathology in the context of daily life.[11] ESM utilizes an electronic device to signal participants to complete self-report questionnaires in real time, multiple times a day, within the context of their own environment. A major advantage of ESM is that it enables the examination of dynamic prospective relationships between variables within individuals, allowing for much stronger causal inferences than would be possible in cross sectional or longitudinal designs that incorporate long intervals between measurements. Computerized ESM uses handheld computers such as personal digital assistants (PDAs) to deliver a preprogrammed signal, and participants respond directly to questions generated on the PDA. Time-stamped data is stored in the PDA's memory, so researchers can verify when participants completed their reports. Many previous ESM investigations of schizophrenia or psychotic processes have used paper-based measures,[10,12–15] but a recent study showed that computerized ESM research using PDAs is a feasible and valid approach in community-dwelling people with schizophrenia.[16]

The purpose of the current study was to examine the prospective relationships predicted by a cognitive model of persecutory ideation[3,6] in the daily lives of patients with schizophrenia or schizoaffective disorder. To do so, we conducted a computerized ESM study in which we sampled negative emotional states (ie, anxiety, sadness), internal anomalous experiences (ie, auditory or visual hallucinations, visions), external life events, occurrence of persecutory thoughts, dimensions of paranoid experience (conviction and distress), and substance use multiple times a day over a 1-week period. Based on the model, we hypothesized that: (*a*) increased anxiety and sadness would be associated with a greater likelihood of experiencing subsequent persecutory ideation at a later time and (*b*) the occurrence of anomalous internal experiences in the form of auditory or visual hallucinations would also be associated with a greater likelihood of experiencing subsequent persecutory thoughts. The model outlines a role for precipitant external events in the formation of persecutory beliefs but does not lend itself to make specific predictions about which types of events might be greater risk factors for paranoid ideation or whether negative emotional states or hallucinations would also negatively impact dimensions of the paranoid experience such as strength of belief conviction and associated distress. An additional objective of the study was to explore whether certain types of external events better predicted subsequent persecutory ideation and whether negative emotions or hallucinations predicted different dimensions of the paranoid experience, such as the strength of associated belief conviction and distress levels. Finally, using ESM methods in the same study sample, we found that substance use was a significant predictor of later general psychotic symptom exacerbation and that negative affect was a significant predictor of substance use (Swendsen,

Ben-Zeev, and Granholm, under review). Therefore, a final objective was to examine the prospective relationships proposed by the cognitive model, while controlling for the possible effects of substance use on persecutory ideation.

Methods

Participants

This study was approved by the Institutional Review Board for the University of California, San Diego. Participants were recruited from a larger psychosocial treatment outcome study requiring patients with schizophrenia or schizoaffective disorder to be physically and clinically stable enough to participate in outpatient group therapy and to not have received cognitive-behavioral therapy in the past 5 years. One hundred and ninety nine community-dwelling people with schizophrenia ($n = 144$) or schizoaffective disorder ($n = 55$) were invited to participate. Individuals who refused participation ($n = 16$) did not differ from those who enrolled in the study concerning age, $t(197) = 0.854$, $P > .05$, sex, $X^2(1) = 0.262$, $P > .05$, or the Positive and Negative Syndrome Scale (PANSS) positive symptoms, $t(197) = 1.002$, $P > .05$, but they had higher scores for PANSS negative symptoms $t(196) = 2.299$, $P < .05$ as well as total PANSS severity, $t(196) = 2.354$, $P < .05$. Thirteen individuals who agreed to participate did not complete the study due to technical problems, and an additional 25 participants were excluded for not achieving minimum compliance (defined as providing the equivalent of at least 2 full days of ambulatory monitoring). The individuals whose data was excluded did not significantly differ from the remaining sample on any demographic or clinical variables. The final participating sample included 145 individuals with a mean age of 46.5 (SD = 11.16) and 12.44 years of education (SD = 2.13). These participants were 61% male, 60% white, 15% African American, 14% Hispanic, and 11% other ethnicities. The mean length of illness reported by participants was 24.35 years (SD = 15.19; range = 2–68 years). Only 6% of participants had previously owned and used a PDA. At baseline, the final sample experienced moderate psychotic symptom severity (PANSS total mean = 66.77, SD = 17.11; positive symptom score, mean = 18.26, SD = 6.04; negative symptom score, mean = 15.26, SD = 5.69), mild depression symptom severity (Beck Depression Inventory II [BDI-2] mean = 15.45, SD = 10.66), mild anxiety symptom severity (Beck Anxiety Inventory [BAI] mean = 14.61, SD = 11.85), and 46% of participants resided in assisted living facilities ("board and care").

