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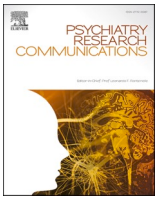

Social defeat and psychosis-related outcomes: Associative and experimental tests related to the nature of defeat, specificity of outcomes, and psychosis-proneness

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ABSTRACT

Several forms of social defeat, including ostracism, discrimination, bullying, and related experiences, have been associated with psychotic disorders and experiences. The social defeat hypothesis of schizophrenia attempts to explain these associations by positing that chronic exclusion due to having outsider status leads to deleterious neurobiological changes that produce psychosis. Here, we test non-neurobiological tenants of this theory, including the relative impact of daily, real-world, chronic social defeat versus an acute, time-limited, experimentally-induced socially defeating experience (social exclusion), the moderating role of psychosis-proneness, and the specificity of social defeat on psychosis-related outcomes. We find that real-world, chronic, but not acute, time-limited, laboratory-based social defeat is associated with decreased trust, but not false-alarms on an auditory signal detection task. These associations were qualified by interactions that are in line with social reconnection (i.e., positive appraisals of social stimuli following exclusion). Real-world, chronic social defeat was also associated with delusion- and hallucination-proneness. Together, these data highlight the importance of daily, real-world forms of social defeat versus laboratory manipulations on specific psychosis-related outcomes.

1. Introduction

Human beings have a fundamental need to establish and maintain meaningful interpersonal relationships (Baumeister and Leary, 1995). So consequential is this need that failure to meet it carries profoundly negative consequences for virtually all aspects of our health (Cacioppo and Cacioppo, 2014; Holt-Lunstad et al., 2015; Wang et al., 2017; Yang et al., 2016). Increasing work suggests that one particularly pernicious form of social disconnection—social exclusion—may even play a critical role in the etiology of psychotic disorders and experiences. As described in the social defeat hypothesis (Cantor-Graae and Selten, 2005; Selten et al., 2013; Selten and Cantor-Graae, 2005; Selten and Ormel, 2023), the long-term experience of having outsider status or a subordinate position leads to deleterious changes in the mesolimbic dopaminergic system, which increases risk for psychosis. Beyond changes to mesolimbic dopaminergic functioning, social defeat and related psychosocial stressors have been shown in human and animal studies to provoke neuroinflammation (Mizrahi, 2016; Weber et al., 2017), which too is associated with psychosis-risk (Bergink et al., 2014; Bloomfield et al., 2016; Cannon et al., 2015; Carter et al., 2014; Khoury and Nasrallah, 2018), suggesting multiple pathways from social stress to pro-psychotic neurobiological changes.

In support of the non-neurobiological tenants of this theory, a common factor underlying many risk factors for psychosis is membership in often socially denigrated minority groups, for example, being an immigrant (Bourque et al., 2011; Cantor-Graae and Selten, 2005), refugee (Brandt et al., 2019), racial/ethnic minority (Barr et al., 2022; Kirkbride et al., 2006; Leaune et al., 2019), sexual minority (Gevonden et al., 2014; Post et al., 2021), or transgender person (Hanna et al., 2019). Adverse social experiences, which in some instances, may be directly linked to minority status, for example, discrimination (Anglin, 2023; Anglin et al., 2014; Bardol et al., 2020; Janssen et al., 2003; Oh et al., 2014), bullying (Van Dam et al., 2012; Wolke et al., 2014), and ostracism (Jaya et al., 2022; Lincoln et al., 2021; Waldeck et al., 2022) are too associated with psychotic disorders and experiences. The emergence of psychotic symptoms may also set the conditions for further social defeat. According to the interactional processing model (Best and Bowie, 2022), observable signs of psychosis, such as responding to

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internal stimuli, diminished emotional expression, and rapport-disrupting social behavior that occurs as the result of social cognitive impairment, may lead others to socially distance themselves from the individual exhibiting these signs. Taken together, these converging sources of evidence suggest a robust connection between various forms of social defeat and psychotic disorders and experiences.

Here, our goal was to examine several aspects of the connection between social defeat and psychotic experiences in terms of the *nature* of the social defeat, the *consequences* of the experience on psychosis-related phenomena, and *moderators* of the association, and in doing so, replicate and extend prior work. On nature of the defeat, the social defeat hypothesis emphasizes psychotic disorders and experiences as the long-term consequence of having outsider status. However, several studies have demonstrated an increase in psychotic experiences (Kesting et al., 2013; Lamster et al., 2017; Lincoln et al., 2018; Smailes et al., 2014; Sundag et al., 2018; Westermann et al., 2012) and related phenomena—e.g., negative symptoms (Pillny and Lincoln, 2020), reduced trusting behavior (Hillebrandt et al., 2011)—after an acute, time-limited socially defeating experience occurring in a controlled laboratory setting (e.g., exclusion during a game, experimentally-induced loneliness). Social defeat has also been shown to increase psychotic experiences over short time-intervals of ≤24 h with daily diary methods (Schlier et al., 2018). This suggests that the impact of social defeat on psychosis-related phenomena may operate over shorter time-intervals, after a single defeating experience outside of the individual's real-world social network, which would further speak to the potency of defeat across form and duration.

