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# Examining self-reported social functioning, sleep quality, and psychotic-like experiences in college students

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ABSTRACT

Impairments in social and role functioning have been associated with the prodromal phase of psychosis. Additionally, sleep disturbances impacting daily functioning have been detected across the schizophrenia spectrum. Relationships between social functioning, sleep quality, and psychotic-like experiences (PLEs) in undergraduate-level student populations are less understood. The current project aimed to investigate whether self-reported measures of sleep quality would moderate the relationship between social functioning and PLE endorsement in a community sample of 3042 undergraduate student participants between the ages of 18–35. Participants completed the Social Functioning Scale, the Pittsburgh Sleep Quality Index, and the Prodromal Questionnaire, which indexed PLEs. Bivariate correlations revealed significant associations between social functioning, sleep, and PLEs. As expected, poor sleep and poor social functioning were associated with increased endorsement of PLEs. Contrary to expectation, poor sleep quality was associated with better social functioning. In hierarchical multiple regression models, the interaction between social functioning and sleep was not associated with PLE endorsement. Results indicated that both poor sleep and poor social functioning were significantly associated with PLEs when included in the same model. These findings suggest that poor social functioning and disrupted sleep may act additively to influence PLEs, and that they are both important contributors to psychotic symptoms. Due to deleterious effects of poor sleep on physical and emotional health, these findings provide impetus to further investigate relationships between sleep quality, social functioning, and PLEs using such high-resolution methods as actigraphy, mobile sensing, ecological momentary assessment, and neuroimaging.

## 1. Introduction

Approximately 8% of psychiatrically healthy individuals experience psychotic-like experiences (PLEs) (van Os et al., 2009) that exist along a continuum of severity. Though these experiences do not signify pathology in isolation, they can precede the onset of psychotic disorders such as schizophrenia (Cougnard et al., 2007; Dominguez et al., 2010; van Os et al., 2009). Presence of PLEs in adolescence has also been associated with increased risk for developing psychotic disorders in adulthood in longitudinal studies (Fisher et al., 2013; Poulton et al., 2000). Therefore, PLEs are an important target for identification and early intervention.

Though individuals endorsing PLEs may never convert to a psychotic disorder, individuals endorsing more PLEs tend to also exhibit impairments in social functioning that are similar, but less pronounced, than what is detected in individuals meeting diagnostic criteria for schizophrenia-spectrum disorders (Addington et al., 2008; Chun et al., 2020; Coughlan et al., 2021). Low social support from friends has also been associated with increased distress from PLEs among college students with past or present mental health diagnoses (Denenny et al., 2015). Impairments in social functioning have, too, been associated with the prodromal phase of psychosis such that poor social and role functioning predicts conversion to psychosis and poorer functional outcomes among clinical high-risk groups (Cannon et al., 2008; Carrión et al., 2013; Cornblatt et al., 2012; Velthorst et al., 2018). As such, social-cognitive treatments for youth at clinical high-risk are in early stages of evaluation (Friedman-Yakoobian et al., 2019).

Associations between dysfunctional sleep and psychotic-like experiences in college students (Andorko et al., 2017) and in adolescents at heightened risk for developing psychosis (Lunsford-Avery and Mittal, 2013) have also been reported. In a recent longitudinal study of a cohort of 160 participants at risk for developing psychosis, results indicated

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that shorter sleep duration was associated with increased severity of delusional ideas and hallucinatory experiences both cross-sectionally and longitudinally (Reeve et al., 2019). These results align with a proposed model in which disrupted sleep is both a reflection of biological vulnerability and an additional stressor, whereby individuals experience a cycle of disrupted sleep exacerbating psychotic experiences leading to increased stress and distress, resulting in worse sleep (Lunsford-Avery and Mittal, 2013). Interestingly, in sleep challenge studies of individuals with no history of PLEs, sudden onset of PLE symptoms have also been reported in response to sleep deprivation, which resolved once baseline sleep schedules were resumed (Orzel-Gryglewska, 2010; Petrovsky et al., 2014; Tyler, 1955). Some psychiatrically healthy individuals also show a greater vulnerability to total and partial sleep loss than others (Rupp et al., 2012). Notably, in a series of studies of military personnel conducted in the 1940s, participants were deprived of sleep for periods of up to 112 h. While sleep deprivation elicited PLEs in most of the young men studied, some reported more severe symptoms such as frank psychosis (Tyler, 1955). Taken together, results indicate that factors regarding individual responses to sleep loss warrant further investigation at varying stages of the psychosis continuum.

