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Socioemotional mechanisms of loneliness in subclinical psychosis

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Abstract

Loneliness is an important predictor of physical and mental health in the general population and in individuals across the psychosis spectrum, including those experiencing subclinical psychotic-like experiences (PLEs). However, the mechanisms underlying loneliness in the psychosis spectrum are not well understood. Emotion processing deficits are well described across the psychosis spectrum, and socioemotional processing biases are critical for the development and maintenance of loneliness through altered social appraisal, including judgements of rejection. Therefore, we propose that PLEs are associated with increased loneliness, and the relationship is mediated by alterations in socioemotional processing. We also explored how this pathway may be affected by mood and anxiety symptoms, which have been associated with loneliness across the psychosis spectrum. As part of the Human Connectome Project, generally healthy adults (n = 1180) reported symptomatology and social functioning and completed the Penn Emotion Recognition Task to assess efficiency in identifying emotions. We found that higher reported PLEs were associated with elevated levels of loneliness and perceived rejection and that these factors were linked by multiple independent pathways. First, anxiety/depression and emotion processing efficiency independently mediated the PLE-loneliness relationship. Second, we found that the association between PLEs and loneliness was serially mediated through inefficient emotion recognition then higher levels of perceived rejection. These separable mechanisms of increased loneliness in subclinical psychosis have implications for treatment and continued study of social functioning in the psychosis spectrum.

Keywords

Emotion recognition; Social rejection; Anxiety; Depression

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Declaration of competing interest

Authors have no conflicts of interest to report.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.schres.2021.10.002.

1. Introduction

Social functioning deficits are a core feature of psychotic spectrum disorders (PSD) such as schizophrenia: patients maintain fewer close relationships and have less social contact relative to healthy peers (Burns and Patrick, 2007; Mueser and Tarrier, 1998). Such deficits are evident in the clinical high risk (CHR) stage (Addington et al., 2008; Niendam et al., 2007) and in individuals experiencing psychotic-like experiences (PLEs), such as perceptual abnormalities and unusual beliefs (Pelletier et al., 2013; Rossler et al., 2007). However, most studies of social functioning in PSD focus on *objective* social functioning (e.g., number of contacts, participation in group activities; (Burns and Patrick, 2007; Cotter et al., 2014) rather than *subjective* social functioning (i.e., an individual's report of social effectiveness and support). While objective social factors relate to subjective appraisal (Lim et al., 2018), the two are dissociable among individuals with PSD (Hansson et al., 2002; Sundermann et al., 2014). The focus on objective social functioning may stem from the belief that negative symptoms of psychosis impair desire for social connection (Kwapil, 1998), yet PSD patients report interest in social connection (Blanchard et al., 2015; Gard et al., 2014) and cite social belonging as a treatment goal (Shumway et al., 2003).

An important marker of subjective social functioning is loneliness, the feeling that actual social relationships do not satisfy social desires (Lim et al., 2018; Perlman and Peplau, 1981). Loneliness is elevated in first-episode psychosis patients (Sundermann et al., 2014), CHR individuals (Robustelli et al., 2017; Sundermann et al., 2014), and individuals reporting subclinical PLEs (Jaya et al., 2016; Narita et al., 2020) relative to controls. This is clinically relevant due to the deleterious effects of loneliness on physical and mental health among individuals across the psychosis spectrum (Badcock et al., 2020), including negative effects on internalizing symptoms (Cacioppo et al., 2006; Muyan et al., 2016), cardiovascular health (Badcock et al., 2019; Tremeau et al., 2016), cognition (Hawkley and Cacioppo, 2010), mortality (Holt-Lunstad et al., 2015), clinical and subclinical positive symptoms (Lim et al., 2018; Narita et al., 2020), substance use (Tremeau et al., 2016), and well-being (Shioda et al., 2016). Given the detrimental effects of loneliness on psychosocial and physical health, mechanisms linking psychosis and loneliness identified in subclinical psychosis are important targets for improving outcomes.

