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Understanding the Consequences of Moment-by-Moment Fluctuations in Mood and Social Experience for Paranoid Ideation in Psychotic Disorders

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Among individuals with psychotic disorders, paranoid ideation is common and associated with increased impairment, decreased quality of life, and a more pessimistic prognosis. Although accumulating research indicates negative affect is a key precipitant of paranoid ideation, the possible protective role of positive affect has not been examined. Further, despite the interpersonal nature of paranoid ideation, there are limited and inconsistent findings regarding how social context, perceptions, and motivation influence paranoid ideation in real-world contexts. In this pilot study, we used smartphone ecological momentary assessment to understand the relevance of hour-by-hour fluctuations in mood and social experience for paranoid ideation in adults with psychotic disorders. Multilevel modeling results indicated that greater negative affect is associated with higher concurrent levels of paranoid ideation and that it is marginally related to elevated levels of future paranoid ideation. In contrast, positive affect was unrelated to momentary experiences of paranoid ideation. More severe momentary paranoid ideation was also associated with an elevated desire to withdraw from social encounters, irrespective of when with familiar or unfamiliar others. These observations underscore the role of negative affect in promoting paranoid ideation and highlight the contribution of paranoid ideation to the motivation to socially withdraw in psychotic disorders.

Key words: digital phenotyping/ecological momentary assessment/experience sampling method (EMA/ESM)/emotion/paranoia/psychosis/schizophrenia

Introduction

Paranoid ideation is a dimensional construct characterized by unsubstantiated beliefs that intentional harm has occurred or is likely to occur.[1] Paranoid ideation spans a continuum, from mild mistrust and suspicion to severe, unshakeable paranoid delusions.[2,3] Among individuals with psychosis, moderate-to-severe paranoid ideation is common, with approximately half of these individuals showing clinically significant paranoid thoughts or delusions.[4–8] For individuals with psychotic disorders, elevated levels of paranoid ideation are associated with increased social impairment, decreased quality of life, and a worse prognosis.[6,9] Although the past 2 decades have seen a remarkable increase in the amount of empirical attention devoted to paranoid ideation and a growing consensus about its nature, mechanisms, and clinical significance, the factors contributing to paranoid ideation in daily life remain incompletely understood.[2,3]

While the etiology of paranoid ideation is complex and multifactorial,[2,3] negative affect appears to be a key precipitant. Cross-sectional relations between negative affect and paranoid ideation have been consistently identified using retrospective trait measures.[10] Likewise, ecological momentary assessment (EMA) studies have consistently found that negative affect prospectively predicts increases in paranoid ideation, suggesting a causal role. This association is evident in community samples,[11] university students with elevated psychotic symptoms,[12] and individuals with clinically diagnosed psychosis.[4,12–15] Findings regarding the reverse association—paranoid ideation predicting future increases in negative affect—are inconsistent, with some studies supporting this relation[16] and others finding no support.[12,14] In sum, negative affect appears to be a key precipitant to paranoid ideation in individuals with psychosis.

As yet, the relevance of positive affect for paranoid ideation remains rarely explored and largely unknown. Positive

affect is altered in psychosis, with research finding low levels of both trait and state positive affect for individuals with schizophrenia spectrum disorders.[17–19] Additionally, positive and negative affect are differentially related to symptoms and functioning in psychosis.[20,21] Converging lines of experimental mood-induction and EMA research suggest that positive and negative affect are mutually inhibitory, particularly during periods of stress, with greater positive affect contributing to lower negative affect and vice versa.[22–24] Positive affect can also ameliorate, buffer, or repair negative thoughts and feelings and protect against the emergence and maintenance of psychopathology.[25–28] Given the central role of negative affect in models of paranoid ideation, this evidence motivates the hypothesis that positive affect contributes to lower levels of paranoid ideation. Consistent with this possibility, EMA work in healthy adolescents provides preliminary evidence that greater positive affect in the morning is associated with lower levels of paranoid ideation later the same day.[29] Whether this inhibitory association translates to adults with psychotic disorders is unknown.