In schizophrenia, up to 80% of patients experience disturbances in sleep which negatively impact functioning (Anderson and Bradley, 2013). This suggests that sleep dysfunction should be explored as a key facet of the illness (Pocivavsek and Rowland, 2018). In an investigation of sleep and life satisfaction, Ritsner et al. (2004) found that patients with insomnia reported lower scores on all domains of quality of life assessed, and these findings were independent of comorbid depression. Commonly endorsed complaints deal with increased sleep latency (time to fall asleep), both shorter and longer duration, and an inability to sleep at appropriate times as dictated by societal and environmental factors (Chiu et al., 2016; Pocivavsek and Rowland, 2018). Subjective poor sleep has also been reported to precede exacerbation of positive symptoms in patients (Monti and Monti 2004), and to be associated with current positive symptom endorsement (Korenic et al., 2020). Disruptions in circadian rhythms have been found to be independent of illness duration and are also observed prior to relapse of psychotic symptoms in patients who were previously in remission (Monti et al., 2013). Most notably, greater sleep disturbances have also been found to be associated with increased social dysfunction in a study of individuals diagnosed with psychotic disorders including schizophrenia, schizoaffective disorder, delusional disorder, and major depression with psychotic features (Blanchard et al., 2020).

Sleep has been demonstrated to be important for social and role functioning in non-clinical populations as well. Sleep disturbances have been studied within the context of occupational functioning, and higher degrees of sleep dysfunction have been associated with increased absences, workplace accidents, and decreases in career progression (Kucharczyk et al., 2012) in community samples. Research findings have also linked sleep quality to one's ability to both accurately interpret social cues and effectively navigate social situations (Lunsford-Avery et al., 2019). Poor sleep has been implicated in marital distress and relationship quality (Troxel et al., 2007), and converging evidence from neuroimaging studies supports a role of sleep in the maintenance of emotional homeostasis, with sleep loss giving rise to heightened reactivity to emotional stimuli and inappropriate processing of social information (Tempesta et al., 2018). Sleep loss has also been posited to instigate a self-reinforcing cycle of social withdrawal and separation in psychiatrically healthy individuals (Ben Simon and Walker, 2018), while better sleep quality has been associated with active socializing in college students (Carney et al., 2006). Notably, increased screen time and digital media use has also been linked to increased sleep disturbances (Dodwell and Clayton, 2019; LeBourgeois et al., 2017; Stiglic and Viner, 2019), low mood, and emotional problems (Woods and Scott, 2016). Taken together with a working bidirectional model of sleep and social processes (Gordon et al., 2017) in which sleep impacts social processes such as social cognition and interpersonal behavior while one's social environment is also thought to have positive or negative impacts on sleep, these findings suggest that sleep quality and social functioning may interact. Given that the adolescence/young adulthood is a time where social engagements hold increasing importance for physical health, mental health, and neuronal development (Blakemore and Mills, 2014), we believe examining relationships between social functioning, sleep, and PLEs in a large, socioeconomically diverse sample will add to extant literature in this area.

Relationships between social functioning, sleep quality, and psychotic-like experiences (PLEs) in college student populations are less understood. The current project aimed to investigate whether social functioning and sleep quality would act additively or interactively in predicting PLE endorsement in a large sample of socioeconomically diverse undergraduate students from the greater Philadelphia region. We predicted that both poorer social functioning and poor sleep would both be associated with increased self-report of PLEs, and that sleep quality would moderate the relationship between social functioning and PLEs. Specifically, we thought that the association between poorer social functioning and PLEs would be stronger among those with poorer sleep, as it is expected that poorer sleep would exacerbate social functioning difficulties.

## 2. Methods

### 2.1. Participant characteristics

Participants in the present study were a racially and socioeconomically diverse group of 3042 undergraduate-level college students between the ages of 18–35. See Table 1 for subject characteristics. Undergraduate students from different departments at a large urban semi-public university were recruited online through the Research Participant System (SONA). Individuals over the age of 35 were excluded so that the study sample would be limited to a period when subthreshold psychotic symptoms tend to emerge. Recruitment of females was occasionally paused in an effort to obtain a more even gender balance, as many SONA participants are female. Participants were compensated in the form of course credit. All procedures were performed in accordance with principles of the Declaration of Helsinki and were approved by the Institutional Review Board of Temple University. Informed consent was obtained before engagement in further research activities took place. Questionnaires were administered individually on laboratory desktop computers with research staff present so they could provide initial instructions and answer questions as needed.

