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Tendency to share positive emotions buffers loneliness-related negativity in the context of shared adversity

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ABSTRACT

Loneliness is associated with adverse outcomes, and the COVID-19 pandemic threatened to increase loneliness. How loneliness-related outcomes unfold, though, varies across individuals. Individuals' sense of social connectedness and engagement with others to regulate emotional experiences (interpersonal emotion regulation; IER) may modulate loneliness-related outcomes. Individuals failing to maintain social connectedness and/or regulate emotions may be at heightened risk. We assessed how loneliness, social connectedness, and IER related to valence bias, a tendency to categorize ambiguity as more positive or negative. Loneliness was associated with a *more negative* valence bias among individuals reporting above *average* social connectedness but who shared positive emotion *less often* (z = -3.19, p =.001). These findings suggest that sharing positive emotional experiences may buffer loneliness-related outcomes during shared adverse experiences.

1. Introduction

Humans are intensely social creatures, so much so that maintaining social relationships buffers against both adverse physical and mental health outcomes (Hawkley & Cacioppo, 2010; Holt-Lunstad et al., 2010). Indeed, threats to these relationships, whether real or perceived, may lead to feelings of loneliness, which has numerous adverse sequelae. The effects of loneliness span physical health (e.g., worsened cardiovascular health, accelerated cognitive decline; Hawkley et al., 2006; Wilson et al., 2007) and psychological well-being (e.g., elevated rates of depression, social anxiety; Cacioppo et al., 2006; Lim et al., 2016), and contribute to mortality longitudinally (O'Súilleabháin et al, 2019). For instance, loneliness is linked to an exacerbated response to negative emotional information (i.e., negativity bias; Jones et al., 1981; Qualter et al., 2013; Vanhalst et al., 2017). Interestingly, these effects are evident even in response to subjective perceptions, as opposed to objective levels, of isolation (e.g., lockdown measures; Cacioppo et al., 2015; Benke et al., 2020). These loneliness-related adversities contribute to the significant link between higher levels of loneliness and premature disease-related mortality, a rate comparable to other serious health risks like obesity or smoking up to fifteen cigarettes per day (Holt-Lunstad, 2017), as well as higher rates of suicidal behavior (McClelland et al., 2020). Thus, mitigating these outcomes is of great importance for reducing societal burdens associated with loneliness.

Recently, the novel coronavirus (COVID-19) pandemic drastically reshaped how social interactions play out on a daily basis, resulting in reduced in-person social interactions and increasing the likelihood of experiencing loneliness. Certainly, the COVID-19 pandemic represents a unique situational context of shared adversity in that people all around the world experienced a sudden need to maintain distance from their social connections (e.g., due to government-imposed lockdowns). Importantly, though, experiences of loneliness varied across individuals. Although many reports indicate that loneliness increased during the pandemic (Bu et al., 2020; Killgore et al., 2020; Lee et al., 2020; Tilburg et al., 2021; but also see Luchetti et al., 2020), the degree to which individuals experienced loneliness during the early pandemic varied as a function of individual differences (e.g., personality traits; Ikizer et al., 2022). Thus, taking a more nuanced approach, by pinpointing *for whom* loneliness most strongly predicted adverse outcomes, is likely to reveal individual-level moderating factors that alter the impact of the COVID-19 pandemic on loneliness and its associated outcomes (e.g., increased negativity bias; Cacioppo et al., 2006; Jones et al., 1981; Lim et al.,

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2016; Qualter et al., 2013; Vanhalst et al., 2017). In addition to elucidating the complex effects of loneliness during the COVID-19 pandemic, a better understanding of putative moderating factors could aid in developing and targeting interventions to mitigate the impacts of loneliness.

One likely resilience factor in moderating loneliness-related outcomes is one's social connectedness. Social connectedness is a trait-like sense of belonging and closeness to both immediate interpersonal connections and society more broadly, and is a crucial aspect of healthy social development (Lee & Robbins, 1995). Although loneliness and social connectedness are inversely related (Lee et al., 2001), there are marked differences between these constructs. Specifically, loneliness may refer to either an acute or chronic affective experience whereas social connectedness refers to a trait-like sense of belonging (Lee & Robbins, 1995). That is, loneliness is one likely consequence of failing to achieve a level of social connectedness in line with one's goals. Notably, one recent study found that higher levels of social connectedness were associated with a diminished tendency for increased internalizing symptoms (depression, anxiety) and decreased life satisfaction throughout the first months of the COVID-19 outbreak (Magson et al., 2021).