In line with a diathesis-stress and proneness-persistence-impairment model of psychosis (van Os et al., 2009), not everyone who experiences a socially defeating experience may demonstrate a symptom, sign, or psychosis-related behavior. Instead, social defeat may lead to a psychotic experience or related behavior only for those who are psychosis-prone, as suggested by other work (Kesting et al., 2013; Lamster et al., 2017; Stewart et al., 2017; Sundag et al., 2018; Westermann et al., 2012). Acute social defeat may also interact with chronic social defeat in producing psychotic experiences; that is, prior social defeat may sensitize individuals to new socially defeating experiences, potentiating their impact on psychotic experiences. These issues make it important to test the influence of psychosis-proneness on associations between defeat and psychotic experiences.

Finally, on consequences of social defeat, studies show an increase in most psychotic experiences, suggesting a generalized impact of defeat on reality-testing (see Jaya et al., 2022; Pillny and Lincoln, 2020 for examples of social defeat's impact on negative symptoms). However, several studies have found either a specific association between social defeat and delusions or delusion-like ideation—most often, paranoia—or a stronger association between social defeat and delusions versus hallucinations (Bardol et al., 2020; Janssen et al., 2003; Kingston et al., 2023; Oh et al., 2014; Pearce et al., 2019; Stowkowy et al., 2016; Veling et al., 2007; Wickham et al., 2014). The potential specificity of the association between social defeat and psychotic experiences would provide critical information regarding risk pathways, their mechanisms (e.g., externalizing biases if only hallucinations were implicated, as in Brookwell et al., 2013; versus involving changes in attribution style if only delusions were implicated, as in Garety et al., 2001), and concomitant intervention.

To evaluate these issues, we measured chronic real-world, socially-defeating experiences, operationalized as ostracism, bullying, and discrimination, and experimentally manipulated acute, time-limited, laboratory-based social defeat in a non-clinical sample assuming continuity between psychotic experiences and disorders (Linscott and Van Os, 2013; van Os et al., 2009). We measured the association between social defeat and two psychosis-related outcomes from separate symptom dimensions: subclinical, behavioral signs of paranoia and social cognitive bias as measured from a trust task, and hallucination-related experiences, as measured on an auditory signal detection task. We also assessed psychosis-proneness as a potential moderator of the association between social defeat and the psychosis-related outcomes tested here. We tested whether chronic and acute socially defeating experiences were associated with/lead to reduced trust and increased false-positives on the auditory signal detect task; whether these associations were moderated by psychosis-proneness; and whether chronic social defeat moderates the impact of acute social defeat on the outcomes.

2. Methods

2.1. Participants

We determined our sample size based on two studies that included an exclusion manipulation and assessed their impact on similar outcomes tested here. Specifically, Hillebrandt et al. (2011) found that excluded participants during Cyberball showed subsequent decreased trusting behavior ($d = 0.71$), and Smailes et al. (2014) found that a loneliness induction increased false-alarms on the auditory signal detection task ($d = 0.52$). In order to detect the smaller of the two effects, a power analysis demonstrated that $N = 120$ was needed to achieve 80% power using two-sample *t*-tests (alpha = .05, two-tailed).

Participants were recruited from the University of Rochester (99%) and greater Rochester community (1%) via Research Match, Craigslist, research listservs, or paper flyers. Inclusion criteria included English fluency, normal or corrected-to-normal hearing and vision, and being between the age of 18 to 40 years in order to test participants within the peak age range of psychosis risk (Solmi et al., 2022). Exclusion criteria included self-reported history of psychiatric hospitalization and/or current psychiatric illness, neurological disease, history of a developmental disorder, and history of serious head injury and/or loss of consciousness.

Our sample included 139 participants of which 71 were randomized via Qualtrics to the inclusion condition and 68 were randomized to the excluded condition (Table 1). Data were excluded if the participant revealed knowing the study hypotheses ($n = 21$), previously played Cyberball ($n = 1$), or failed attention check questions in the Qualtrics survey ($n = 0$). This left a final sample of 117 participants of which 62 were in the inclusion group and 55 were in the exclusion group. With these *n*s, sensitivity analysis revealed that we still had over 80% power to detect the smaller of the two expected effects. This *N* also afforded us 80% power to detect correlations of $r = 0.26$ (alpha = .05, two-tailed). Demographically, participants were on average 19.8 ± 1.6 years of age (range = 18-30), predominantly female (73%), described their gender identity as woman (71%), predominantly Asian (48%), non-Hispanic/Latino (91%), and having completed high school or its equivalent (85%). We note that only a single participant was 30 years of age (randomized to the inclusion group); all other participants were 18-23 years of age. Removing this one participant did not change any of the main findings reported below.