In addition to the role of negative affect, experimental research suggests that social context also plays an important role in paranoid ideation. In a laboratory study, Freeman et al.[30] used virtual reality (VR) to expose nonclinical controls with low paranoid ideation, nonclinical controls with high paranoid ideation, and participants with clinically documented extreme paranoid ideation, to objectively neutral social stimuli: a virtual subway car populated with emotionally neutral avatars who engaged in everyday actions, such as reading a newspaper or glancing about the car. Results revealed that participants with psychosis were 12 times more likely and the nonclinical, high paranoia group approximately 3 times more likely to experience paranoid ideation. Other VR studies have yielded similar effects. For instance, Veling et al.[31] showed that distress and paranoid ideation systematically co-varied with the degree of social crowding in a virtual pub. Similarly, Freeman et al.[32] demonstrated that, for individuals with current paranoid delusions, the mere act of walking through a crowded, but otherwise unthreatening, urban shopping center was sufficient to amplify paranoid ideation (compared to an indoor control task) and showed that this effect was mediated by parallel increases in negative affect. Collectively, these findings suggest that the presence of strangers, especially in more densely populated environments, triggers increased negative affect and, ultimately, elevated levels of paranoid ideation.

While experimental research provides useful mechanistic insights, the relevance of these discoveries to everyday paranoid ideation remains uncertain. Although several EMA studies have examined social functioning and social experiences in individuals with psychotic disorders[33] and there is EMA evidence to suggest that individuals with psychosis experience heightened feelings of threat in the company of others,[34] few EMA studies have directly examined the impact of social context on paranoid ideation in individuals with psychosis. Leveraging a novel, year-long approach, Buck et al.[35] showed that self-reported social activity is associated with concurrent increases in paranoid ideation. However, passively collected cellular data from the same study found that on days of higher reported paranoid ideation, individuals with psychotic disorders spent less time around speech and on outgoing calls, suggesting an association between social withdrawal and paranoid ideation.[35] Likewise, Collip et al.[36] used EMA to show that the presence of less-familiar individuals is associated with concurrent increases in paranoid ideation. Similarly, Fett et al.[37] found that momentary paranoid ideation was greater when around strangers compared to when around familiar others, but also found that paranoid ideation was greater when alone compared to when with others. Using a more stringent time-lagged analytic approach, Ben-Zeev et al.[4] failed to detect an association between the presence of strangers and subsequent levels of paranoid ideation though this null association may reflect the fact that a branching EMA survey was used; consequently, social experiences were infrequently assessed. Given the complexity and contradictory nature of prior findings, additional research is needed to clarify relations between momentary levels of paranoid ideation and social context in individuals with psychosis.

In addition to exploring the relation between momentary paranoid ideation and social context, it is also useful to clarify how paranoid ideation is associated with perceptions of social situations and motivation to engage in social contexts. Prior research indicates that individuals with psychotic disorders experience social encounters as less pleasant and report an enhanced motivation to withdraw from them.[34,38,39] Whether such perceptions relate to momentary levels of paranoid ideation remains unknown. Affiliative feelings may be undermined by the interpersonal sensitivity and exaggerated social evaluative concerns that are associated with paranoid ideation.[40] Also, it is possible that the motivation to withdraw from social encounters is influenced by the safety-seeking and avoidance tendencies that characterize many individuals with elevated levels of paranoid ideation.[41,42]

The current pilot study leveraged an intensive, week-long smartphone EMA protocol to better understand the relevance of hour-by-hour fluctuations in mood, social context, social perception, and social motivation for paranoid ideation in individuals with psychotic disorders. In addition to examining the impact of negative affect, we tested whether positive affect dampens paranoid ideation. We also tested the potential influence of momentary fluctuations in social context and perceptions of that context on paranoid ideation. We hypothesized that paranoid ideation would be greater in the presence of unfamiliar individuals, when compared to periods of solitude.