Procedures

After providing written informed consent, patients were administered a structured diagnostic interview (*Structured Clinical Interview for DSM-IV Axis I Disorders-Patient Edition*[17]) in order to verify diagnoses of

Table 1. Description of the Computerized ESM Question Items

Anxious (L)	"How anxious do you feel right now?"
Sad (L)	"How sad do you feel right now?"
External events (M)	"Since the last questionnaire, which of the following categories best describes the type of event that has affected you the most?"
Anomalous experiences (D)	"Since the last questionnaire, have you heard things (such as voices), had visions, or seen things that others could not see or hear?"
Persecutory ideation (D)	"Since the last questionnaire, have you had the impression that someone was spying on you or plotting against you?"
Conviction (L)	"How strongly do you believe someone was truly spying on you or plotting against you?"
Distress (L)	"How much did your thoughts about people spying on you or plotting against you cause you distress?"
Substance use (Mo)	"Since the last questionnaire, have you taken or used any of the following substances?"

Note: (L), participant rated on a 7-point visual analog scale (1-"not at all" to 7-"extremely"); (M), multiple choice, (1-"work or education," 2-"family or friend relationships," 3-"interactions with strangers," 4-"finances or housing," 5-"other event") (responses were dichotomized as individual predictors for the analyses); (D), dichotomous variable (1-"no," 2-"yes"); (Mo), multiple option, (1-"alcohol," 2-"Cannabis, marijuana," 3-"cocaine/crack or crystal/meth," 4-"other nonprescribed drug," 5-"no substance or drug use") (responses were dichotomized for the analyses-"any substance use/no substance use").

schizophrenia and to assess additional lifetime and current mental disorders. Patients then completed an extensive battery of laboratory-based self-report and interview measures that included demographic information, measures of symptoms of schizophrenia (PANSS[18]), symptoms of anxiety (BAI[19]), and symptoms of depression (BDI-2[20]), for the weeks prior to assessment. Following assessment, a 45-min training session was provided concerning the meaning of all computerized ESM questions and response choices, as well as training in how to operate a PDA programmed using a modified version of the Purdue Momentary Assessment Tool (PMAT) version 2.1.2.[21] ESM sampling schedules, electronic interview content, and question format were previously validated in a subsample ($n = 56$) of current participants.[16] In summary, participants were given PDAs to carry with them for 7 days, and each PDA was programmed to administer 4 electronic interviews per day. The PDA program permitted responses to be provided only within a 15-min period following the signal, and all data entries were time stamped. The assessment times were fixed for each participant but randomized across participants. Investigation of fatigue effects and reactivity to the ambulatory methodology using this specific protocol revealed no correlation of time in the study with missing data or with the frequency or intensity of variables,[22] and no participant indicated that they changed their usual activities due to PDA use. The signals occurred within each of the following time periods: 9.00 AM to 12.00 noon, 12.00 noon to 3.00 PM, 3.00 PM to 6.00 PM, and 6.00 PM to 9.00 PM. Sampling windows were also adjusted to accommodate each participant's typical sleep and wake schedules. Participants were given the capacity to temporarily silence alarms as a function of social or personal constraints (eg, during church, driving, and naps). Two practice

ESM questionnaires were completed in the laboratory under the supervision of the research staff in order to resolve eventual difficulties or address questions. Individuals demonstrating greater difficulty in understanding questions or operating the device were provided additional training. Information about sampling procedures, battery charging, and a pager number to call in case of questions were provided to participants in writing along with a carrying pack. All participants were then contacted once by telephone on the third day of sampling to resolve any question or difficulties and to remind participants to charge the PDA. Participants received $35 for completing the week-long ESM assessments.