2.2. Acute social defeat

To induce feelings of acute social defeat, we used Cyberball, a widely-used virtual ball-tossing game that produces feelings of social exclusion (Hartgerink et al., 2015; Williams et al., 2000; Williams and Jarvis, 2006). To increase the authenticity of the game situation, participants were told that they will play an online game of catch with two other individuals playing the game in nearby rooms, although the two other players were actually computer-generated. Prior to starting the game, participants were instructed to "virtually" introduce themselves to the other players by creating a username and writing a short paragraph describing themselves that the other two players would see. Participants were then introduced to the other two players by reading the descriptions provided by the other two players (generated by the experimenters), and told that they would all play a ball tossing game together, the purpose of which was to practice engaging in mental visualization. Participants were instructed to pass the ball equally to the

Table 1
Participant characteristics.

	Exclusion (n = 55)	Inclusion (n = 62)	Group Difference
Age, *M* (*SD*)	19.6 (1.5)	19.9 (1.8)	$t(115) = .85$, $p = .398$
Sex, *n* (%)			$\chi^2(1, N = 117) = .00$, $p = 1.00$
Female	40 (73)	45 (73)	
Male	15 (27)	17 (27)	
Gender Identity, *n* (%)			$\chi^2(4, N = 117) = 2.73$, $p = .604$
Agender	0 (0)	1 (2)	
Genderfluid	0 (0)	1 (2)	
Genderqueer	0 (0)	1 (2)	
Man	15 (27)	16 (26)	
Woman	40 (73)	43 (69)	
Race, *n* (%)			$\chi^2(6, N = 117) = 6.53$, $p = .367$
American Indian or Alaska Native	1 (2)	0 (0)	
Asian	21 (38)	35 (56)	
Black or African American	7 (13)	4 (6)	
Multiracial	6 (11)	6 (10)	
Other	2 (4)	1 (2)	
Not Reported	0 (0)	1 (2)	
White	18 (33)	15 (24)	
Ethnicity, *n* (%)			$\chi^2(2, N = 117) = 1.01$, $p = .604$
Hispanic/Latino	4 (7)	2 (3)	
Non-Hispanic/Latino	49 (89)	58 (94)	
Not Reported	2 (4)	2 (3)	
Highest Degree, *n* (%)			$\chi^2(5, N = 117) = 7.11$, $p = .212$
Associates	2 (4)	0 (0)	
Bachelors	4 (7)	2 (3)	
High School/GED	46 (84)	54 (87)	
Masters	0 (0)	1 (2)	
Other	0 (0)	3 (5)	
Not Reported	3 (5)	2 (3)	
Ostracism Experiences Scale, *M* (*SD*)	2.0 (0.9)	2.1 (1.0)	$t(115) = .80$, $p = .427$
Bullying Scale for Adults, *M* (*SD*)	4.2 (4.6)	4.5 (4.8)	$t(114) = .35$, $p = .729$
Everyday Discrimination Scale, *M* (*SD*)	9.3 (6.5)	10.8 (8.5)	$t(113) = 1.06$, $p = .293$
Revised Green Paranoid Thoughts Scale—Persecution, *M* (*SD*)	3.9 (5.4)	6.0 (6.1)	$t(115) = 2.02$, $p = .046$
Revised Green Paranoid Thoughts Scale—Reference, *M* (*SD*)	9.7 (6.5)	10.6 (5.7)	$t(108) = .79$, $p = .432$
Cardiff Anomalous Perceptions Scale, *M* (*SD*)	8.7 (6.4)	9.2 (6.4)	$t(113) = .43$, $p = .670$

other players and that the other participants received identical instructions.

The game depicts three players with the usernames of all players displayed above each players' animated icon. The timing of ball-tosses also varied randomly throughout the game to mimic the time it would take a human player to pass the ball. When the ball is tossed to the participant, they are instructed to click on one of the other two player icons to indicate their intended recipient, and the ball then moves toward that player. The game involved 30 ball tosses among the three players. Participants randomly assigned to the inclusion condition received the ball an equal number of times to the other players; those assigned to the exclusion condition received the ball twice at the beginning of the task and did not receive it again thereafter. A figure in the top corner of the screen depicted the number of total ball tosses and the number received by the participant.

Following Cyberball, participants completed a modified 8-item version of the inclusion/ostracism scale reported in Zadro et al. (2004) as a manipulation check. Participants rated their level of agreement with statements using a 9-point Likert scale (1 = *not at all*, 9 = *very much so*), where higher total scores indicated greater feelings of inclusion (omega = .89). As expected, the excluded group reported lower scores ($M = 24.8$, $SD = 9.7$) compared to the included group ($M = 42.4$, $SD = 11.2$), which was a large difference, $d = -1.68$, 95% CI [-2.16, -1.20], and unexpected under the null hypothesis, $t(115) = 9.10$, $p < .001$, confirming that the social exclusion manipulation was effective. The magnitude of this difference is consistent with a meta-analytic estimate of Cyberball's impact on feelings of ostracism (Hartgerink et al., 2015).