In schizophrenia, self-reported social cognitive difficulties are associated with loneliness (Tremeau et al., 2016), but there is a lack of research on mechanisms linking social cognition with loneliness (Lim et al., 2018). Theoretical models of loneliness (Cacioppo and Hawkley, 2009; Cacioppo et al., 2016) offer a mechanism by which social cognitive – specifically emotion processing – biases may contribute to and perpetuate loneliness. Lonely individuals show biases in processing threatening and pleasurable social stimuli (Cacioppo et al., 2014a; Cacioppo and Hawkley, 2009). These biases then contribute to more negative social expectations and appraisals, increasing loneliness (Cacioppo and Hawkley, 2009; Cacioppo et al., 2014b). Similar processing biases to social threat and reward are seen in PSD (Fett et al., 2019; Green and Phillips, 2004; Mow et al., 2020). Patients with schizophrenia display altered neural (Lindner et al., 2014; Taylor et al., 2012) and behavioral responses (Ruocco et al., 2014) to social threat (disgusted, angry, and fearful facial expressions) and social reward cues (happy faces; Lee et al., 2019) relative to controls.

These impairments may contribute to social deficits seen in patients with PSD, including less anticipated pleasure from social interactions (Campellone and Kring, 2018), more negative judgements about them (Beck et al., 2013; Grant and Beck, 2009), and less social motivation (Fulford et al., 2018). Negative social appraisals have also been linked to greater loneliness in PSD (Tharayil, 2007). However, no study to date has investigated these deficits as mechanisms linking subclinical psychosis with negative social appraisals and loneliness.

Broad emotion processing deficits are seen in PSD (Ruocco et al., 2014) and subclinical samples (Statucka and Walder, 2017), but only one study has investigated emotion processing and loneliness in schizophrenia, finding no correlation (Ludwig et al., 2020). A possible limitation here is the focus on emotion processing accuracy, despite deficits in response latency seen in PSD samples (Barkhof et al., 2015). In CHR individuals, emotion processing speed has been associated with functional outcomes (Glenthoj et al., 2019) and conversion to psychosis (Corcoran et al., 2015). Because social interactions rely on successful *and* rapid information processing (Aviezer et al., 2008; Green et al., 2015), efficiency of socioemotional processing is critical. Combining accuracy and latency on emotion processing tasks, including the Penn Emotion Recognition (ER-40) task used here, distinguishes youth who endorse PLEs from those who do not (Gur et al., 2014). Inefficient social processing (i.e., eye gaze) has been associated with loneliness in a non- clinical sample (Kanai et al., 2012), but this is the first study to evaluate the contributing role of socioemotional efficiency to loneliness in the psychosis spectrum.

Degree of loneliness is positively associated with PLE severity, (Jaya et al., 2016; Narita et al., 2020). However, loneliness is also predicted by social anxiety (Lim et al., 2016), and the PLE-loneliness association is longitudinally mediated by depression (Jaya et al., 2016). Anxiety and depression are also well supported predictors of loneliness in patient populations (Lim et al., 2018). Further, emotion processing deficits have been described in both anxiety (Demenescu et al., 2010) and depression (Dalili et al., 2015). Taken together, these findings indicate the importance of directly investigating the role of anxiety and depression in the relationship between loneliness and PLEs. For example, internalizing symptoms and emotion processing deficits may independently affect social functioning outcomes like loneliness. Alternatively, emotion processing may be a common pathway through which PLEs and internalizing symptoms contribute to loneliness. This study seeks to elucidate how the interplay of psychosis, anxiety, and depression impact socioemotional processing and social functioning.

Here, we evaluate emotion processing efficiency as a mediator in the relationship between subclinical psychosis and loneliness while building upon previous support for the role of internalizing symptoms, which may be associated with loneliness independently or through emotion processing. Finally, given the role of social appraisal in the relationship between emotion and social functioning (Cacioppo and Hawkley, 2009; Fulford et al., 2018; Granholm et al., 2013), we propose that emotion processing deficits contribute to greater loneliness via greater perceived rejection in a subclinical sample.

Hypotheses

1. Both emotion processing efficiency and anxiety/depression symptoms will mediate the relationship between PLEs and loneliness (Fig. 1).
2. The effect of anxiety/depression on loneliness will be mediated by emotion processing efficiency.
3. There will be serial mediation such that the effect of PLE on loneliness will operate sequentially through emotion processing efficiency and perceived social rejection.

In secondary analyses, we test how individual emotion conditions contribute to the relationships found in these models. Previous work suggests processing threatening and positive faces may be most relevant for loneliness. However, given findings of general emotion processing deficits in PSD, all emotion conditions will be evaluated.