Another likely resilience factor is the use of interpersonal emotion regulation (IER), which refers to the use of social connections to regulate one's own emotions. Whereas social connectedness reflects the degree of emotional closeness and belongingness that one feels, IER captures how individuals *use* their social connections. As such, IER is a unique factor which may further alter the trajectory of loneliness-related negativity, especially among those with relatively high levels of social connectedness. Interestingly, some work has linked variability in IER to loneliness. For instance, IER is inversely related to loneliness (Williams et al., 2018), and social support accounts for a portion of the variability in loneliness predicted by emotion regulation strategies (Kearns & Creaven, 2017). Additionally, aiding others in their emotion regulation, as compared to intrapersonal (self-oriented) regulation, is associated with improved coping efficacy and reduced worries related to COVID-19 (Arbel et al., 2020).

Altogether, the extant literature suggests that those who fail to maintain their social connectedness and/or fail to reach out to others to regulate their emotions may be at greater risk for adverse loneliness-related outcomes (e.g., detrimental physical and mental health outcomes; Hawkley & Cacioppo, 2010; Holt-Lunstad et al., 2010), particularly at the onset of a recent increase in loneliness. Indeed, greater levels of social connectedness – especially for individuals who value or desire social connectedness – might confer protection from loneliness-related negativity (Jones et al., 1981; Qualter et al., 2013; Vanhalst et al., 2017). For example, greater levels of social connectedness might represent access to social support and resources for engaging in effective interpersonal regulation. Likewise, relying on others to regulate emotions may confer protection from loneliness-related negativity through mechanisms ranging from improved social cohesion in the face of a shared adversity (e.g., the COVID-19 pandemic), more secure internal working models (Altan-Atalay, 2019), or even practice effects (i.e., regulating in an interpersonal context may boost intrapersonal regulation abilities, although these are only weakly related constructs; Williams et al., 2018).

To test this putative mechanism, we measured feelings of acute feelings of pandemic-related loneliness, social connectedness, IER, and loneliness-related negativity in a sample of U.S.-based adults several times during the COVID-19 pandemic. Self-report measures were used to assess loneliness, social connectedness, and IER. For our outcome measure of loneliness-related negativity, we assessed valence bias – the trait-like tendency to categorize emotionally ambiguous signals as having a more positive or negative meaning (Neta et al., 2009). Valence bias is measured using a behavioral task in which participants categorize emotionally ambiguous social stimuli as positive or negative. Thus, it offers greater ecological validity and is less sensitive to demand characteristics or estimation biases than self-report measures of negativity. Further, valence bias is both a stable (Harp et al., 2022) and generalizable response (Harp et al., 2021; Neta et al., 2013) that is linked to internalizing behaviors and negative affect (e.g., depression symptoms, neuroticism; Brock et al., 2022; Neta & Brock, 2021; Petro et al., 2021) as well as social connectedness (Neta & Brock, 2021). Nonetheless, valence bias is also sensitive to context. For example, manipulations that serve to increase or reduce stress have been shown to shift valence bias in the negative or positive direction, respectively (Brown et al., 2017; Harp et al., 2022). In particular, an increased negative valence bias has also been demonstrated in response to higher perceived stress during the pandemic (Raio et al., 2021). As such, given loneliness is associated with heightened sensitivity to negative social cues and generalized negativity bias (Jones et al., 1981; Qualter et al., 2013; Vanhalst et al., 2017), we predicted that individuals experiencing greater loneliness during the pandemic would be expected to have – at least transiently – an increase in negative valence bias. Here, we tested whether loneliness was related to a more negative valence bias during the COVID-19 pandemic, and whether social connectedness and IER strategies buffered the loneliness-related negativity associated with the pandemic.