2.3. Chronic social defeat

To assess chronic—i.e., ongoing or regular—experiences of real-world social defeat, participants completed three measures assessing daily and/or lifelong ostracism, bullying, and discrimination. We assessed ostracism with The Ostracism Experiences Scale (Carter-Sowell, 2010), which is an 8-item self-report scale answered with a 1 (*hardly ever*) to 7 (*almost always*) Likert scale that measures the frequency of being ignored and/or excluded (omega = .90). We assessed bullying with the 6-items from Bullying Scale for Adults (Haidl et al., 2020) that asks about problematic consequences of being bullied. Questions are answered using a 0 (*never a problem*) to 4 (*always a problem*) Likert scale (omega = .91). We assessed discrimination with the Everyday Discrimination Scale (Anglin et al., 2014), which is a 10-item measure self-report measure answered with a 0 (*never*) to 5 (*almost every day*) Likert scale measuring the frequency of 10 discriminatory events (omega = .88).

2.4. Psychosis-proneness

We administered the Revised-Green Paranoid Thoughts Scale (R-GPTS; Freeman et al., 2021) as a measure of delusion-proneness and the Cardiff Anomalous Perceptions Scale (CAPS; Bell et al., 2006) as a measure of hallucination-proneness. The R-GPTS is a self-report measure that assesses persecutory and referential ideation with 8 and 10 questions, respectively, answered on a 0 (*not at all*) to 4 (*totally*) scale (omega = .90). The CAPS is a 32-item self-report questionnaire in which participants answer *yes/no* to questions about various perceptual anomalies (omega = .89).

2.5. Outcome measures

We included two outcome measures associated with the broader psychosis phenotype, including a measure of social information processing associated with paranoia—the Trust Task (Adolphs et al., 1998; Pinkham et al., 2016)—and a measure of hallucinatory experiences—the Auditory Signal Detection Task (Barkus et al., 2007, 2011; Moseley et al., 2021; Smailes et al., 2014).

In the Trust Task, participants rated how trustworthy they perceived 16 mixed-race/ethnicity faces (8 female, 8 male) with a neutral expression from the American Multiracial Face Database (Chen et al., 2021) using a 1 (*not at all*) to 7 (*extremely*) scale. Trust was calculated as the *M* rating across faces with higher scores indicating greater levels of perceived trustworthiness. In similar tasks, individuals with psychotic-spectrum disorders rate faces as less trustworthy (Pinkham et al., 2016), which is associated with higher levels of paranoia (Buck et al., 2016).

In the auditory signal detection task, participants listened to 72, 3.5 s fragments of pink noise. In 36 of these trials, speech was presented for 1.5 s at varying levels of signal-to-noise ratio; in the other 36 trials, no speech was present. After each trial, participants were asked, "Did you hear speech?" and responded *yes/no*. Our main outcome variable was the false-alarm rate, which was calculated as the proportion of no speech trials in which a participant reported hearing speech. Other work with this measure has shown that psychosis-proneness is associated with a higher false-alarm rate (Barkus et al., 2007, 2011; Moseley et al., 2021).

Due to technical issues, data were not collected for 3 participants leaving an analyzed $N = 114$ (exclusion $n = 54$, inclusion $n = 60$).

2.6. Procedure

The entire experiment was conducted during a single laboratory visit. Following the consent process in which experimenters provided a cover story pertaining to the purpose of the study, participants completed Cyberball, the manipulation check, and then, to mitigate the possibility that the effect of Cyberball may become weaker across time, participants completed the two outcome measures in counterbalanced order. Following completion of the outcome measures, participants completed the measures of chronic social defeat, psychosis-proneness, and demographic questions. Following study completion, an experimenter debriefed all participants, and obtained consent to use their data given the deception. Participants received compensation for their time in the form of research credit or money. All research procedures were approved by the University of Rochester's Research Subject Review Board.

2.7. Data analysis

All data were analyzed in R (R Core Team, 2018) and R Studio (RStudio Team, 2020) using the following packages: *confintr* (Mayer, 2022), *cocor (Diedenhofen and Musch, 2015)*, *lavaan* (Rosseel, 2012), *psych* (Revelle, 2018), *psycho* (Makowski, 2018), *rockchalk* (Johnson, 2022), and *rstatix* (Kassambara, 2021). Data were visually inspected for normality and outliers. We Winsorized the data at the 90th percentile for the Trust Task and all Auditory Signal Detection Task outcomes due to the presence of outlying datapoints on boxplots. All findings are considered unexpected under the null hypothesis when $p<.05$.

To address the impact of acute social defeat on the two outcome measures, we compared scores using Welch's two-sample *t*-tests (two-tailed). Effect sizes were estimated as Cohen's *d*, accompanied by 95% CI derived from bias-corrected-and-accelerated bootstrap confidence intervals (10,000 resamples), and are interpreted using empirical benchmarks described in Schäfer and Schwarz (2019). To evaluate whether psychosis-proneness, specifically, delusion-proneness and hallucination-proneness, moderated the effect of acute social defeat on the outcomes, we conducted follow-up linear regressions that include terms for condition, R-GPTS-persecution/reference or CAPS, and their interaction. In the presence of a significant interaction, we conducted simple slopes analysis.