### 2.2. Measures

Social functioning of participants was evaluated using a modified version of the **Social Functioning Scale** (SFS) (Birchwood et al., 1990). Originally designed to assess social functioning relevant to impairments and needs of schizophrenia patients, the SFS is useful for measuring functional impairment across the psychosis continuum (Hajdúk et al., 2019). The scale includes questions pertaining to seven domains: social withdrawal/social engagement, interpersonal communication,

**Table 1**
Participant demographics.

| Participant Demographics ($N$ = 3042) | |
|---|---|
| Age (years) M (SD) [range] | 20.20 (2.4) [18–35] |
| Gender % (n) Male | 25.4% (772) |
| Ethnicity % (n) Hispanic | 0.6% (182) |
| Race % (n) | |
| Asian | 14.8% (450) |
| African American | 15.7% (477) |
| Caucasian | 58.9% (1,791) |
| Multiracial | 4.8% (146) |
| Unknown | 5.1% (155) |

independence (performance), independence (competence), recreational activity engagement, prosocial behavior, and employment/occupational functioning. Since all participants were recruited using SONA, and were assumed to be students by virtue of this recruitment method, items in the occupation/employment domain were adjusted to reflect minimum status of part-time student with possible total scores ranging between 7 and 10 instead of 0–10. To address potential concerns associated with multicollinearity, responses to item 1 (dealing with sleep) were not included when calculating our modified SFS total score. Modified SFS total score was used as a predictor variable in the current study, and higher scores on this measure reflect better global social functioning.

All participants completed the **Pittsburgh Sleep Quality Index** (PSQI) (Buysse et al., 1989). This is a 19-item self-report questionnaire used to assess sleep quality over the preceding month. A composite score of sleep quality was generated for each participant, in addition to seven component scores: sleep duration, sleep disturbance, sleep latency, daytime dysfunction, sleep efficiency, subjective sleep quality, and sleep-aiding medication use. For the purpose of the current study, PSQI composite score was used as an additional predictor variable. Of note, higher PSQI composite scores denote worse subjective sleep quality, and scores of 5 or above reflect poor sleep quality (Buysse et al., 1989).

The positive symptom subscale (45 items) of the full-length **Prodromal Questionnaire** (PQ) (Loewy et al., 2005, 2007) was used to evaluate total number of PLEs participants endorsed within the past month while not under the influence of medications, drugs, or alcohol. The PQ has been shown to predict psychosis risk syndromes with 90% sensitivity and 49% specificity when validated against the Structured Interview for Psychosis-Risk Syndromes (SIPS) (Loewy et al., 2005, 2007). The total number of PLEs endorsed in the past month was utilized as the dependent variable for the current study.

### 2.3. Statistical analyses

Statistical analyses were conducted in R (R Core Team, 2019) using version February 1, 5033 of RStudio (RStudio Team, 2015). The tidyverse (Wickham et al., 2019), psych (Revelle, 2020), reghelper (Hughes, 2020), and apaTables (Stanley, 2018) packages facilitated analyses and presentation of results. Normality of the PLE variable was examined visually and statistically with inspection of skewness and kurtosis values. Pearson product-moment correlations were obtained to examine relationships between social functioning, subjective sleep quality, and PLE endorsement. Age and gender were investigated as potential covariates using Pearson product-moment correlations and independent sample T-Tests respectively.

Influences of social functioning, sleep quality, and their interaction on PLE endorsement were examined using hierarchical multiple regression. In the first step of the model, only gender was included so the amount of variance explained solely by social functioning and sleep quality could be isolated. Second, main effects of social functioning and sleep quality were examined with gender treated as a covariate. Third, the interaction between social functioning and sleep quality was examined. All variables were centered for the analysis, and the interaction term (social functioning x sleep quality) was computed as the product of centered variables. Tests were deemed significant if $p < 0.05$, two-tailed.