During social encounters, we anticipated that reduced feelings of closeness and increased withdrawal motivation would be associated with elevated paranoid ideation. We also tested whether these hypothesized relations are influenced by the degree of social familiarity. During moments of solitude, we anticipated that perceptions of social rejection and a diminished desire for the company of others would be associated with elevated paranoid ideation. By improving our understanding of the precipitants to paranoid ideation, the findings from this study have the potential to illuminate targets for treatments aimed at reducing paranoid ideation and improving social functioning among individuals with psychosis.

Method

Participants

As part of a larger program of research focused on understanding the nature and brain bases of emotional and motivational deficits in psychosis,[43,44] 37 individuals with psychotic disorders were recruited from outpatient mental health clinics in the Baltimore-Washington DC metropolitan area and enrolled. Consistent with the dimensional approach to researching psychopathology laid out in the National institute of Mental Health's Research Domain Criteria (RDoC)[45,46] a transdiagnostic sample was recruited. Inclusion criteria included being 18–60 years old, lifetime history of a psychotic disorder, English fluency, and a willingness to be videotaped. Exclusion criteria included clinical instability (ie, psychiatric hospitalization in the past 3 months, change in psychiatric medication in the past month), current substance use disorder, lifetime history of neurological damage or disorder, and lifetime history of pervasive developmental or intellectual disorder. Recruitment was independent of the severity of paranoia ideation. Five participants were excluded from analyses due to inadequate compliance with the EMA protocol (see below). Demographic and diagnostic characteristics for the final sample (N = 32) are summarized in table 1. All participants provided informed written consent in accordance with procedures approved by the University of Maryland School of Medicine Institutional Review Board.

Table 1. Sample Characteristics

	Mean (*SD*) or *n* (%)
Age (years)	41.66 (12.94)
Sex	
Male	18 (56.3%)
Female	14 (43.8%)
Race	
African American	18 (56.3%)
White	8 (25%)
Asian	1 (3.1%)
More than one race	5 (15.6%)
Ethnicity	
Non-Hispanic or Latino	27 (84.4%)
Hispanic or Latino	5 (15.6%)
Education (years)	12.78 (2.0)
Current employment	
Yes	10 (31.3%)
No	22 (68.8%)
Diagnosis	
Schizophrenia	11 (34.4%)
Schizoaffective bipolar Type	7 (21.9%)
Schizoaffective depressive Type	6 (18.8%)
BP I w/psychotic features	5 (15.6%)
MDD w/psychotic features	3 (9.4%)
Antipsychotic medication	
Typical	5 (15.6%)
Atypical	22 (68.8%)
Combined (typical and atypical)	1 (3.1%)
Neither	3 (9.4%)
Unknown	1 (3.1%)

Note: BP, bipolar; MDD, major depressive disorder.

Overview

Participants attended an initial study visit where they completed baseline assessments, were provided with a Samsung Galaxy S7 smartphone, and were trained to understand and comply with the EMA protocol. They then completed up to 8 surveys per day for the next 7 days, consistent with prior work in both university[47] and psychosis samples.[37,48] At a follow-up visit, participants returned the smartphone and were compensated.

Diagnostic and Clinical Assessment. To confirm psychiatric diagnoses, the mood and psychotic disorder modules of the Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (SCID-5)[49] were administered to all participants. Relevant substance use disorder modules were administered for participants who indicated substance use in the past 6 months during screening.

The Expanded Brief Psychiatric Rating Scale (BPRS)[50] was used to measure clinician-rated symptomatology at baseline. The BPRS is a 24-item semi-structured interview designed to assess clinical symptomatology over the past week. In the current study, the suspiciousness item was used to assess clinician-rated paranoid ideation (M = 2.13, SD = 1.72, Range = 1–7).