2. Methods

2.1. Subjects

Data from 1206 generally healthy community-recruited subjects were made available as part of the Human Connectome Project (HCP). Twenty-six subjects were excluded for incomplete symptom ($n = 8$), social functioning ($n = 1$), ER-40 ($n = 3$), or processing speed ($n = 4$) data; blood-alcohol content above 0.05% (n = 3); or ER-40 data below quality thresholds, described below ($n = 7$). No differences were found in demographic or clinical data between the analyzed sample ($n = 1180$) and the full sample with clinical data ($n = 1198$, Table 1).

2.2. Surveys

Symptomatology was assessed using the Achenbach Adult Self- Report (ASR, Rescorla and Achenbach, 2004), which includes an 18- item Anxious/Depressed Syndrome scale. Anxiety and depression strongly covary in nationally representative community samples (Achenbach et al., 2005), so this internalizing problems scale was selected to represent such covariation. ASR items are scored 0 for “Not True” to 2 for “Very True or Often True.” To reduce construct overlap with the social functioning scales described below, three interpersonal problem items (“I feel lonely,” “I feel that no one loves me,” and “I worry about my relations with the opposite sex”) were removed and the remaining 15 items summed to produce an anxiety/depression score.

PLEs were assessed with a previously used (Barber et al., 2018; Sheffield et al., 2016) four-item summed score from the ASR Thought Problems Syndrome scale (“I see things that others don’t,” “I hear things that others don’t,” “I do things other people think are strange,” and “I have thoughts other people would think are strange”).

Loneliness and Perceived Rejection were surveyed using the NIH Toolbox (http://www.nihtoolbox.org). Raw scores from these measures were converted into T scores prior to analysis.

2.3. Behavioral tasks

Emotion processing was evaluated using the Penn Emotion Recognition task (ER-40, Gur et al., 2002). Participants were shown photographs of faces representing five emotions: happiness, sadness, anger, fear, and neutral. Participants were asked to identify the emotion from a list of the five states as quickly as possible. 40 trials were presented (8 per condition). Prior to calculating efficiency, trial reaction times exceeding three standard deviations above the reaction time mean (M =2320.23 ms, SD = 1619.40) were flagged, as were reaction times 100 ms or faster, as responses of that speed are likely characteristic of impulsive or unconscientious responding. Participants with more than 25% of trials (10 of 40) flagged were removed from analyses (n = 7). Inverse efficiency scores (IES) were calculated, such that higher scores indicate lower efficiency (Bruyer and Brysbaert, 2011):

$$\text{IES} = \frac{RT_C}{1 - PE},$$

where RT_C is median reaction time for correct trials and PE proportion of errors. IES thus estimates the speed at which emotions are identified correctly, adjusted for incorrect responses. Other measures of efficiency have been used in the literature; for example, some studies calculate the approximate reciprocal (accuracy divided by reaction time) or make additional adjustments for task parameters (see Vandierendonck, 2018).

To assess behavioral confounds, analyses were re-run excluding individuals who performed poorly (< 75% accuracy, n = 37), but inferences were unchanged (see Appendix A). Given racial and ethnic group differences on facial emotion processing tasks (Brekke et al., 2005), group differences were evaluated, and analyses were re-run with race and ethnicity as covariates (see Appendix A).

General cognitive deficits have been well described in psychosis spectrum populations (Barch and Sheffield, 2014). Individual differences in attention, processing speed, and psychomotor ability may contribute to ER-40 efficiency and underlie its associations with other variables, including PLEs (Tsotsi et al., 2015). To better isolate emotion processing from general cognitive effects, we included a measure of non- emotional processing speed: median response time for true positive responses on the Short Continuous Performance Test (SCPT Kurtz et al., 2001). SCPT latency served as a covariate in all analyses.

2.4. Analysis

Path and mediation analyses were estimated using PROCESS version 3.4 for SPSS version 26 (Hayes, 2017). Standardized beta values and confidence intervals were estimated over 5000 bootstrapped iterations. Three analyses were performed to address corresponding hypotheses underlying our model of loneliness in subclinical psychosis (Fig. 1). To evaluate the role of anxiety/depression and ER-40 efficiency in mediating the relationship between PLEs and loneliness (Analysis 1), a parallel mediation model with anxiety/depression and ER-40 efficiency as mediators was run with age, sex, and processing speed as covariates. Then, to determine whether the relationship between anxiety/depression and loneliness was also mediated by ER-40 efficiency (Analysis 2), two models were estimated: a simple

mediation (ER-40 efficiency mediates the effect of anxiety/depression on loneliness, with PLEs as a covariate) and a serial mediation model (the effect of PLEs on loneliness is mediated through anxiety/depression and *then* ER-40 efficiency). Finally, the effect of negative social judgement was assessed using a serial mediation model with the association between PLEs and loneliness mediated through ER-40 efficiency then through perceived rejection (Analysis 3). Significant mediation effects through ER-40 efficiency were explored by evaluating individual emotion conditions (Secondary Analyses). To control for Type I error, follow-up effects were compared against a Bonferroni-corrected α-level of 0.05/5 = 0.01.