Given the gender differences in PLEs and many other risk factors for psychosis, we also performed exploratory post-hoc analyses in which we probed for gender-based differences pertinent to the main study question. A model with main effects of gender, sleep problems, and social functioning, the three two-way interactions, and the three-way interaction between variables in predicting PLE endorsements was estimated.

## 3. Results

In the present sample, participants reported high levels of social functioning on average ($M = 142.18$, $SD = 21.31$) as indexed by a modified SFS total. Participants reported poor sleep quality on average ($M = 7.41$, $SD = 2.86$) as indexed by the PSQI, with only 15.4% of participants (469/3042) reporting good sleep based on PSQI scoring conventions. Participants in our sample had experienced an average of 9.29 ($SD = 7.34$) PLEs over the past month as evaluated with the PQ. Bivariate correlations revealed significant associations between social functioning, sleep quality, and PLEs. As expected, poor social functioning ($r = -0.097$, $p < 0.001$) and poor sleep ($r = 0.261$, $p < 0.001$) were both associated with increased endorsement of PLEs in the past month. Contrary to expectation, poor sleep quality was associated with better social functioning ($r = 0.054$, $p = 0.003$) in this sample. All correlation strengths were small. Skewness and kurtosis for the dependent variable (PLEs) were within normal limits.

There were significant gender differences in PLE endorsement [$t(3020) = 4.16$, $p = 0.008$] such that females reported fewer PLEs ($M = 8.97$, $SD = 7.21$) than males ($M = 10.23$, $SD = 7.64$). Age was not correlated with PLE endorsement ($r = -0.031$, $p = 0.088$). As such, we included gender as a covariate in subsequent analyses.

The first step of the hierarchical regression model (Table 2) included gender so that the amount of variance explained solely by social functioning and sleep quality could be isolated in the next step by examining change in $R^2$. Based on this step, 0.05% of variance in population-level PLE endorsement could be accounted for by gender.

Results from the second step of the model (Table 2) revealed that both poorer social functioning and poorer sleep, controlling for gender, were significantly associated with higher PLE endorsement. Based on this additive model, 8.03% of variance in population-level PLE endorsement could be accounted for by considering social functioning and sleep quality, controlling for gender. Cohen's $f^2$ statistic was calculated to describe the magnitude of this effect, which is small ($f^2 = 0.09$).

In the third step of the model (Table 2), an interaction term between social functioning and sleep quality was added. The interaction between social functioning and sleep quality was not significantly associated with PLEs.

To further probe gender-based differences in the major study question, we performed additional exploratory analyses. We estimated a model with main effects of gender, sleep quality, and social functioning, the three two-way interactions, and the three-way interaction between variables in predicting PLE endorsements. This analysis indicated that there was not a significant three-way interaction, suggesting that the interaction between sleep and social functioning on PLEs did not differ by gender ($B = -0.004$, $SE = 0.005$, $p = 0.372$). The model was then re-estimated without the three-way interaction. In this second model, the gender by social functioning interaction was significant ($p = 0.042$), suggesting that associations differed by gender. Simple slopes (Aiken and West, 1991) of gender on psychotic-like experience endorsement were estimated at low (−1 SD below the mean), moderate (at the mean), and high (1 SD above the mean) levels of social functioning. At low levels of social functioning, gender was not significantly associated with

**Table 2**
Hierarchical linear regression models predicting PLE endorsement. ($N = 3042$).

| | *B* | *SE* | *β* | *t* | *p* |
|---|---|---|---|---|---|
| **Step 1:** Covariate | | | | | |
| Gender | −1.265 | 0.304 | −0.075 | −4.156 | <0.001 |
| **Step 2:** Additive Effect | | | | | |
| SFS | −0.035 | 0.006 | −0.103 | 73.026 | <0.001 |
| PSQI | 0.695 | 0.045 | 0.271 | −5.877 | <0.001 |
| Gender | −1.287 | 0.294 | −0.076 | 15.577 | <0.001 |
| **Step 3:** Examining SFS X PSQI (Moderation Effect) | | | | | |
| SFS | −0.035 | 0.006 | −0.086 | −5.78 | <0.001 |
| PSQI | 0.696 | 0.045 | 0.313 | 15.576 | <0.001 |
| Gender | −1.291 | 0.295 | −0.077 | −4.383 | <0.001 |
| SFS X PSQI | −0.001 | 0.002 | −0.046 | −0.386 | 0.713 |

PLE endorsement ($B = -0.530$, $SE = 0.399$, $t = -1.328$, $p = 0.184$). At moderate levels of social functioning, compared to males, female gender was associated with lower PLE endorsement ($B = -1.164$, SE = 0.308, $t = -3.783$, $p < 0.001$). At high levels of social functioning, compared to males, female gender was also significantly associated with lower PLE endorsement ($B = -1.797$, $SE = 0.452$, $t = -3.980$, $p < 0.001$). Other interactions (gender X sleep and sleep X social functioning) were not statistically significant ($p$'s $< 0.05$).