The Green Paranoid Thoughts Scales (GPTS)[51] was used to assess paranoid ideation at baseline. The GPTS is a 32-item self-report measure of paranoid thinking on which participants indicate the extent of thoughts and feelings they have had over the past month from 1 (*not at all*) to 5 (*totally*). The GPTS consists of 2 subscales, social reference and persecution. Trait-like individual differences in paranoid ideation were assessed using the total score (M = 58.84, SD = 26.83, Range = 32–132, α = .96). The GPTS is considered the most valid and psychometrically sound self-report measure of paranoid ideation.[52]

EMA Procedures and Compliance. During the baseline laboratory session, participants were trained to understand and comply with the EMA protocol. Consistent with published recommendations,[53] training included responding to a test EMA in the laboratory. Participants demonstrating inadequate comprehension were given additional instruction. The EMA protocol was administered using OmniTrack for Research,[54] a cloud-based research platform that handles EMA configuration, mobile application deployment, and real-time data monitoring. A mobile app generated by the platform was installed on the provided smartphones to administer 8 surveys at pseudo-random times between 8 AM and 9 PM (>60-min between EMAs; mean within-day interval = 126 min) during the 7-day EMA protocol.[55] Each 5-min survey could be accessed for 15 min following the initial prompt. Compliance was monitored by staff using a web-based dashboard, and participants demonstrating poor compliance were contacted and provided with technical support and encouragement. Participants received a monetary bonus for completing ≥80% of EMAs. Five participants showing inadequate compliance (<25% completion) were removed from analyses. In the final sample, EMA compliance was acceptable (M = 66.63%, SD = 26.64%) and similar to other studies of psychosis using a similarly intensive sampling protocol.[56] Individual differences in trait paranoid ideation were unrelated to compliance (p = .30).

EMA Survey. Momentary levels of paranoid ideation were assessed using 5 items adapted from prior work: "*I worry that others are plotting against me," "I feel that I can trust no one," "I believe that some people want to hurt me deliberately," "I feel suspicious,"* and *"I feel mistreated."*[4,11,12,57] Participants rated the momentary intensity of each item at the time of the EMA prompt using the same scale used in previous studies, ranging from 1 (*not at all*) to 7 (*very much*). A composite measure of paranoid ideation was calculated by averaging items (α = .85).

Momentary affect was assessed using ten items adapted from prior work.[47,57–59] Negative affect items encompassed anxiety, depression, and anger (*anxious, scared, sad, hopeless, annoyed, angry*). Positive affect items included both high and low arousal states (*happy, cheerful, calm, relaxed*). Participants rated the current intensity of each emotion using the same scale from previous studies, ranging from 1 (*not at all*) to 5 (*extremely*). Composite measures of positive and negative affect were computed by averaging the relevant items (α = .78 and .90, respectively).

Participants reported their current social context by reporting whether they were with others at the time of the prompt (*Yes*/*No*) and, if so, the nature of the social relationship (*acquaintances, friends, romantic partners, family, strangers*) and the number of other individuals present (*1, 2, 3, 4, 5+, 10+, 15+, 20+*). As in prior work by our group, friends, family, and romantic partners were recoded as "familiar" others, whereas acquaintances and strangers were recoded as "unfamiliar."[60] Assessments completed in the presence of a mixture of familiar and unfamiliar individuals, were coded as familiar. Social density was conservatively quantified as the lowest value for each range (eg, 10 for 10+).

Social perceptions and motivations were assessed using items adapted from prior work.[59] When participants responded in the affirmative that they were in the presence of others, they rated perceptions of social closeness (*"I feel close to this person (these people)"*) and motivation to socially withdraw (*"Right now, I would prefer to be alone"*) using the aforementioned 7-point scale. When participants responded in the negative when asked if they were in the presence of others, they rated perceptions of social rejection (*"I am alone right now because people do not want to be with me"*) and motivation for social engagement (*"Right now, I would prefer to be with others"*) using the same scale.

Descriptive statistics for relevant EMA items are depicted in table 2.