For estimated effects in a mediation analysis to be considered causal, a primary assumption is that there are no unmeasured confounders. This assumption cannot be guaranteed in cross-sectional data like these. Therefore, sensitivity analyses were performed using the R *mediation* package to estimate the size of a hypothetical confounding effect, as measured by a correlation coefficient, needed to eliminate the indirect effect (Tingley et al., 2014; VanderWeele and Chiba, 2014). A larger coefficient suggests a larger confounding relationship would be required to eliminate the indirect effect, supporting a relatively robust effect.

3. Results

3.1. Analysis 1: role of anxiety/depression and ER-40 efficiency

We first evaluated the degree to which anxiety/depression and ER-40 efficiency mediated the effect of PLEs on loneliness. Anxiety/depression scores and ER-40 efficiency were entered simultaneously into the model predicting loneliness from PLEs, with gender, age, and processing speed as covariates. PLEs significantly predicted loneliness ($\beta = 0.226$, $p < .001$), anxiety/depression ($\beta = 0.324$, $p < .001$), and ER-40 efficiency ($\beta = 0.101$, $p < .001$) controlling for covariates. With anxiety/depression and ER-40 efficiency as parallel mediators (Fig. 2), the direct effect of PLEs on loneliness was not significant ($\beta = 0.051$, $p = .052$). Significant indirect effects were present for anxiety/depression and ER-40 efficiency ($\beta_{Anxiety/Depression} = 0.169$ bootstrapped 95% confidence interval = [0.128, 0.211]; $\beta_{ER\text{-}40} = 0.006$, $CI_{95\%} = [0.001, 0.014]$). Sensitivity analyses estimated that the indirect effects of anxiety/depression and ER-40 efficiency would be reduced to zero at $\rho = 0.50$ and ρs between 0.05 and 0.10, respectively, suggesting that a confounder with a medium-sized effect on the relationship between anxiety/depression and loneliness would be needed to eliminate that indirect effect, but a relatively small confounding effect could eliminate the indirect effect through ER-40 efficiency.

3.2. Analysis 2: ER-40 efficiency as a transdiagnostic mediator

To examine if the data support a model where ER-40 efficiency mediates the relationship between anxiety/depression and loneliness, two models were evaluated: a simple mediation model in which ER-40 efficiency mediated the relationship between anxiety/depression scores and loneliness and a serial mediation model in which the indirect effect of PLEs on loneliness was mediated sequentially by anxiety/ depression and ER-40 efficiency. Age, gender, and processing speed were included as covariates in both models, with PLEs as a

covariate in the simple mediation model. Neither indirect effect was significant ($\beta simple$ = −0.004, CI95% = [−0.009, 0.0001]; $\beta serial$ = −0.001, CI95% = [−0.003, 0.0001]). Across Analyses 1 and 2, a significant indirect effect through ER-40 efficiency was only observed when considered as a mediator of the relationship between PLEs and loneliness, independent from anxiety/depression (Table 2).

3.3. Analysis 3: serial mediation: role of perceived rejection

We next tested the hypothesis that altered emotion processing contributes to higher loneliness via negative social judgements. Perceived rejection was significantly associated with PLEs controlling for age, gender, processing speed, and anxiety/depression (β = 0.124, p < .001). A serial mediation model in which the effect of PLEs on loneliness is mediated through ER-40 efficiency and then through perceived rejection was estimated. The direct effect of PLEs on loneliness was not significant (β = −0.005, p = .832). The serial indirect effect was significant (β = 0.005, $CI_{95\%}$ = [0.001, 0.010]). The indirect effect through ER-40 efficiency alone was not significant (β = 0.003, $CI_{95\%}$ = [−0.002, 0.009]), but the indirect effect through perceived rejection alone was significant (β = 0.056, $CI_{95\%}$ = [0.024, 0.088], Fig. 3). A sensitivity analysis estimated that the indirect effect through perceived rejection would be reduced to zero at ρs between 0.50 and 0.55.