## 4. Discussion

To our knowledge, this is the first study to evaluate utility of examining social functioning and sleep within the same model as predictors for PLE endorsement in undergraduate students, in addition to examining their interaction. Taken together, findings suggest that poor social functioning and poor sleep may act additively to influence PLEs and are thus both important predictors of subclinical psychotic symptoms. This work extends previous literature by examining factors contributing to subsequent PLE endorsement in a large sample of over 3000 young adults. Notably, our results indicate that 8% of population-level PLE endorsement in college students is accounted for by social functioning and sleep. Associations between these variables may be even greater for help-seeking populations, and for those with frank psychosis.

In our sample, social functioning scores ($M = 142.18$, $SD = 21.31$) fell between ranges reported for psychiatrically healthy control subjects and individuals at clinical high risk for developing psychosis by Addington et al. (2008). Aside from the occupation/education domain, ceiling effects were not detected in subscales. The association of lower social functioning with increased PLE endorsement aligns well with extant results of studies in high-risk groups. Deficits in social functioning are among the most robust behavioral correlates of genetic-based schizophrenia risk, with observable deficits beginning during childhood (Cannon et al., 2008). Findings from the North American Prodrome Longitudinal Study (NAPLS), in which 291 treatment-seeking individuals at-risk for psychosis were assessed at baseline and 2.5 years later across 8 sites, indicated that poorer social functioning and more severe positive symptom expression (particularly unusual thought content and suspiciousness) were associated with being closer to conversion to a psychotic disorder (Cannon et al., 2008). In a prospective study of the same cohort, subjects who converted were significantly more likely to have had social impairments than age-matched high-risk comparison subjects who did not convert, even after controlling for neurocognition (Cornblatt et al., 2012). In another prospective study of the same cohort, periods of early and later dynamic changes in social and role functioning could be detected between converters and non-converters (Velthorst et al., 2018). Between the ages of 15–18, social functioning of those who converted to psychotic disorders stagnated and diverged from that of subjects who did not convert, and between the ages of 21–23 the social growth seen in those who did not convert was not detected in the converter group (Velthorst et al., 2018). Though we recruited undergraduate students for the current study, their age range (18–35) aligned with the timeframe during which conversion to psychosis typically occurs.

The significant association between poor sleep and increased PLE endorsement also aligns well with previous findings in studies of students (Barton et al., 2018; Ered et al., 2018), and helps to expand this newer area of research inquiry. In a recent study of college students, fragmented sleep, sleep hallucinations, and night anxiety were associated with subsequent PLE endorsement, and insomnias and parasomnias were associated with both the experience of PLEs in addition to average distress attributed to these experiences (Andorko et al., 2017).

Contrary to expectation, an interaction between social functioning and sleep was not detected. This suggests that the association between overall social functioning and PLEs is uniform across overall levels of sleep disruption. In the current study, we assessed generalized social functioning and sleep using self-report questionnaires with limited target timeframes. It may be necessary to examine finer distinctions of social functioning and/or sleep disruptions over a longer period of time to identify the relevant constellation of factors that would reveal an interaction effect. In future work, it could be informative to focus on gaining a better understanding of basic social network structure and fluctuations in social network engagement over time using measures such as the Lubben Social Network Scale (Lubben et al., 2006) and by applying principles of social network analysis in conjunction with collecting sleep and PLE endorsement data using methods such as EMA and passive phenotyping as participants go about daily activities. Using such designs, we predict that interactions between social functioning and sleep will be detectable, and that it will also be possible to parse apart temporal relationships between fluctuations in social functioning, sleep, and PLE endorsements.