Computerized ESM Measures

Eight items from a larger questionnaire (see Granholm et al[16]) were selected to examine participants' anxiety, sadness, internal anomalous experiences (operationalized as auditory/visual hallucinations or visions), recent external events, occurrence of persecutory ideation, belief conviction and distress, and substance use (Table 1). The conviction and distress items were administered by the PDA as follow-up questions only if the participant endorsed having persecutory thoughts. Data were time lagged so that the occurrence of persecutory ideation, as well as belief conviction and distress could be regressed on participant anxiety, sadness, internal anomalous experiences, recent external events, and substance use measured at the previous assessment point.

Overview of Analyses

Data were analyzed using hierarchical linear model (HLM) 6.08[23] in order to accommodate the multilevel structure of the data (ie, observations nested within

participants). In examining the primary hypotheses, the first set of analyses included the estimation of 2-level hierarchical generalized linear models (HGLMs) with a Bernoulli sampling model and logit link function as the criterion in these models was dichotomous (ie, 0 = no occurrence of persecutory ideations, 1 = experienced persecutory ideations). Occurrences of persecutory ideations (at time $t + 1$) were regressed on prior occurrence of persecutory ideations (control variable), participant anxiety, sadness, internal anomalous experiences, and recent external events, measured at the previous assessment point (t). All analyses were limited to examining within-day associations.

Multilevel modeling followed a staged approach,[24] with the first stage including the estimation of an unconditional model with no predictors in order to test for significant between-person variability in persecutory ideation. The second stage included the estimation of several preliminary conditional models. First, a conditional model was examined in order to determine if there were significant changes in persecutory ideation in relation to the passage of time. Although examining "growth curves" was not the purpose of this study, ruling out the potential influence of linear or curvilinear changes in the criterion with time was a necessary preliminary step. Next, a preliminary conditional model was examined with the level-1 predictors of subsequent occurrences of persecutory ideation, where both intercepts and slopes were allowed to vary across participants (ie, random-coefficient model). Values for participant anxiety and sadness were centered around their individual's mean, as there was no meaningful zero point for these variables and to help stabilize the analyses by decreasing multicollinearity among predictors and between random intercepts and slopes.[25] This initial conditional model was conducted in order to determine if the effects of any of the level-1 predictors varied across participants. Based on the results of this initial conditional model, a final conditional model was estimated where only those slopes found to significantly vary across participants were allowed to vary, and all others were fixed. To control for the possible effects of substance use, the model was repeated with substance use (at time t) added as a predictor.

A second set of analyses was conducted to provide a preliminary investigation of the relationships between participant anxiety, sadness, internal anomalous experiences, subsequent belief conviction, and distress levels for a small subset of participants who experienced persecutory ideation and had complete data on all variables. Given the expected small sample sizes for these secondary analyses, only participants who reported occurrences of persecutory ideation (and correspondingly provided ratings of conviction and distress) on at least 4 occasions throughout the week were retained for analysis, in order to obtain more stable within-person estimates. The subsample did not differ significantly from the larger sample in demographic or clinical characteristics. Two-level HLMs were estimated for the 2 continuous criterion variables (ie, conviction and distress) and again followed a staged approach.[24] The first stage included the estimation of unconditional models to test for significant between-participant variability in the outcome variables. Again, this was followed by preliminary conditional models in order to determine if there were significant changes in the outcomes associated with the passage of time. Given the expected small sample size for these analyses, a fully random-coefficient conditional model was not possible and therefore only slopes which varied from the previous analyses with larger samples were allowed to vary across participants. Conviction and distress levels (at time $t + 1$) were regressed on prior conviction and distress levels (control variables), participant anxiety, sadness, and internal anomalous experiences measured at the previous assessment point (t). Values for participant prior conviction, prior distress, anxiety, and sadness were centered around their individual's mean.