3.4. Secondary analyses: role of individual emotions

We performed follow-up analyses to evaluate whether the effect of overall ER-40 performance is driven by specific emotions (happy, sad, fearful, angry, neutral), at α = 0.01. PLEs only significantly predicted inefficiency of processing happy faces (β = 0.121, p < .001) controlling for age, gender, and processing speed (all other emotions, ps > 0.01). When entered as a simultaneous mediator with anxiety/depression, the indirect effect of PLEs on loneliness through efficiency for happy faces was not significant (β = 0.007, $CI_{99\%}$ = [−0.001, 0.019]). However, the serial indirect effect of PLEs on loneliness through efficiency for happy faces and then perceived rejection was significant (β = 0.006, $CI_{99\%}$ = [0.001, 0.015]). The indirect effect of PLEs on loneliness through efficiency for happy faces alone was not significant (β = 0.002, $CI_{99\%}$ = [−0.008, 0.012]), but the indirect effect through perceived rejection was significant (β = 0.054, $CI_{99\%}$ = [0.014, 0.100]). PLEs were specifically associated with poorer efficiency in processing happy faces, and these differences mediated the relationship between PLEs and loneliness through elevated perceived social rejection. However, this serial indirect effect was no longer significant when controlling for race and ethnicity (other inferences unchanged; Appendix A).

4. Discussion

Using a large community sample, we reproduced findings that subclinical PLEs were associated with poorer subjective social functioning, including higher loneliness (Lim et al., 2018). Additionally, our findings support the importance of anxiety and depression symptoms in explaining the link between PLEs and loneliness (Jaya et al., 2016; Lim et al., 2016). Guided by theoretical models of loneliness (Cacioppo and Hawkley, 2009; Lim et al., 2018) and research on objective social functioning in patient populations (Hooker and Park, 2002; Penn et al., 2001; Tremeau et al., 2016), we sought to determine

whether this relationship could be further explained through emotion processing, a validated social cognitive impairment in patient populations (Pinkham et al., 2018) that has been associated with subclinical psychotic symptoms (Germine and Hooker, 2011; Statucka and Walder, 2017). We found, in addition to the mediating pathway of anxiety and depression, an independent emotion processing pathway explaining part of the relationship between PLEs and loneliness, with higher PLEs associated with lower efficiency of recognizing emotion states and, subsequently, higher loneliness. This pathway is further mediated by higher perceived rejection, consistent with models of loneliness in the general population (Cacioppo and Hawkley, 2009) that posit emotion processing biases lead to negative social appraisals and then to increased loneliness. Further, we included a non-emotional computerized task (SCPT) as a covariate in order to emphasize the specific role of emotion processing, separate from general cognitive impairments seen in the psychosis spectrum. Emotion processing deficits in PSD impair a variety of abilities involved in successful social interactions and maintenance of social connections (Green et al., 2015) that may also explain the relationship with loneliness. Tasks that evaluate an individual's appraisals of themselves and others after social interactions (Smith et al., 2018) may help tease this apart.

Our finding that inefficient processing of happy faces drives the socioemotional pathway to loneliness should be interpreted with caution given the small number of trials and the effect of race and ethnicity on performance (Appendix A). However, this mechanism deserves further study, considering impairments among individuals with PSD in processing social rewards (Catalano et al., 2018; Gromann et al., 2013) and anticipating pleasure from social interactions and smiling faces (Blanchard et al., 1998; Campellone and Kring, 2018; Gard et al., 2007). Although individuals with depression and anxiety have shown impaired detection of happy faces (Bourke et al., 2010; Demenescu et al., 2010), the mechanism described here may be independent from internalizing symptoms.

There are certain limitations to this investigation. With cross- sectional data like these, mediation analyses may result in biased estimates (Maxwell and Cole, 2007), thus causal inferences cannot be made. The sensitivity analyses provide information about how robust results are to omitted confounders, but do not provide information about correct temporal ordering of variables or omitted mediators. However, utilizing an open dataset, we have described behavioral and symptom- tied mechanisms of emotion processing and loneliness that may guide longitudinal study to determine directionality and intervention points.