The nature of our sample may have contributed to the unexpected finding of poor sleep quality being associated with better social functioning in these participants. College students have notoriously poor sleep quality, as supported by a study in which over 60% of students were categorized as being poor sleepers based on PSQI ratings (Lund et al., 2010). In this study, poor sleepers endorsed significantly more problems with physical and psychological health, and multiple regression results indicated that 24% of the variance in PSQI scores could be accounted for by tension and stress relating to emotional and academic experiences (Lund et al., 2010). Notably, 84.6% of participants in our study were categorized as being poor sleepers. This percentage is higher than in other reports of sleep quality in college students (Lund et al., 2010). While it is unclear what accounts for these differences, the use of screen time has been increasing steadily since the Lund et al. (2010) paper was published, and increased screen time has clear associations with disruptions in sleep (Dodwell and Clayton, 2019; Stiglic and Viner, 2019). We did not examine how individuals were socializing with friends, so it is possible that many of these relationships could have been at least in part, maintained over social media, thus potentially further increasing time students spent in front of screens and mobile devices. It also is important to note that 49% of students in this sample had either part-time or full-time jobs while attending school, reflecting the larger variability in socioeconomic statuses at this university compared to many others, which could contribute to higher sleep difficulties but also increases the generalizability of this sample. Using experience sampling techniques, collecting data on value-based decision making (i.e., whether a person values sleep, social connections, work, or schoolwork more) and daily activity engagement may be informative.

Furthermore, the current study did not assess chronotypes or circadian rhythms, only generalized sleep quality. Recent work suggests that circadian disturbances may be predictive of future severity of psychosis symptoms in individuals at risk for developing bipolar disorder and psychosis (Castro et al., 2015; Lunsford-Avery et al., 2019), but this line of inquiry has not yet been extended to PLEs. In a recent study of socioemotional cognition and social functioning in young adults, eveningness diurnal preference was associated with poorer interpersonal outcomes and performance on the Managing Emotions subtest of the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) (Lunsford-Avery et al., 2019). We also did not examine sleep staging. It has been posited that rapid-eye movement (REM) sleep both governs long-term consolidation of emotional episodic memory and plays a key role in homeostasis of affective brain functionality (Goldstein and Walker, 2014). Alterations in REM sleep have been reported in disorders with affective components such as exaggerated REM sleep qualities in depression (Goldstein and Walker, 2014). Increases in REM sleep latency and duration have also been reported in schizophrenia (Pocivavsek and Rowland, 2018). Further work is warranted to determine whether REM sleep alterations are also present in non-help seeking individuals reporting PLEs, which would provide additional evidence for a common mechanism existing across the psychosis continuum.

Despite the fact that the magnitude of associations identified in the current study were small as evinced by correlation coefficients and the Cohen's $f^2$ statistic for the main study model, it is common to find

smaller associations in non-clinical samples, which will still have important ramifications for understanding the etiology of psychosis. Nevertheless, future studies would benefit from examining how social functioning and sleep disruptions interact and/or additively influence other predictors of PLEs, such as childhood trauma, stress, and substance use, all of which also have been associated with sleep disruptions and changes in social functioning.

Considering the deleterious effects of poor sleep on physical and emotional health, our findings provide impetus to further investigate relationships between sleep quality, social functioning, and PLEs. To address various limitations outlined above, future work will incorporate methods which afford higher-resolution data collection, such as actigraphy, mobile sensing, ecological momentary assessment, and neuroimaging. By examining temporal relationships between different domains of social functioning, sleep, and PLE fluctuations in daily life, we may be able to elucidate mechanisms driving relationships between these factors. Furthermore, continuation of this line of research inquiry may help to identify intervention targets for clinically relevant symptomatology across the psychosis continuum.

## Author contributions statement

SAK: Conceptualization, Methodology, Data Curation; Formal Analysis, Writing – Original Draft; AE: Formal Analysis, Writing – Review & Editing; KMP: Formal Analysis, Writing – Review & Editing; EMC: Project Administration, Data Curation, Writing – Review & Editing; TMO: Supervision, Writing – Review & Editing; VPM: Supervision, Writing – Review & Editing; LME: Conceptualization, Methodology, Supervision, Writing – Review & Editing.

## Declaration of competing interest

The authors have no competing interests to declare. This work was supported by a National Science Foundation Graduate Research Fellowship Program award (SAK: 2038235) and by grants/awards from the National Institute of Mental Health (LME: R01MH112613, R01MH120091, R01MH118545; VPM: K01MH111991; AE: F31MH119720).

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