We conceptualized the individual self-report measures of ostracism, bullying, and discrimination as tapping into a common social defeat variable, and we evaluated whether principal components analysis (PCA) was appropriate. Correlations between the three self-report measures were large, $rs = .41$-$.48$, Bartlett's test was statistically significant ($p<.001$), and Kaiser-Meyer-Olkin measure of sampling adequacy was .67, all of which indicated that PCA was appropriate. Parallel analysis and a scree plot indicated one factor was present, which explained 63% of the total variance. Standardized loadings were .77–.81. We extracted component scores, which represented the chronic social defeat variable. To evaluate the association between chronic social defeat and the outcomes, we conducted separate linear regressions. To evaluate whether psychosis-proneness moderated the effect of acute social defeat on the outcomes, we conducted follow-up linear regressions that included terms for condition, either R-GPTS-persecution, R-GPTS-reference, or CAPS, and their interaction. In the presence of a significant interaction, we conducted simples slopes analysis.

Finally, to evaluate whether the impact of the acute socially defeating experience depended on levels of chronic social defeat, we evaluated the interaction of condition and the chronic social defeat variable on the two outcomes by conducting linear regression.

3. Results

3.1. Acute social defeat

3.1.1. Trust task

We hypothesized that the social exclusion group would show reduced trust compared to the inclusion group. This hypothesis was not confirmed: the groups showed nearly equivalent levels of trust (exclusion $M = 6.01$, $SD = 0.52$; inclusion $M = 5.97$, $SD = 0.54$), $t(114) = .44$, $p = .658$, $d = .08$, 95% CI [-.29, .44] (Fig. 1A). As the groups showed a statistically significant difference in RGPTS-persecution scores, we repeated the group comparison controlling for RGPTS-persecution using ANCOVA; findings were unchanged, condition $F(1, 114) = .04$, $p = .840$. Next, we tested whether delusion-proneness influenced whether exclusion impacted ratings of trust by conducting linear regressions that included a group by RGPTS-persecution term, and separately, a group by RGPTS-reference term. In both models, we observed an interaction between group and persecution, $\beta = -.52$, 95% CI [-.89, −.16], $p = .006$, and reference, $\beta = -.42$, 95% CI [-.79, −.06], $p = .022$. With persecution, simple slopes analysis revealed a non-significant, positive association between persecution and trust for the exclusion group, $b = .02$, $p = .192$, and a significant, negative association between persecution and trust for the inclusion group, $b = -.03$, $p = .006$. Similarly, for reference, simple slopes analysis revealed a non-significant, positive association between reference and trust for the exclusion group, $b = .01$, $p = .535$, and a significant, negative association between reference and trust for the inclusion group, $b = -.03$, $p = .011$. Taken together, greater delusion-proneness was expectedly associated with less trust, but only for included individuals. Those experiencing an acute socially defeating event did not show the expected association between delusion-proneness and trust.

3.1.2. Auditory signal detection task

We hypothesized that excluded participants would show a higher false-alarm rate on the auditory signal detection task. This hypothesis was not confirmed. On average, excluded participants ($M = 0.29$, $SD = 0.22$) demonstrated a marginally higher false-alarm rate compared to included participants ($M = 0.27$, $SD = 0.23$), with the difference being very small in magnitude, $d = .08$, 95% CI [-.29, .47], and not unexpected under the null hypothesis, $t(112) = .42$, $p = .675$ (Fig. 1B). We next evaluated whether hallucination-proneness influenced whether social exclusion impacted the false-alarm rate by conducting a linear regression that included a group by CAPS term. The interaction term was not significant, $\beta = .32$, 95% CI [-.05, .69], $p = .091$, suggesting that hallucination-proneness did not potentiate or temper the impact of social exclusion on voice-hearing.

3.2. Chronic social defeat

3.2.1. Trust task

We hypothesized that chronic forms of social defeat, which we operationalized as a variable derived from daily experiences of ostracism, bullying, and discrimination, would be negatively associated with trust. This hypothesis was confirmed: higher scores on the chronic social defeat variable were associated with lower levels of trust, $\beta = -.21$, 95% CI [-.39, −.03], $p = .020$ (Fig. 2A). Delusion-proneness did not moderate this association, RGPTS-persecution interaction, $\beta = .15$, 95% CI [-.00, .30], $p = .056$, RGPTS-reference interaction, $\beta = .16$, 95% CI [-.01, .32], $p = .065$.

3.2.2. Auditory signal detection task

We hypothesized that chronic forms of social defeat would be positively associated with the number of false-alarms. This hypothesis was not confirmed, $\beta = .02$, 95% CI [-.17, .21], $p = .844$ (Fig. 2B). The association between chronic social defeat and the false-alarm rate was not influenced by hallucination-proneness, interaction term $\beta = .07$, 95% CI

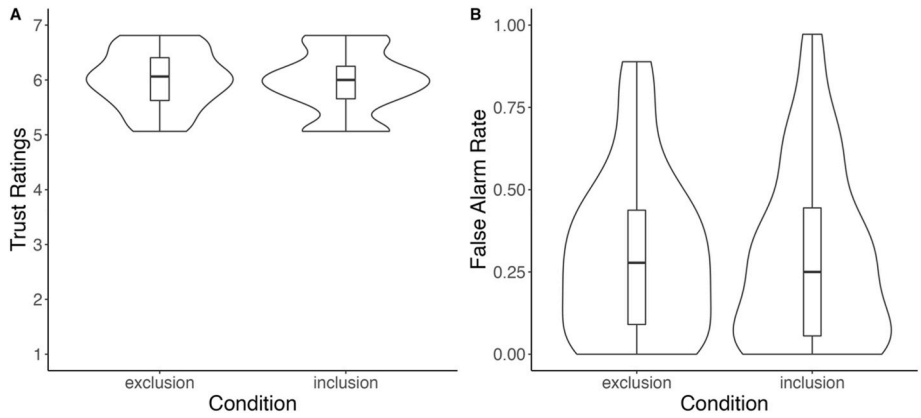

Fig. 1. The impact of acute social defeat (exclusion versus inclusion) on trust ratings (A) and the false alarm rate on the auditory signal detection task (B).