While the full ASR is highly validated, the subset of questions used to assess PLEs is relatively limited. Despite this, we found hypothesized associations between PLEs and anxiety/depression (van Os and Reininghaus, 2016; Yung et al., 2006), social functioning (Lim et al., 2016; Pelletier et al., 2013), and emotion processing (Germine and Hooker, 2011; Statucka and Walder, 2017). These findings indicate that the low levels of PLEs indexed here scale with behavioral and functional outcomes. This PLE measure has shown other expected associations, such as with education level (Sheffield et al., 2016), executive functioning, and income (Barber et al., 2018). In the Adolescent Brain Cognitive Development study, this four-item sum was significantly associated with other measures of PLEs (Karcher et al., 2018). While our findings and previous work lend support for this measure as a brief assessment of psychotic experiences, a thorough validation is warranted

given the continued use of the HCP data to investigate subclinical samples. Additionally, low- level experiences measured here differ markedly from clinical hallucinations and delusions and do not include negative symptoms seen in patient populations. While endorsement of these items may slightly increase psychosis risk (Nelson et al., 2012), this model may not generalize to high-risk and clinical populations.

In sum, this work supports the idea that socioemotional impairments contribute to the development of poor social functioning in subclinical psychosis (Fett et al., 2011; Hooker and Park, 2002; Modinos et al., 2020). The relationship between PLEs and ER-40 efficiency may be implicated in the emergence of negative symptoms (Pelletier-Baldelli and Holt, 2020), including social anhedonia, as deficits in processing positive social cues (happy faces) may lead to negative social judgements (Campellone and Kring, 2018), perceived rejection, loneliness, and reduced interest and motivation (Fulford et al., 2018).

Further work that broadens our understanding of the directionality of these relationships and downstream effects on symptomatology and functioning is crucial for improving well-being among individuals across the psychosis spectrum (Lim et al., 2018). We describe multiple independent pathways between PLEs and loneliness, which have important implications for remediation of loneliness in the psychosis spectrum, as social cognitive training has been shown to be effective in PSD (Kurtz and Richardson, 2012; Roberts and Penn, 2009). Loneliness has also been suggested as both a contributing (Michalska da Rocha et al., 2018; Narita et al., 2020) and a maintaining factor for psychosis (Gayer-Anderson and Morgan, 2013). This may indicate a cycle in which psychotic experiences are associated with higher loneliness via socioemotional biases, and high loneliness, in turn, increases psychosis risk. Future work and intervention in this cycle may help mitigate psychosis risk. This work and its potential implications highlight the importance of measurement and study of subjective, in addition to objective, social functioning across the psychosis spectrum.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Biography

Logan D. Leathem is a Clinical Psychology Ph.D. student at the University of California, Los Angeles. He received bachelor's degrees in Psychology and Biology from the University of Kentucky in 2016 and a master's degree in Psychology from UCLA in 2019. His research is focused on social functioning and neurodevelopment across the psychosis spectrum.

Danielle L. Currin is a Clinical Psychology Ph.D. student at UCLA. She received a bachelor's degree in Psychology with a focus in Neuroscience from Yale University in 2016, and a master's degree in Psychology from UCLA in 2019. Her research focuses on the interactions of hot and cold cognition deficits in predicting behavioral outcomes in adolescents and early adults across the psychosis spectrum.

Amanda K. Montoya is an Assistant Professor of Psychology at UCLA in the Quantitative area, arriving in 2018. She received her Ph.D. in 2018 from The Ohio State University, master's in Statistics and master's in Psychology in 2016 from The Ohio State University, and Bachelor of Science in Psychology from the University of Washington in 2013. Her research interests include mediation, moderation, conditional process models, structural equation modeling, and meta-science. She focuses on developing models and tools to improve statistical practices across areas of psychology and other social and behavioral sciences.

Katherine H. Karlsgodt is an Associate Professor of Psychology and Psychiatry at UCLA. She received her Ph.D. in 2007 from UCLA, after completing undergraduate studies at Trinity College in Hartford, CT. She trained further as a Postdoctoral Scholar and Research Scientist in the Semel Institute at UCLA before transitioning to a position as an Assistant Professor at the Feinstein Institute for Medical Research and Zucker School of Medicine at Hofstra/Northwell. She returned to UCLA in 2016. Dr. Karlsgodt's research focuses on the schizophrenia spectrum, with an emphasis on neurodevelopment, using multimodal techniques including cognitive testing and structural and functional MRI.