2. Method

Participants. Data were collected from a large cross-sectional sample via Amazon's Mechanical Turk (Mturk) and advertisements posted to social media (e.g., Twitter) during the early part of the COVID-19 pandemic (i.e., March-April 2020), and again at two later times (i.e., Fall 2020 [October-November], Spring 2021 [March-April]). We specified a pre-registered sample size of approximately 500 participants, which would allow us to detect relatively small effects observed in the literature (e.g., interactions of emotion regulation tendencies with social anxiety to predict loneliness; $r = 0.12$-0.14; O'day et al., 2019) in a highly powered design. Specifically, G*Power 3.1 reports that a linear regression with ten predictors would be 80 % powered for detecting a small effect size ($f^2 = 0.02$) at alpha of 0.05 with a sample size of 395 participants. Thus, we were well-powered for the present investigation. To be eligible, participants needed to indicate that they were aged 18 years or older, native English speakers, and had no history of psychological or neurological disorder. Of the 1,278 eligible participants that initiated the study (US$0.10 compensation), 762 completed the primary task (US$4.90 compensation). Those that completed the full experiment received total monetary compensation of US$5.00. Of these, 81 participants were removed due to insufficient trials following reaction time cleaning (i.e., < 75 % or 105 trials, described below) and 14 were removed after being identified as duplicate subjects (i.e., identical Mturk IDs). An additional 102 participants were removed for failing to pass a data quality check (described below). Thus, the final sample for the primary analyses consisted of 565 participants (297 female, 266 male, 2 other; $N_{Mturk} = 423$; $N_{Social\ Media} = 142$), ages 18–89 ($M(SD) = 38.46$ (13.40)). Of these participants, 432 were White (not of Hispanic origin), 35 were Black (not of Hispanic origin), 33 were Asian, 8 were American Indian or Alaskan Native, 2 were Native Hawaiian or Pacific Islander, 46 Hispanic or Latino, and 9 Other). All procedures were approved by the local IRB (Approval #20200520425EP).

Procedure. The task was administered using Gorilla Experiment Builder (Anwyl-Irvine et al., 2019), and was only accessible to participants in the United States through a computer (i.e., no phones or tablets). Participants were randomly assigned to pseudorandom presentation orders of six task blocks (two blocks each of face, scene, and word stimuli; see Harp et al., 2021). The face blocks consisted of 24 trials: 12 ambiguous (surprised) and 12 clear – 6 positive (happy) and 6 negative (angry). The facial expressions were selected from the NimStim (Tottenham et al., 2009) and Karolinska Directed Emotional Faces (Lundqvist et al., 1998) collections. The scene blocks also consisted of 24 trials: 12 ambiguous and 12 clear – 6 positive and 6 negative – all taken from the International Affective Picture System (Lang et al., 2008). The word blocks consisted of 44 trials: 22 ambiguous and 22 clear – 11 positive and 11 negative. The words were shown in all capital letters in black font on a white background.

Within each block, all stimuli were preceded by a 1500 ms fixation cross and presented for 500 ms in a randomized presentation order. Participants responded by pressing either the "A" or "L" key on their keyboard, with the response keys counterbalanced across participants. If participants did not make a response within 2000 ms, no response was recorded and the task advanced to the next trial. In the event of multiple responses during presentation of a single stimulus, only the first response was retained for analysis. The percent negative categorizations for each stimulus type were then calculated out of the total number of trials for that condition (excluding omissions; Neta et al., 2009). For example, if a participant categorized 60 % of ambiguous words as negative, that individual's percent negative categorizations for words would be 60 %.

After the valence bias task, participants completed a series of survey measures described below. Additional measures of interest were collected but are beyond the scope of this report and thus not reported here (see pre-registration for more details at https://osf.io/t7sr6/).

Measures. *Valence bias.* Valence bias was defined as a latent construct which represents the shared variability among responses to emotionally ambiguous faces, scenes, and words. Responses to each stimulus type were first converted to the percentage of negative categorizations within each stimulus type. For example, the valence bias in response to faces would be 75 % for an individual that rated 18 out of 24 ambiguous faces as negative. The latent construct was standardized such that the mean was fixed to zero and each unit of the measure represents a single standard deviation.

Interpersonal emotion regulation (IER). IER was assessed with the Interpersonal Regulation Questionnaire (IRQ; Williams et al., 2018). This 16-item scale consists of four separate subscales which assess four unique dimensions: interpersonal regulation of positive versus negative affect, as well as how frequently (i.e., tendency) and effective (i.e., efficacy) are these regulation attempts. These dimensions produce four subscores: (1) positive – tendency, (2) positive – efficacy, (3) negative – tendency, and (4) negative – efficacy. Participants provided responses to each of the 16 questions on a 7-point Likert scale (1 = Strongly Disagree, 7 = Strongly Agree), and the ratings are summed for a total composite score (possible range = 16–112, observed range = 18–112). Subscale composites were also calculated. The total scale showed excellent internal consistency in this sample (Cronbach's alpha = 0.92).