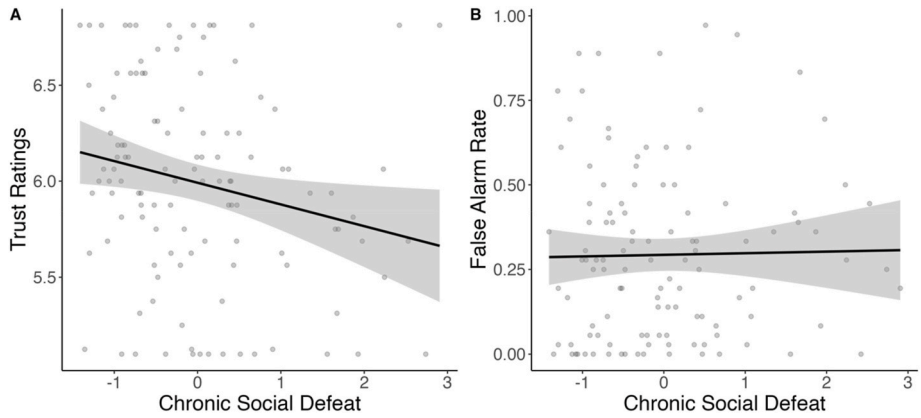

Fig. 2. Associations between chronic social defeat and trust (A), and chronic social defeat and false-alarm rate on the auditory signal detection task (B). Gray dots depict individual data points. Black lines represent the regression slope with its 95% CI depicted by the gray shaded area.

[-.11, .25], $p = .449$.

3.3. The interaction of acute and chronic social defeat

3.3.1. Trust task

We evaluated whether the impact of having an acute socially defeating experience on the outcomes might be influenced by someone's daily, chronic experience of social defeat. We tested this idea by conducting linear regressions that included a group by chronic social defeat interaction term. In line with this idea, we observed an acute by chronic social defeat interaction, $\beta = -.42$, 95% CI [-.78, −.06], $p = .023$, such that for included participants, there was an expected negative association between chronic social defeat and trust, $b = -.21$, $p = .001$, which not observed for excluded participants, $b = .01$, $p = .841$ (Fig. 3).

3.3.2. Auditory signal detection task

We conducted similar analyses as above, and found no interaction between acute and chronic social defeat on the false-alarm rate, $\beta = -.16$, 95% CI [-.55, .22], $p = .395$.

3.4. Associations between psychosis-proneness and chronic social defeat

Given the similar nature of the interactions between group (i.e., acute social defeat) and delusion-proneness, and group and chronic social defeat in predicting trust ratings, we conducted exploratory analyses to evaluate the association between psychosis-proneness and chronic social defeat. We observed large, positive associations between chronic social defeat and delusion-proneness, RGPTS-persecution: $r(115) = .57$, 95% CI [.44, .68], $p<.001$, RGPTS-reference: $r(115) = .58$,

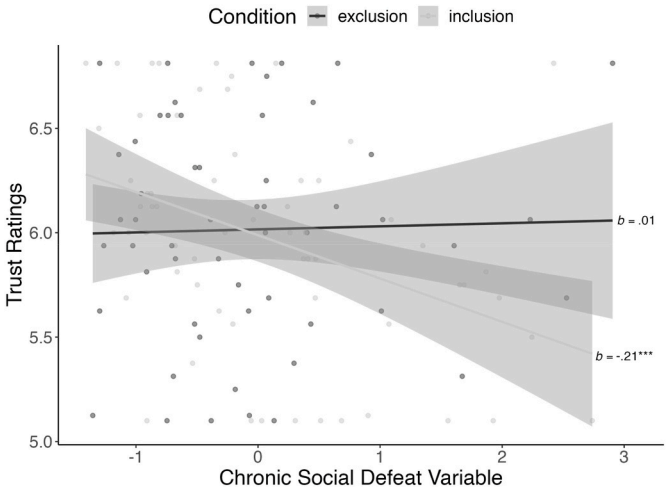

Fig. 3. Dark gray data points and regression line depict excluded participants and slope, respectively; light gray data points and regression line depict included participants and slope, respectively. Shaded areas represent 95% CI of the slope. *b* values indicate simple slopes.***$p<.001$.