Hypothesis Testing Strategy

Consistent with our goal of understanding the impact of hour-by-hour fluctuations in affect, social perceptions, social evaluations on paranoid ideation, and in line with similar work by our group,[60] a series of multi-level models (MLMs)—sometimes termed "hierarchical linear" or

Table 2. EMA Descriptive Results

EMA Items (scale)	Number of EMAs	Mean (*SD*)	Frequency (%)
Negative affect (1–5)	1152	1.27 (0.40)	–
Positive affect (1–5)	1152	3.30 (1.10)	–
Paranoid ideation (1–7)	1141	1.64 (1.19)	–
Social contexts	1144	–	–
Alone	–	–	664 (58.0%)
With familiar others	–	–	372 (32.5%)
With unfamiliar others	–	–	108 (9.4%)
Perceptions in the presence of others (1–7)			
Perceived social closeness	480	5.03 (2.35)	–
Social withdrawal motivation	480	1.89 (1.72)	–
Perceptions in the absence of others (1–7)			
Perceived social rejection	664	1.30 (0.98)	–
Motivation for social engagement	664	1.43 (1.12)	–

"linear mixed" models—was used to examine relations between paranoid ideation and momentary fluctuations in mood, social context, social perceptions, and social motivation. MLM is the standard analytic framework for EMA and other kinds of experience-sampling data because it naturally handles the nested dependency and variable number of longitudinal assessments provided by each subject, unlike traditional repeated-measures general linear modeling approaches.[61,62] Hypothesis testing was performed using SPSS (version 24.0.0.0). MLMs were computed using a "variance components" covariance structure, restricted maximum likelihood estimates, and random intercepts. Dimensional Level 1 measures were separately mean-centered for each participant ("person-centered") and Level 2 variables were mean-centered across participants ("grand-average centered"). Significance was determined using two-tailed tests.

The equations defined below outline the basic structure of our MLMs in standard notation.[63] At the first level, paranoid ideation (PI) during EMA t for individual i was modeled as a function of concurrent levels of negative affect (NA) or positive affect (PA).

$$PI_{ti} = \pi_{0i} + \pi_{1i}(NAorPA) + e_{ti}(Level1) \quad (1)$$

$$\pi_{0i} = \beta_{00} + r_{0i}(Level\ 2) \quad (2)$$

To clarify temporal dependence, time-lagged analyses were performed. At the first level, paranoid ideation at the current time-point t (PI_{ti}) for individual i was modeled as a function of negative or positive affect at the prior time-point (eg, NA_{t-1i}), controlling for i's level of paranoid ideation at the prior time-point (PI_{t-1i}). For negative affect, the equation was as follows:

$$PI_{ti} = \pi_{0i} + \pi_{1i}(NA_{t-1i}) + \pi_{2i}(PI_{t-1i}) + e_{ti}(Level\ 1) \quad (3)$$

$$\pi_{0i} = \beta_{00} + r_{0i}(Level\ 2) \quad (4)$$

Given evidence of bi-directional relations between negative affect and paranoid ideation, time-lagged analyses were also used to assess negative affect as a function of paranoid ideation.

Next, we examined the association between momentary assessments of social context and paranoid ideation, with moments of solitude ("Alone") serving as the reference category.

$$PI_{ti} = \pi_{0i} + \pi_{1i}(Others) + e_{ti}(Level\ 1) \quad (5)$$

$$\pi_{0i} = \beta_{00} + r_{0i}(Level2) \quad (6)$$

Within each social context (alone, with unfamiliar others, with familiar others), the concurrent association between momentary assessments of paranoid ideation and social perceptions and motivations were examined using the same MLM strategy detailed above.

All of our key results remained significant while controlling for variation in EMA compliance.

Results

As a precursor to hypothesis testing, we determined whether individuals with higher levels of clinician-rated (BPRS) and self-reported (GPTS) trait paranoid ideation experienced elevated levels of momentary paranoid ideation. MLM results revealed the expected convergence between trait and state measures for both clinician-rated (t = 4.34, b = 0.62, SE = 0.14, p < .001) and self-reported (t = 3.77, b = 0.58, SE = 0.15, p = .001) paranoid ideation, reinforcing the validity of our EMA approach.