Social connectedness. Social connectedness was assessed using the Social Connectedness Scale developed by Lee and Robbins (1995). This scale is used to measure perceptions of the self in relation to others. Specifically, the measure is intended to assess the degree of emotional closeness or connectedness among an individual and others, including friends and society more broadly. For example, questions include items like "I catch myself losing all sense of connectedness with society" and "I don't feel I participate with anyone or any group." Participants responded to each of the eight statements using a 6-point Likert scale (1 = Strongly Disagree, 6 = Strongly Agree). All items were reverse scored and summed to create a total composite score (possible and observed range = 8–48). The scale showed excellent internal consistency in this sample (Cronbach's alpha = 0.96).

Loneliness. Loneliness was assessed with a 7-point Likert scale. Specifically, participants were asked, "When you have thought about the coronavirus pandemic over the past week, has it made you feel **LONELY**?" Responses ranged from (0) "No – not at all" to (3) "Yes – somewhat" to (6) "Yes – extremely." Notably, this question targeted participants perceptions of loneliness directly related to the COVID-19 pandemic, rather than assessing loneliness as a more stable or tonic experience. In other words, we sought to capture the degree to which the shared adverse experience of the pandemic resulted in acute increases in feelings of loneliness (i.e., over the period of one week), rather than assessing chronic loneliness (e.g., by using more fine-grained measures or more multi-dimensional assessments of loneliness; Gierveld & Tilburg, 2006; Russell, 1996).

Control variables. Given previous work that has linked differences in valence bias to age and gender, we included both measures as covariates in our analyses. In addition, we included self-reported ease of social distancing (i.e., how easy is it for you to maintain social distancing guidelines? on a 7-point Likert scale from (-3) Strongly Disagree to (3) Strongly Agree). We expected ease of social distancing might impact the pandemic-related influences on categorizations of ambiguity as those facing greater difficulties related to social distancing may react more negatively to ambiguity/risk in the pandemic context. Importantly, previous work has shown age and gender-related differences in valence bias (Neta and Tong, 2016; Neta et al., 2019), and that social distancing behavior varies across individuals according to personality traits, particularly in the absence of strong social norms guiding such behavior (Ludeke et al., 2021).

Analysis. All data cleaning, analyses, and visualizations were completed using R (Version 4.2.1; R Core Team, 2021) and Mplus (Muthén & Muthén, 2011). De-identified data and analysis script are available here: https://osf.io/sqbtj/. Only participants' first response to each stimulus presentation was retained for calculating the percent negative categorizations for each stimulus type. As in previous work (Harp et al., 2021), trials with reaction times<250 ms (n = 8,024) or larger than 3 SDs above participant means (n = 1,275) were removed prior to calculating percent negative categorizations for each stimulus type. Then, participants with<75 % of trials retained after reaction time trimming (i.e., < 105 trials) were removed prior to statistical analysis. Additionally, participants that failed to categorize clearly positive and clearly negative stimuli above 60 % accuracy for two or more stimulus categories were removed (n = 102), as in previous work (Harp et al., 2021). Participants that only failed to categorize stimuli for a single stimulus type (i.e., faces, scenes, or words) had data for that stimulus type treated as missing and data for the remaining categories was retained for analysis.

Pearsons correlations with pairwise deletion were computed using the rcorr function in the Hmisc package (Harrell, 2021) and model-implied correlations were computed for the latent variable. For structural equation modeling, we used the lavaan package in R (Rosseel, 2012). Specifically, we constructed a latent measure of valence bias using three observed indicator variables: face, scene, and word bias. This latent measure was then standardized to have a mean of 0 and variance of 1, and factor loadings for each indicator were estimated. After, the latent measure of valence bias was regressed on feelings of loneliness, social connectedness, IER and their interactions.[2] These three variables were standardized prior to analysis to ease interpretation. We also controlled for age, gender (treated as binary due to the small number of participants not identifying as male or female), and self-reported social distancing behavior (i.e., ease of maintaining 6 + feet distance) by including these as covariates. Missing data were addressed using maximum likelihood estimation, and robust (Huber-White) standard errors and scaled test statistics were used to account for non-normality. Significant three-way interactions were probed using a combination of the pick-a-point and regions of significance, or Johnson-Neyman, approaches. Specifically, analyses were conducted by calculating the conditional effect of the focal predictor (loneliness, "x") at each level of the first moderator (IRQ, "w") for three representative levels (i.e., −1 SD, mean, +1 SD) of the second moderator (social connectedness, "z").