95% CI [.44, .69], $p<.001$ (Fig. 4), such that individuals high in delusion-proneness also reported greater levels of chronic social defeat. We observed a similar positive association, of a slightly smaller magnitude, between chronic social defeat and hallucination-proneness (CAPS), $r(115) = .46$, 95% CI [.30, .59], $p<.001$. The difference in

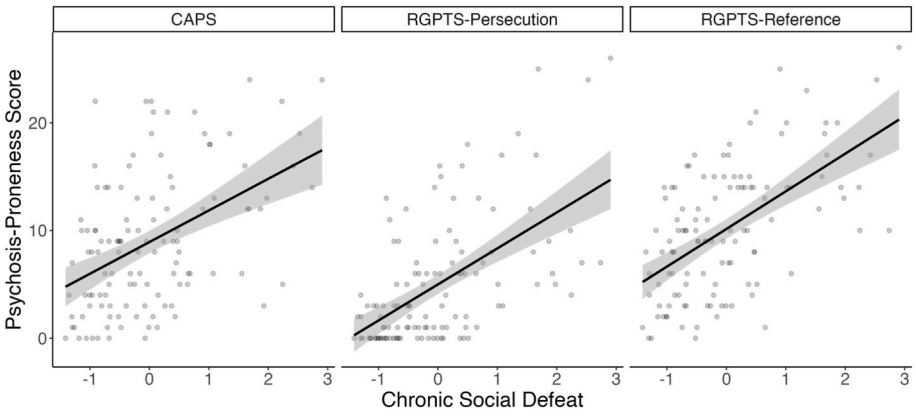

Fig. 4. Associations between chronic social defeat and the three psychosis-proneness measures: Cardiff Anomalous Perceptions Scale (CAPS; left), Revised Green Paranoid Thoughts Scale-Persecution (RGPTS-Persecution; middle), and Revised Green Paranoid Thoughts Scale-Reference (RGPTS-Reference; right). Gray dots depict individual data points. Black lines represent the regression slope with its 95% CI depicted by the gray shaded area.

correlation magnitude between the variables (using Zou's 2007 method) was not statistically significant, 95% CI of difference between social defeat and RGPTS-persecution versus CAPS: [-.04, .27], 95% CI of difference between social defeat and RGPTS-reference versus CAPS: [-.03, .27].

4. Discussion

Here, we evaluated several aspects of the social defeat theory of schizophrenia towards conceptually replicating and extending prior work testing predictions of this theory. Specifically, we evaluated how the nature of the defeat impacts two distinct psychosis-related outcomes; how psychosis-proneness moderates these associations; and whether acute and chronic social defeat interact in producing psychosis-related outcomes. We find that real-world, more chronic forms of social defeat, but not an acute socially defeating experience involving social exclusion in a laboratory setting, is related to paranoia-related phenomena, but not hallucination-related phenomena. Delusion-proneness moderated this association, but in an unexpected way: included, but not excluded individuals showed a negative association between delusion-proneness and trust. We also observed an interaction between chronic and acute social defeat in predicting paranoia-related phenomenon, but in a similarly unexpected way: chronic social defeat was negatively associated with trust, but only for included participants. Finally, in support of many other findings connecting various forms of social defeat to psychotic experiences, we found large magnitude associations between chronic social defeat and delusion-proneness, which were slightly larger in magnitude, but not statistically different, than associations between chronic social defeat and hallucination-proneness.

We see several possibilities as to why experimentally-induced social exclusion did not impact the psychosis-related outcomes tested here, which is contrast to some other work (Hillebrandt et al., 2011; Kesting et al., 2013; Lamster et al., 2017; Lincoln et al., 2018; Smailes et al., 2014; Sundag et al., 2018; Westermann et al., 2012). First, there might exist critical moderators in our sample that we failed to measure, such as exclusion-related changes in negative affect (Bagrowska et al., 2022), self-esteem (Kesting et al., 2013; Stewart et al., 2017), or use of emotion regulation techniques (Westermann et al., 2012). Second, although Cyberball produced large-magnitude feelings of exclusion consistent with meta-analytic estimates of Cyberball's effect (Hartgerink et al., 2015), the nature of these feelings of exclusion produced by our laboratory manipulation may be fundamentally different from the feelings of exclusion produced in real-life when exclusion happens in the context of meaningful relationships or social interactions. Indeed, this might explain why we did find associations between the chronic, real-world social defeat variable and trust. Similarly, other work has found experimental manipulations of social defeat involving thinking about past personal social experiences to be more effective in generating feelings of rejection than Cyberball (Bagrowska et al., 2022). Third, the impact of social exclusion on our particular outcome measures may have simply been smaller than what we were able to detect with our sample size.