Positive and Negative Affect

As expected, cross-sectional MLM results revealed that higher levels of negative affect were associated with significantly elevated levels of paranoid ideation (t = 5.31, b = 0.44, SE = 0.08, p < .001). In contrast, higher levels of positive affect were unrelated to paranoid ideation (t = −1.79, b = −0.06, SE = 0.03, p = .10). Cross-sectional relations between negative affect and paranoid ideation remained significant after controlling for positive affect (t = 5.49, b = 0.47, SE = 0.08, p < .001).

Next, we used a time-lagged MLM to determine whether negative affect prospectively predicts future increases in paranoid ideation, while controlling for the initial degree of ideation. As expected, results showed that elevated negative affect was associated with more severe paranoid ideation at the next assessment, although this association was only marginally significant (*Negative Affect → Paranoid Ideation:* t = 1.85, b = 0.12, SE = 0.06, p = .08). The reverse temporal association was not significant (*Paranoid Ideation → Negative Affect:* t = 0.63, b = 0.02, SE = 0.03, p = .55). Although the results are only marginally significant, they are consistent with the hypothesis that negative affect triggers an elevated state of paranoid ideation which can persist for up to several hours (mean inter-assessment interval = 2.1 h).

In a similar manner, we used a time-lagged MLM to determine whether positive affect prospectively predicts future increases in paranoid ideation, while controlling for the initial degree of ideation. Results showed that elevated positive affect was not associated with less severe paranoid ideation at the next assessment (*Positive Affect → Paranoid Ideation:* t = −.58, b = −.03, SE = 0.05, p = .57).

Social Context

Prior to hypothesis testing, we examined the amount of time that participants allocate to different environments. Results indicated that slightly more than half of EMAs were completed when alone (58%), with the remainder completed in the presence of others (42%, M = 3.9 other individuals, SD = 5.49), in broad accord with other studies of this population.[33,64] When with others, participants were approximately 3.5 times more likely to be in the company of familiar (friends, family, and/or romantic partners: 32.5% of total EMAs) compared to unfamiliar individuals (acquaintances or strangers: 9.4% of total EMAs). The presence of familiar others was associated with significantly greater feelings of social closeness when compared to unfamiliar others (t = 4.70, b = 1.86, SE = 0.40, p < .001). Furthermore, this association remained significant after controlling for variation in the amount of time allocated to different social contexts (t = 2.56, b = 2.50, SE = 1.11, p = .03).

For hypothesis testing, we used a series of MLM analyses to examine within-participant relations between social context and momentary levels of paranoid ideation and affect. Contrary to expectations, paranoid ideation (ps > .15), negative affect (ps > .27), and positive affect (ps > .46) did not systematically differ across the 3 social contexts.

Social Perceptions and Motivation

Finally, we examined the influence of subjective social perceptions and social motivation on paranoid ideation. Analyses focused on social contexts demonstrated that heightened social withdrawal motivation was associated with more severe paranoid ideation in the company of others (t = 2.27, b = 0.09, SE = 0.04, p = .03). This association was not moderated by the degree of social familiarity (close versus distant; t = .49, b = 0.02, SE = 0.03, p = .63). Perceptions of social closeness were unrelated to the degree of paranoid ideation (t = −1.36, b = −.04, SE = 0.03, p = .19).

Analyses focused on periods of solitude indicated that perceptions of social rejection and motivation for social engagement were unrelated to paranoid ideation (social rejection: t = 0.25, b = 0.03, SE = 0.11, p = .81, engagement motivation: t = 0.14, b = 0.01, SE = 0.04, p = .89). In short, across a range of subjective perceptions, paranoid ideation was primarily related to the momentary desire to withdraw from the company of others.

Discussion

Among individuals with psychotic disorders, elevated levels of paranoid ideation are common and associated with substantial distress and impairment. A growing body of experimental research has begun to reveal factors that promote paranoid ideation, but the relevance of these discoveries for the real world has remained uncertain. Leveraging an intensive, week-long EMA protocol in a sample of individuals with psychotic disorders, the present pilot study provides insight into the processes that shape paranoid ideation in the daily lives of individuals with psychosis.