Results

A total of 71 (49%) participants reported experiencing persecutory ideation on at least one occasion during the week, with a total of 378 reported occurrences of persecutory ideation. For participants that reported experiencing persecutory ideation on at least one or more occasions, the number of occurrences ranged from 1 to 21, with a mean of 5.07. In examining the occurrences of persecutory ideation across the 4 daily signals, results indicated that 91 (24.07%) occurred at signal 1, 87 (23.02%) at signal 2, 98 (25.93%) at signal 3, and 102 (26.98%) at signal 4. Of those that did experience persecutory ideation, the mean belief conviction and distress levels were 5.23 (SD = 1.58) and 4.43 (SD = 1.73), respectively. The mean anxiety rating reported for the sample was 2.69 (SD = 1.70), and the mean sadness rating was 2.55 (SD = 1.64). Finally, a total of 97 (67%) participants reported experiencing hallucinations during the week, with a total of 871 reported occurrences of hallucinations.

Results from the unconditional HGLM analysis for the full sample of 145 participants indicated significant between-participant variability in the log-odds of experiencing persecutory ideation (τ_{00} = 3.65, $P < .01$). The average log-odds of reporting occurrences of persecutory ideation were 2.74, which corresponds to an odds ratio of 0.06 and a probability of .06. Preliminary analyses conducted to determine if changes in occurrences of persecutory ideations were associated with the passage of time indicated a nonsignificant effect for both linear ($\beta = -.01$) and quadratic ($\beta = -.00$) time components. These variables were therefore omitted from all further analyses. Results from the preliminary conditional model with random coefficients for all predictors indicated that only the slope for prior occurrences of persecutory ideation varied significantly across participants (τ_{01} = 3.72,

Table 2. Final Conditional HGLM Model Results for Occurrences of Persecutory Ideations (Sample Size $N = 145$)

Fixed Effects	Coefficient	SE	t Ratio	Odds Ratio	Confidence Interval
Intercept	−3.213**	0.369	−8.713	0.040	0.019, 0.084
Prior occurrence of persecutory ideations	2.931**	0.483	6.062	18.738	7.196, 48.789
Anxiety	0.275**	0.080	3.417	1.316	1.124, 1.541
Sadness	0.230**	0.100	2.298	1.259	1.034, 1.532
Hallucinations	−0.540	0.405	−1.333	0.582	0.264, 1.289
Events[1]					
Work/education	0.006	0.759	0.008	1.006	0.227, 4.453
Stranger	−0.036	0.536	−0.068	0.964	0.337, 2.756
Finance/Housing	0.329	0.593	0.554	1.390	0.434, 4.447
Other	0.277	0.359	0.773	1.320	0.653, 2.667

Note: Level-1 $N = 807$, Level-2 $N = 106$; SE = robust standard error.
[1]Family/friend event is the reference category.
*$P \le .05$, **$P \le .01$ (one-tailed).

$P < .01$), therefore all other slopes were fixed in subsequent models.

The final conditional HGLM results for occurrences of persecutory ideation in the full sample is presented in Table 2. Results indicated that both prior anxiety ($\beta = .28$, $P < .01$) and sadness ($\beta = .23$, $P < .01$) had significant positive relationships with the log-odds of subsequently experiencing persecutory ideation, while controlling for prior occurrences of persecutory ideation ($\beta = 2.93$, $P < .01$). For participants who experienced persecutory ideation at the previous time point, the odds of subsequent persecutory ideation was 18.74 times the odds for an otherwise similar participant, which corresponds to a probability of .95. For participants who differ by one unit in anxiety at any given time point (but are otherwise similar), the data suggest that the odds of subsequent persecutory ideations for individuals with increased anxiety were 1.32 times (probability = .57) the odds for individuals with lower anxiety. Similarly, for participants who differed by one unit in sadness, the odds of subsequent persecutory ideations for the individuals with increased sadness were 1.26 times (probability = .56) the odds for individuals with lower sadness ratings. None of the other predictors examined were significantly associated with the log-odds of subsequent persecutory ideations ($P > .05$).