In contrast, we found support for the idea that ongoing, real-life experiences of various forms of social defeat—i.e., past, ongoing, and/or daily experiences of ostracism, discrimination, and bullying—was negatively associated with trust. This finding converges with others demonstrating the various forms of social defeat is associated with paranoid-ideation (Anglin, 2023; Janssen et al., 2003; Oh et al., 2014; Valmaggia et al., 2015) suggesting that ongoing experiences of social exclusion and victimization may fundamentally alter social perception and appraisals in a way that fosters a negative social attribution style (Buck et al., 2016; Kesting et al., 2013; Klein et al., 2020; Pinkham et al., 2016), which may over time foster the development of paranoia (Garety et al., 2001). One important difference is that our measure assessed a correlate and potential behavioral marker of paranoia, and not paranoia per se. In the face of repeated socially defeating experiences, especially discrimination, reduced trust may be culturally appropriate and adaptive, and not a harbinger of a psychotic disorder (Kingston et al., 2023). On the auditory signal detection task, we found no association between chronic social defeat and the number of false-alarms suggesting specificity between social defeat and psychotic experiences in our sample. Of course, here too, the impact of social defeat on hallucination-like experiences may simply be smaller than what we were able to detect. Nonetheless, taken with other work, this could suggest a separate pathway between social adversity, unhelpful social comparisons related to rank and status (Freeman et al., 2005, 2014; Gilbert et al., 2005; Wickham et al., 2014), the development of negative social schemas related to self-worth and acceptance (Lincoln et al., 2010), and social cognitive bias and paranoia in psychosis.

Interestingly, we found interactions between psychosis-proneness and chronic social defeat, and between acute and chronic social defeat, in predicting trust ratings. However, in contrast to prior work and our predictions, social defeat was negatively associated with trust, but only for individuals low in delusion-proneness and those who were not socially excluded in the lab. Said otherwise, we observed the expected association between social defeat and trust only for individuals who either reported few daily delusion-like experiences or those who were included during Cyberball. High delusion-proneness, and separately, having just experienced social exclusion in the lab, mitigated the effects of chronic social defeat on trust. Though seemingly counterintuitive, this pattern of results is consistent with predictions from the social reconnection hypothesis (Maner et al., 2007), which posits that,

given our fundamental need to belong, social exclusion increases motivation to reconnect with social partners and build social bonds. In support of this idea and relevant to the current findings, recently excluded individuals show selective attention to positive social signals, rate novel social targets more positively, and demonstrate approach-related social attitudes (DeWall et al., 2009; Maner et al., 2007). Thus, recently excluded individuals in our study may have evaluated the faces more favorably in terms of trustworthiness as part of a reconnection phenomenon. Given that delusion-proneness was strongly correlated with chronic social defeat, a similar explanation may account for the lack of association between chronic social defeat and trust for those high in delusion-proneness.

As social reconnection is not observed with the perpetrator of exclusion (Maner et al., 2007), it is not clear how this would work outside of the laboratory, where social categorization processes may come to bear. For example, for someone routinely experiencing discrimination, the perpetrator could be a single individual or a social group the perpetrator belongs to (e.g., all individuals of a particular race/ethnicity) meaning that reconnection, and the positive social evaluations and behaviors it entails, may be observed with a small number of individuals or no one at all. It is similarly unclear how social connection might manifest for someone experiencing marked levels of social defeat; that is, the clinically significant levels that are thought to provoke pathogenic mechanisms of psychotic disorders. As we tested our hypotheses in healthy adults from the community who presumably are not experiencing this degree of defeat, we cannot assume that approach-related social judgments, indicative of a social reconnection process, would be observed with a clinical sample. Related, social reconnection processes presumably rely on preserved socio-affiliative processes; that is, the "fundamental need to belong" (Baumeister and Leary, 1995) thought to be disrupted in psychosis-risk states (Brown et al., 2007; Kwapil, 1998; Kwapil et al., 2009) and individuals with psychotic disorders, as evidenced by findings of by reduced social pleasure (Abel et al., 2023; Shovestul et al., 2022) and affiliative feelings (Blanchard et al., 2015; McCarthy et al., 2017). For this reason, it is unclear that social reconnection processes would necessarily be observed in individuals with a psychotic disorder.

Several limitations are noteworthy. First, our measure of real-world, ongoing aspects of social defeat, indexed a number of different experiences that were not manipulated in the laboratory manipulation of defeat, which only involved exclusion, making it hard to directly compare the two defeat variables. This speaks to a larger issue in the social defeat literature regarding how to best operationalize, measure, and test defeat (Schalbroeck, 2023; Selten, 2023; Selten and Ormel, 2023). Second, we did not measure other potential moderators, which may well account for how and whether social defeat impacts the outcomes measured here. Third, we measured only a limited number of psychosis-related outcomes.

In conclusion, we find that real-world, chronic, but not acute, time-limited social defeat experienced in the laboratory is related to reduced trust, but not false-alarms on an auditory signal detection task. This finding was characterized by an interaction that may speak to the importance of social reconnection processes in the context of exclusion. Given that our two defeat variables indexed different aspects of defeat, caution is warranted in comparing the findings with these variables. Nonetheless, together, these data converge with other studies to highlight the relevance of certain forms of social defeat for certain psychosis-related phenomena.

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Author contributions

Bridget Shovestul: Conceptualization, formal analysis, investigation, methodology, writing – original draft, project administration; Mars Scharf: Formal analysis, investigation, project administration, writing – review & editing; Gloria Liu: Investigation, writing – review & editing; David Dodell-Feder: Conceptualization, formal analysis, funding acquisition, methodology, supervision, writing – original draft, writing – review & editing.

Declaration of competing interest

None.

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