[2] An analysis using each indicator variable (faces, scenes, words) as the outcome, rather than the latent valence bias measure, is available in the Supplementary Material.

3. Results

Bivariate relationships. We first assessed bivariate relationships, which were in the expected directions (see Table 1 for descriptive statistics, Table 2 for correlations). The relationships among the three indicators of the latent valence bias measure were all positively correlated ($r = 0.31$ to 0.43), although the correlations were small to moderate in magnitude, as in prior work (Harp et al., 2021; Neta & Brock, 2021). In addition, a more negative valence bias (i.e., higher values) tended to be related to higher levels of COVID-related loneliness ($r = 0.14$) and lower social connectedness ($r = -0.16$). Replicating previous work, older age tended to be related to a more positive valence bias ($r = -0.20$; Neta & Tong, 2016). Additionally, participants identifying as females showed a more negative bias than those identifying as males ($r = -0.16$; Neta et al., 2019). There was also a tendency for those who had an easier time practicing social distancing to show a more positive bias ($r = -0.16$).

The strongest bivariate relationship among the predictors was that of social connectedness and loneliness ($r = -0.43$), such that higher social connectedness was associated with lower loneliness. However, this relationship was not so strong as to suggest issues with discriminant validity, and an exploratory factor analysis confirms that the loneliness item did not load onto the social connectedness factor (see Figure S1).

Structural equation modeling. We tested the fit of our full structural equation model and found that the global fit indices were acceptable (Robust CFI = 0.97; Robust TLI = 0.96; Robust RMSEA = 0.03; 90 % CI = [0.00, 0.05]; SRMR = 0.02). After confirming acceptable global fit, we assessed each predictor in the regression. The path diagram of this model with unstandardized estimates is shown in Fig. 1. The three-way interaction among loneliness, IER, and social connectedness was not significant ($z = -1.85$, $p = .06$; see Table 3 for full model results).

Given the diverse nature of IER strategies, we next assessed this interaction for each subscale of the IRQ separately. We found a significant effect for the positive – tendency subscale, specifically, which measures the tendency to seek out others for regulating positive emotions (IRQ-PT; $z = -3.19$, $p = .001$; see Table 3). Similar to the model using total IRQ scores, the interaction for the positive – efficacy subscale was not significant ($z = -1.85$, $p = .06$). There was also no evidence of a three-way interaction effect for either of the negative subscales (IRQ-NT; $z = 0.16$, $p = .88$; IRQ-NE; $z = -0.68$, $p = .50$; Table 3).

To probe the significant interaction effect for IRQ-PT, we next completed a regions of significance analysis, assessing the conditional relationship between loneliness and a more negative valence bias at each level of IRQ-PT for three different levels of social connectedness (i.e., −1 SD, mean, +1 SD). The results of this analysis are shown in Fig. 2. In short, for those with average or higher social connectedness, loneliness was associated with an increasingly negative bias with decreasing IRQ-PT. Specifically, at higher levels of social connectedness (+1 SD; Fig. 2a), loneliness was associated with a more negative valence bias beneath approximately average levels of IRQ-PT ($z = 0.03$). At higher levels of IRQ-PT, the effect of loneliness was no longer significant, suggesting that IRQ-PT buffers or mitigates the relationship between loneliness and a more negative valence bias. At average levels of social connectedness (mean; Fig. 2b), loneliness was associated with a more negative valence bias from relatively low IRQ-PT scores ($z = -1.85$) to average IRQ-PT scores ($z = 0.00$). Again, at IRQ-PT scores outside of this range, the effect of loneliness was no longer significant, suggesting that IRQ-PT may still somewhat buffer the relationship between loneliness and a more negative valence bias. At low levels of social connectedness (-1 SD; Fig. 2c), there was no significant relationship between loneliness and valence bias at any level of IRQ-PT.

Notably, the inclusion of additional covariates does not impact the overall pattern of findings for either the IRQ total or IRQ-PT scales. More specifically, the three-way interaction with IRQ-PT remains significant even when accounting for individual differences in depression (see Table S1) or for differences between the Mturk and social media samples (see Table S2). There were, however, some stimulus-specific differences, in that an analysis of each stimulus type separately showed that the three-way interaction with IRQ-PT was primarily driven by responses to the emotionally ambiguous scenes rather than faces or words (see Table S3). That is, there were similar stimulus-specific differences evident in the full model as reported in the bivariate relationships above.