Our results show that negative affect is associated with more severe paranoid ideation at the same assessment. Our time-lagged MLM results provide evidence, albeit marginally (p = .08), that momentary levels of negative affect are prospectively associated with heightened paranoid ideation some 2 h later, even while controlling for initial levels of ideation. This finding is consistent with other EMA studies focused on individuals with psychotic disorders, which have found that greater momentary negative affect precedes and predicts greater paranoid ideation.[4,11,12,14,65] Support for the reverse association—paranoid ideation predicting future increases in negative affect—has been less consistently reported in the literature[12,14] and was not evident here. Taken together, these observations suggest that negative affect plays a causal role in paranoid ideation[1,41] but that paranoid ideation does not necessarily contribute to subsequent increases in negative affect, especially when examining hour-by-hour fluctuations in both constructs.

Contrary to our hypothesis, there was no significant relation between positive affect and paranoid ideation and, in a simultaneous model which included both positive and negative affect, only negative affect significantly co-varied with the severity of momentary ideation. While preliminary, these observations suggest that associations previously detected in adolescents may not generalize to adults with psychotic disorders.[29] We also found that positive affect did not vary across different social contexts (alone, familiar, and unfamiliar others). This result is inconsistent with prior research indicating that social contact is associated with increased positive affect in individuals with serious mental illness[37,64,66,67] but similar to other null findings for affect and social context.[68] Given that positive affect can act as a buffer against the maintenance of psychopathology,[25–27] additional research should seek to replicate the current null findings in larger samples.

Our MLM results show that variation in social context was unrelated to momentary levels of paranoid ideation. These findings contradict experimental research, which suggests that exposure to strangers, including in densely populated urban environments, is sufficient to increase paranoid ideation.[30–32] While this experimental work provides mechanistic evidence that the presence of unfamiliar others in socially dense environments contributes to increases in paranoid ideation, the current findings raise questions about whether this mechanism is a major determinant of paranoid ideation in the daily lives of individuals with psychosis, given the rarity of such

experiences. Consistent with the findings of other EMA research,[4] the present study failed to find associations between social context and paranoid ideation. Additionally, the present results provide additional evidence that encounters with unfamiliar individuals occur infrequently for individuals with psychosis,[33,37] accounting for <10% of momentary assessments in the current sample, and that social encounters occur in relatively low-density social environments (ie, on average with fewer than four other people using conservative estimates for binned responses). Taken together, these findings suggest that, although densely populated urban environments have the potential to increase paranoid ideation,[30–32] most of the variance in daily paranoid ideation for individuals with psychosis may not be due to encounters with unfamiliar others in these environments.

Our results also highlight the importance of social motivation for paranoid ideation, demonstrating that more severe paranoid ideation is associated with elevated desires to withdraw from social encounters, irrespective of when with familiar or unfamiliar others. Prior research has shown that, compared to controls, individuals with psychosis report a greater preference for being alone when with others.[33] However, very little EMA research has directly explored how symptoms relate to the preference to be alone with one study examining negative symptoms finding no association[69] and no studies directly examining the relation with paranoid ideation. Our findings are the first to link momentary paranoid ideation with a greater desire to be alone when with others. This association is consistent with models which suggest that elevated levels of paranoid ideation leads to safety behaviors, such as social withdrawal and isolation, allowing individuals with paranoid ideation to avoid situations perceived as threatening, thus perpetuating paranoid ideation.[2,41,42] However, further research is needed to understand the directionality of this relation as the branching logic in our EMA survey prevented such analysis. Also, further work is needed to understand how the relation between paranoid ideation and social withdrawal motivation may drive actual behavior. Contrary to hypotheses, when with others, momentary paranoid ideation was unrelated to feelings of closeness. Also, when respondents were alone, paranoid ideation was unrelated to a diminished desire to be with others or attributing being alone to a consequence of being rejected by others.