An aggregate substance use variable was created, where participants who reported using any of the 4 categories of substances at any given time point were assigned a "1," and otherwise were assigned a "0." Thirty-two percentage of the sample reported using alcohol or other substances at some time during the sampling week. Including this substance use variable in the model as a covariate did not impact the significance of our 2 primary negative affect predictors of interest. The odds ratio for anxiety in the original model was 1.32 and 1.34 in the model with the substance use covariate, and for sadness was 1.26 in the original model and 1.25 with substance

use as a covariate. Both negative affect predictors remained significant at the 0.01 level. The aggregated substance abuse variable was significant at the 0.01 level and had a large odds ratio of 3.26. Therefore, using substances at the previous time point significantly increased the odds of reporting persecutory ideation at the subsequent time point, but negative affect remained a significant predictor of paranoia, when controlling for substance use.

Based on the previously mentioned inclusion criteria (ie, experienced persecutory ideations, complete data on all variables, and a minimum of 4 observations), the secondary analyses of persecutory belief conviction and distress levels included 72 observations from 15 participants. Based on the previous finding that the relationship between prior persecutory ideation and subsequent ideations varied across participants (while other predictors did not), the slopes for prior conviction and distress levels were allowed to vary and all other slopes were fixed. Preliminary conditional model results indicated that neither linear nor quadratic time variables accounted for significant within-person variation in conviction or distress levels, therefore these variables were again excluded from further analyses. The unconditional model results for persecutory belief conviction indicated significant between-participant variability in conviction levels ($\tau_{00} = 1.07$, $P < .01$), with 42% of the variability residing between individuals. The final conditional HLM results for persecutory belief conviction levels is presented in Table 3. Prior conviction level ($\beta = .18$) and anxiety ($\beta = .20$) were significant predictors of subsequent conviction levels, while none of the other predictors were significant. The predictor set as a whole explained 8% of the within-person and 68% of the between-person variability in conviction levels. Unconditional model results for persecutory belief distress level also indicated significant between-participant variability in distress levels ($\tau_{00} = 1.69$, $P < .01$), with 55% of the variability residing between

Table 3. Final Conditional HLM Results for Persecutory Belief Conviction Levels (Sample Size $N = 15$)

Fixed Effects	Coefficient	SE	t Ratio
Intercept	5.324**	0.287	18.547
Prior conviction level	0.182*	0.104	1.746
Anxiety	0.199*	0.112	1.776
Sadness	−0.026	0.124	−0.213
Hallucinations	0.478	0.508	0.941

Note: Level-1 $N = 72$, Level-2 $N = 15$.
*$P \leq .05$, **$P \leq .01$ (one-tailed).

Table 4. Final Conditional HLM Results for Persecutory Belief Distress Levels (Sample Size $N = 15$)

Fixed Effects	Coefficient	SE	t Ratio
Intercept	4.545**	0.286	15.898
Prior distress level	0.253**	0.115	2.192
Anxiety	0.227**	0.109	2.089
Sadness	0.219*	0.120	1.835
Hallucinations	−0.036	0.487	−0.073

Note: Level-1 $N = 72$, Level-2 $N = 15$.
*$P \leq .05$, **$P \leq .01$ (one-tailed).

individuals. The final conditional HLM results for persecutory belief distress is presented in Table 4. Prior distress level ($\beta = .25$), anxiety ($\beta = .23$), and sadness ($\beta = .22$) were significant predictors of subsequent distress levels; however, prior hallucinations were nonsignificant. The predictor set as a whole explained 7% of the within-person and 70% of the between-person variability in distress levels.

Discussion

This investigation used computerized ESM to examine whether the prospective relationships suggested by a psychological model of paranoia are demonstrated in the daily lives of people with schizophrenia or schizoaffective disorder. Consistent with our first hypothesis, increased anxiety and sadness were significant predictors of persecutory ideation over the subsequent hours of the same day. Contrary to our second hypothesis, the occurrence of anomalous internal experiences in the form of auditory/visual hallucinations or "visions" did not significantly predict subsequent paranoid ideation. Furthermore, we did not find evidence suggesting that any specific external events were more predictive of persecutory thoughts than others. Negative affect predictors were significant, even when controlling for substance use. Exploratory analyses revealed that in a subset of individuals who did have persecutory thoughts, anxiety states predicted subsequent levels of belief conviction and distress, while sadness predicted only levels of associated distress.