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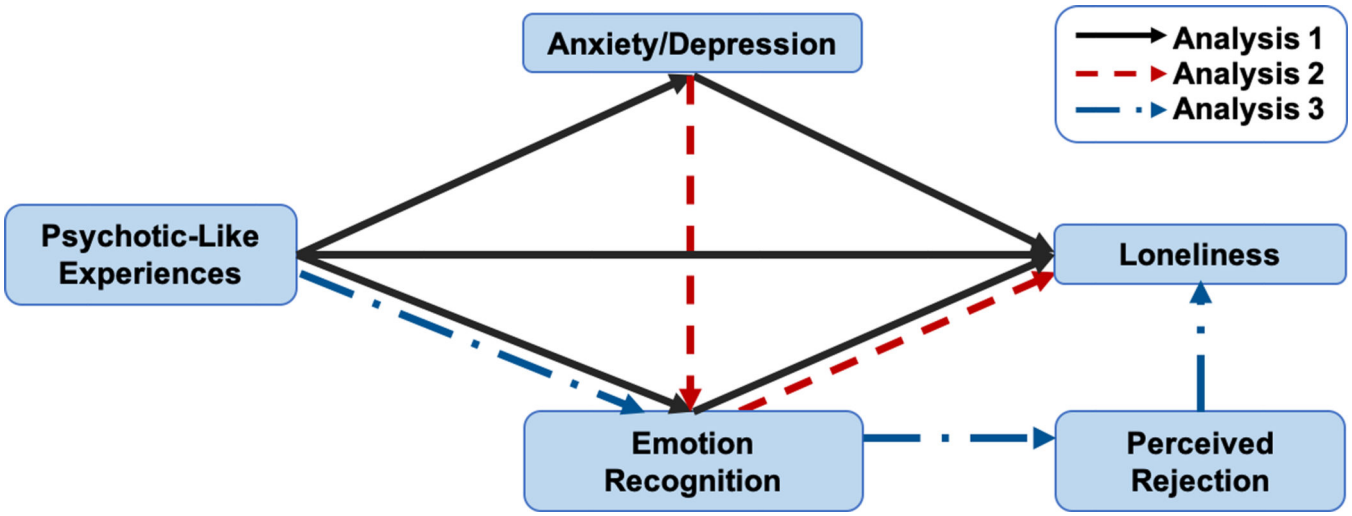

Fig. 1.

Relationship between psychosis and loneliness. Each symptom has a distinct effect on emotion processing. Emotion processing then contributes increased perceived rejection, resulting in greater loneliness.

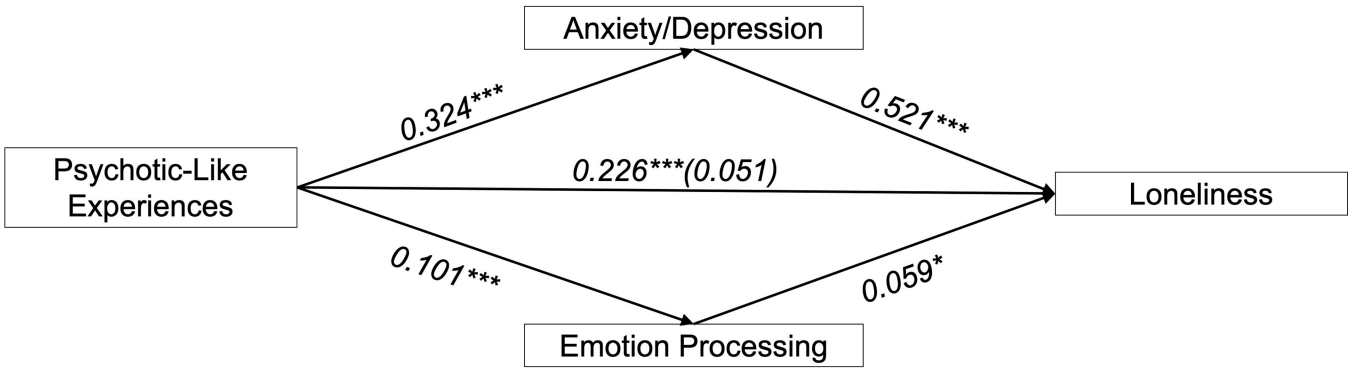

Fig. 2.

Results from Analysis 1. PLEs significantly predict levels of loneliness. Anxiety/depression and ER-40 efficiency independently mediate this relationship. Age, sex, and SCPT reaction time are included as covariates. Standardized betas are reported. * = $p < .05$, *** = $p < .001$.