Taken together, the current findings suggest that the relation between social context and paranoid ideation is more nuanced and multifactorial than a simple association between paranoid ideation and the presence or absence of others. Given the complexities of social environments, research on social context and paranoid ideation may need to go beyond broad indicators of both the familiarity of others or social density and look more closely at the quality of social interactions as those with psychosis may have a similar amount of social engagement but engage in lower quality social interactions compared to the general population.[68] Further, recent research on social context and affect suggests the need to examine the nature of activities performed in different social contexts as these activities may themselves determine affective experience.[70]

The present findings highlight several avenues for future research. While the current sample size limited our ability to examine the role of potentially important demographic factors on paranoid ideation, including gender and race,[71,72] most studies utilizing EMA to explore similar questions regarding paranoid ideation have either failed to report the ethnoracial makeup of their samples or relied on mostly White samples, with only one EMA study from the above literature review recruiting a minority racial sample.[37] Thus, while the inclusion of a traditionally underrepresented group is a strength of the current study, future research should seek to collect larger, more diverse samples. Additionally, the current sample size precluded us from examining the potential role of specific diagnosis on the current findings. While this approach is consistent with the dimensional perspective embodied in RDoC,[45,46] it may be informative for future studies to explore whether categorical diagnoses play a role in the association between paranoia, affect, and social context. Also, given that the current study utilized convenience sampling and did not require heightened levels of paranoid ideation, future studies should utilize stratified sampling or other methods to recruit samples which better represent the broad spectrum of paranoid ideation, including those with severe symptomatology. Despite this limitation, however, it should be noted that the current study drew from a pool of clinically stable outpatients and may therefore be particularly relevant to this population. In the current study, participants reported spending most assessment periods alone (58%). Although consistent with EMA findings in samples of individuals with psychosis[33,37,64] this does reduce the number of assessments that involve social contact. Relatedly, when participants reported being with others they were in relatively low-density environments (ie, on average with fewer than four other people) and were predominantly with familiar people. This suggests the potential importance for future studies to combine EMA methodology that relies on self-selected experiences with laboratory-based assessments that can ensure exposure to a range of standardized social environments. It may also be insightful for future studies to adopt more complex sampling protocols (eg, event-triggered burst designs) to increase the likelihood of capturing rare, but potentially clinically relevant, transitions in social context. Given that encountering densely populated social environments with strangers was rare in the current study, it will also be useful for future EMA studies to assess for longer periods

of time to either capture these less frequent events or to provide further evidence of the rarity of such experiences.

In summary, the present pilot study provides preliminary evidence for a novel framework for understanding the factors that promote paranoid ideation in the daily lives of individuals with psychotic disorders. Our findings provide additional support for the role of negative affect, showing that momentary increases in negative affect can precipitate a sustained state of heightened paranoid ideation. Although paranoid ideation was unrelated to social context across the course of a week, it proved sensitive to momentary fluctuations in social motivation, co-varying with a heightened desire to withdraw from social encounters. These observations have implications for our understanding of experimental studies of paranoid ideation, provide a roadmap to the most important challenges for future EMA studies, and set the stage for developing improved intervention strategies.

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Author Contributions

RDO managed data collection and study administration, contributed to data acquisition and analysis, and drafted the paper. JH developed the analytic plan, contributed to data analysis and interpretation, created tables, and drafted the paper. AMJ contributed to data acquisition and analysis and created tables. CLGS contributed to data acquisition and analysis. SEG contributed to data analysis and interpretation. YHK developed and optimized the EMA paradigm and designed the cloud-based EMA monitoring software. EKC developed and optimized the EMA paradigm and contributed to research design. AJS contributed to research conception and design, co-developed the data analytic plan, contributed to writing, and funded the study. JJB contributed to research conception and design, contributed to writing, funded the study, and supervised all aspects of the study. All authors contributed to reviewing and editing the paper and approved the final version.

Data Availability

De-identified data will be made publicly available via OSF: DOI 10.17605/OSF.IO/EQ4JZ.

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The Authors have declared that there are no conflicts of interest in relation to the subject of this study.

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