Approximately half of all participants had at least one paranoid thought during the week, with high levels of associated belief conviction and moderate levels of distress on average. Even participants who had a large number of persecutory thoughts during the week did not experience them during every measurement, suggesting that persecutory thoughts fluctuate and are not constantly present. Percentages of persecutory thoughts across participants over a week of data collection were remarkably similar in 4 different segments of the day, suggesting that there are no salient diurnal patterns in the occurrence of paranoid thoughts. Overall, support was found for components of Freeman and colleagues' cognitive model of persecutory ideations in suggesting that negative emotional state experiences predict subsequent paranoid ideation in individuals with schizophrenia and schizoaffective disorder.

Previous research has shown associations between negative emotional states such as anxiety[26–29] and depression[30–32] and paranoia in clinical samples of patients with psychosis cross-sectionally or prospectively with extended intervals between very few measurements. The current study adds to this literature by using a powerful repeated measures methodology to identify the in vivo dynamic relationship between negative emotional states and the occurrence of persecutory ideations in the day-to-day life of individuals with schizophrenia. Moreover, the control for concurrent persecutory ideation in the prediction of future ideation provides a stronger test of the directionality of these associations.

In the context of a diathesis-stress model, it is possible that experiencing negative emotions serves as a general stressor for individuals who are predisposed to paranoid thinking, increasing the likelihood of generating subsequent persecutory ideations. Alternatively, a cognitive-behavioral perspective would suggest that individuals' preexisting core beliefs about the world (the world is perilous) and self (I am incompetent) are utilized to interpret life events, resulting in negative emotional states, whose cognitive content (I am in danger, I am weak) feeds into the formation of persecutory beliefs ("agents are spying and plotting against me").[3,6,33] This interpretation of the findings would be consistent with previous studies that have shown greater paranoia in individuals who exhibit negative-other ("people are dangerous") and negative-self (I am weak) evaluations.[34] Our preliminary analyses revealed that anxiety was predictive of both persecutory belief conviction and associated distress and that sadness predicted only associated levels of distress. This is consistent with the notion that various dimensions of paranoid experiences are associated with different factors.[35] The observation that anxiety states are predictive of levels of belief related distress is also consistent with previous research indicating that increased anxiety, worry, and catastrophizing are associated with high levels of persecutory delusion distress[29] and may be an indication that

beyond the influence of belief content, individuals experience meta-worry concerning their ability to control thoughts about the belief.[36] However, the results of the exploratory analyses of persecutory belief conviction and distress were based on a small subsample of participants and therefore should be interpreted with caution. In addition, the predictors in the analyses account for only a small amount of the variance in within-person variability in distress and belief conviction. Future research with larger samples should attempt to replicate these relationships and examine additional factors from the cognitive model such as cognitive biases associated with psychosis (eg, "jumping to conclusions," Theory of Mind dysfunction) and psychosocial factors (eg, social isolation, poor social support) as predictors. Breaking up the relatively broad constructs of "anxiety" and "sadness" into more fine-grained predictors (eg, social vs general anxiety) may shed even more light on the role of negative emotional states in the formation and maintenance of persecutory beliefs.

The ability to detect prospective relationships between variables is directly linked to the methodological advantages of using computerized ESM. Previous cross sectional or long-interval studies did not permit the identification of temporal relationships between negative emotions and paranoid ideations as they occur in real time. Computerized ESM, in contrast, does allow the examination of temporal relationships between variables over short assessment periods. Previous studies utilized retrospective reports or clinical interviews in which participants were asked to recall and summarize mood states and symptoms that occurred over previous weeks or months, a process which is susceptible to significant retrospective recall biases in both clinical and healthy populations.[37–39]

By using computerized ESM, we were able to avoid these measurement problems and ensure that participants only rated how they felt at the time they were signaled or since the prior signal, summarizing only a few minutes or hours in each report. Finally, the majority of previous research collected emotion and symptom data in research laboratories or other artificial settings, and it is unclear whether these data were representative of naturally occurring phenomena. The current study was conducted in the context of the participants' naturally occurring life and in their own environments, greatly improving the ecological validity of the results.