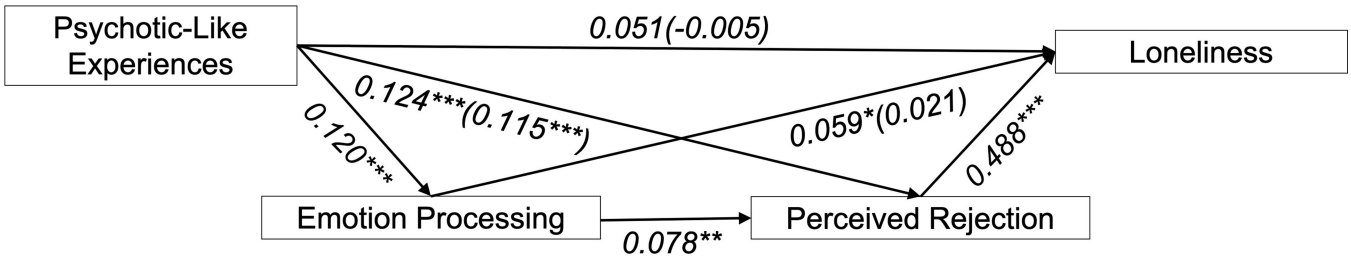

Fig. 3.

Results from Analysis 3. Perceived rejection further mediates relationship between PLEs, ER-40 efficiency, and loneliness. Age, sex, processing speed, and anxiety/depression are included as covariates. Standardized betas are reported. * = $p < .05$, ** = $p < .01$, *** = $p < .001$.

Table 1

Demographic and Summary Statistics

	Full Sample (n = 1198)	Analyzed Sample (n = 1180)	Difference
Age	28.83 (3.69)	28.83 (3.68)	t = -.05, p = .96
Number Female (%)	649 (54.2%)	638 (54.1%)	χ^2 < .001, p = .99
Race (%) White Black/African American Asian/Hawaiian Native/Pacific Islander American Indian/Alaska Native More than one Not reported	 883 (73.7%) 192 (16.0%) 67 (5.6%) 2 (0.2%) 31 (2.6%) 23 (1.9%)	 870 (73.7%) 188 (15.9%) 66 (5.6%) 2 (0.2%) 31 (2.6%) 23 (1.9%)	χ^2 = .01, p = .99
Hispanic/Latinx (%)	105 (8.8%)	104 (8.8%)	χ^2 = .034, p = .98
Anxiety/Depression	4.96 (4.46)	4.96 (4.47)	t = -.02, p = .98
PLEs	.46 (.97)	.46 (.97)	t = .08, p = .94
Perceived Rejection	-	48.7 (8.92)	-
Loneliness	-	51.1 (8.82)	-

Table 1: Categorical data presented as total number (percentage). Continuous data presented as mean (standard deviation). No differences between the analyzed sample and the full sample; p*s from chi-square and t-tests all > .05.*

Table 2

Summary of Mediation Model Results

	Primary Mediator	Secondary Mediator	Indirect Effect
Hypothesis 1: PLEs -> Loneliness	Anxiety/Depression	-	$\beta = 0.169$, $CI_{95\%} = [0.128, 0.211]$
	ER-40 Efficiency	-	$\beta = 0.006$, $CI_{95\%} = [0.001, 0.014]$
Hypothesis 2: Anxiety/Depression -> Loneliness†	ER-40 Efficiency	-	$\beta = -0.004$, $CI_{95\%} = [-0.009, 0.0001]$
Hypothesis 2: PLEs -> Loneliness	Anxiety/Depression	ER-40 Efficiency	$\beta = -0.001$, $CI_{95\%} = [-0.003, 0.0001]$
Hypothesis 3: PLEs -> Loneliness	ER-40 Efficiency	Perceived Rejection	$\beta = 0.005$, $CI_{95\%} = [0.001, 0.010]$
Individual Emotions: PLEs -> Loneliness††	Happy Faces Efficiency	-	$\beta = 0.007$, $CI_{99\%} = [-0.001, 0.019]$
Individual Emotions: PLEs -> Loneliness††	Happy Faces Efficiency	Perceived Rejection	$\beta = 0.006$, $CI_{99\%} = [0.001, 0.015]$

Table 2: Summary of mediation models. Secondary mediators listed for serial mediation models. Betas and confidence intervals are standardized and indicate serial indirect effect for serial models. Age, gender, and processing speed are included as covariates in all analyses.

†PLEs included as a covariate,

††Anxiety/depression included as a covariate.