Implications

Our findings have a number of clinical implications for the assessment and treatment of persecutory ideation in individuals with psychosis, especially within a cognitive-behavioral framework. The majority of contemporary cognitive-behavioral treatments (CBTs) for schizophrenia target the positive symptoms of the illness.[40,41] The current study suggests that in addition to focusing on persecutory

beliefs directly, clinicians could impact these symptoms indirectly by making good use of evidence-based cognitive and behavioral interventions aimed at ameliorating anxiety and depression. Working with patients with schizophrenia on methods to identify and address anxious and sad mood states as they occur in the moment may help reduce the frequency of subsequent persecutory thoughts, as well as belief conviction and associated distress. In addition, beyond its utility in research, ESM should be examined as a possible aid in the treatment of persecutory ideation and other symptoms of psychosis.[14] In the same manner in which computerized ESM proved instrumental in identifying the predictors of persecutory beliefs in our study, the method may be utilized to identify the predictors of other symptoms of psychosis in patients undergoing psychotherapy. Computerized ESM assessment can be easily executed at various stages of treatment, first as part of an initial assessment identifying patient symptom patterns, cognitive style, and daily behaviors, and at subsequent times to help monitor their progress and changes made in the course of treatment. One particular advantage of ESM is that it may help identify and challenge specific cognitive biases. For example, patients in our group CBT for functional impairment in schizophrenia[40] often reported refraining from social and other activities because they experienced persecutory thoughts or other symptoms "all the time" and were concerned that this would impact their ability to function. Conducting collaborative discussions outlining the disparities between how patients perceive their illness, and their actual ESM recordings may help challenge patient beliefs that they are constantly symptomatic and therefore cannot develop meaningful relationships, venture outside of their home or seek employment opportunities. Identifying specific predictors of the onset of particular symptoms may also help increase a sense of controllability as patients would have a better idea of when and why symptoms appear.

In the past, PDAs and other mobile technologies were prohibitively expensive and required programming expertise that made ESM an exceedingly complex endeavor. However, advances in technology and widespread marketing and manufacturing of mobile computers and wireless devices in the last few years have resulted in dramatic drops in PDA costs. Combined with the current availability of easy to use open source software such as the PMAT[21] and the Experience Sampling Program,[41] researchers and clinicians should no longer be deterred from utilizing these strategies in their research and clinical practice.

Limitations

The results of this study should be interpreted in the context of several limitations. First, our measure of persecutory ideations is relatively narrow in content and only assesses experiences of feeling spied upon or plotted against, without covering other themes common to paranoia. In addition, we asked individuals to report

persecutory ideation since the last signal was given, summarizing a number of hours, which may be susceptible to some recall inaccuracy. We decided to ask for brief summaries as opposed to momentary "snapshots" because unlike emotional states that may linger for longer periods of time (and consequently easier to record with momentary questions after they started), automatic thoughts may be more fleeting in nature and difficult to capture as they occur. Second, recent life events were not found to be significant predictors of persecutory ideation, but it is conceivable that our ESM question item was too vague or captured daily hassles rather than assessing the more stressful life occurrences suggested by the model. Therefore, it may be premature to conclude that significant negative life events do not contribute to subsequent paranoia. Third, the prospective associations between variables found in our study are not conclusively indicative of a causal relationship. It is possible that additional unknown variables that caused increases in anxiety and sadness were also responsible for the subsequent occurrence of persecutory thoughts. Coupling ecologically valid designs such as computerized ESM with other contemporary laboratory paradigms such as virtual reality[42,43] to experimentally examine the predictors of persecutory beliefs is especially warranted. Finally, our participants were all chronic patients recruited from a larger psychosocial treatment outcome study and were physically and clinically stable enough to participate in outpatient therapy. This group may be a more motivated, higher functioning subset and not fully representative of the broader clinical population or patient groups with more recent illness onset.

Funding

Acknowledgments

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