Replication analyses. To examine the replicability and contextual sensitivity of the present findings, we next fit the otherwise identical statistical model to measurements collected at later times in the COVID-19 pandemic. Specifically, we examined whether the three-way interaction emerged – either for the total IRQ score or the IRQ-PT subscale – in the Fall 2020 as well as the Spring 2021 data (see Table S4 for complete model results). In short, neither model produced a significant three-way interaction, suggesting that the present findings were indeed sensitive to the recent onset of a shared adversity (i.e., the COVID-19 pandemic). There was, however, a two-way interaction between IRQ and Social Connectedness in the Spring 2021 data. Probing the interaction effect revealed that higher levels of social connectedness were associated with a more positive bias only at IRQ levels above z = 1.13 (see Figure S2 for regions of significance plot).

Table 1
Descriptive statistics for observed measures.

Measure	M (SD)	Possible range
Face Bias	57.94 (27.09)	0–100
Scene Bias	49.50 (20.27)	0–100
Word Bias	49.97 (19.99)	0–100
Loneliness	2.07 (1.99)	0–6
IER Total	74.62 (16.25)	16–112
Soc Conn	23.01 (10.55)	8–48
Age	38.45 (13.40)	18+
Gender	0.47 (0.50)	0–1
Ease of Social Distancing	1.77 (1.41)	−3–3

Note: IER = Interpersonal emotion regulation, Soc Conn = Social connectedness, Gender (0 = Female, 1 = Male).

4. Discussion

Here, we tested whether two different resilience factors (trait-like social connectedness and the use of these social connections to regulate one's emotions) moderated loneliness outcomes during the early days of the COVID-19 pandemic. Specifically, in a series of moderation models, we assessed whether social connectedness and interpersonal emotion regulation (IER) played a role in mitigating the associative relationship between pandemic-related loneliness and a more negative valence bias. Consistent with our predictions, a greater sense of loneliness in the early stages of the pandemic was related to a more negative bias. This relationship was buffered among those with average or above average levels of social connectedness who also reported engaging in average or above levels of IER for positive emotions, specifically in the early stages of the pandemic (i.e., at the height of social distancing and lockdown measures). In other words, individuals with higher trait levels of social connectedness that tend to use those social connections to share experiences of positive emotion more often showed no association between loneliness and a more negative valence bias. Conversely, those who did not tend to share positive emotions with others showed a link between feelings of loneliness and a more negative valence bias. Below, we discuss the implications of these effects for psychological well-being and how these findings might inform interventions intended to mitigate adverse loneliness-related outcomes.

4.1. Implications for psychological well-being

First, the findings provide initial evidence linking higher levels of loneliness to a more negative valence bias. Given research linking the adverse sequelae of loneliness (e.g., physical inactivity, elevated internalizing symptoms; Hawkley et al., 2006, 2009, 2010; Holt-Lunstad

Table 2
Bivariate relationships among observed and latent measures.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Face Bias	1.00	0.43***	0.31***	0.56***	0.10*	0.05	−0.04	−0.13**	−0.07	−0.07
2. Scene Bias		1.00	0.40***	0.78***	0.10*	−0.02	−0.14***	−0.16***	−0.10*	−0.15***
3. Word Bias			1.00	0.55***	0.05	0.01	−0.06	−0.05	−0.17***	0.00
4. Valence Bias+				1.00	0.14***	−0.00	−0.16***	−0.20***	−0.16***	−0.16***
5. Loneliness					1.00	0.11**	−0.43***	−0.11**	−0.13**	−0.09*
6. IER						1.00	0.29***	−0.01	−0.19***	0.03
7. Soc Conn							1.00	0.16***	−0.01	0.11**
8. Age								1.00	−0.18***	0.11***
9. Gender									1.00	−0.08
10. Ease of Social Distancing										1.00

Note: IER = Interpersonal emotion regulation, Soc Conn = Social connectedness, Gender (0 = Female, 1 = Male). +This represents a latent construct of valence bias; correlations are model-implied. * = p ≤ 0.05, ** = p ≤ 0.01, *** = p ≤ 0.001.

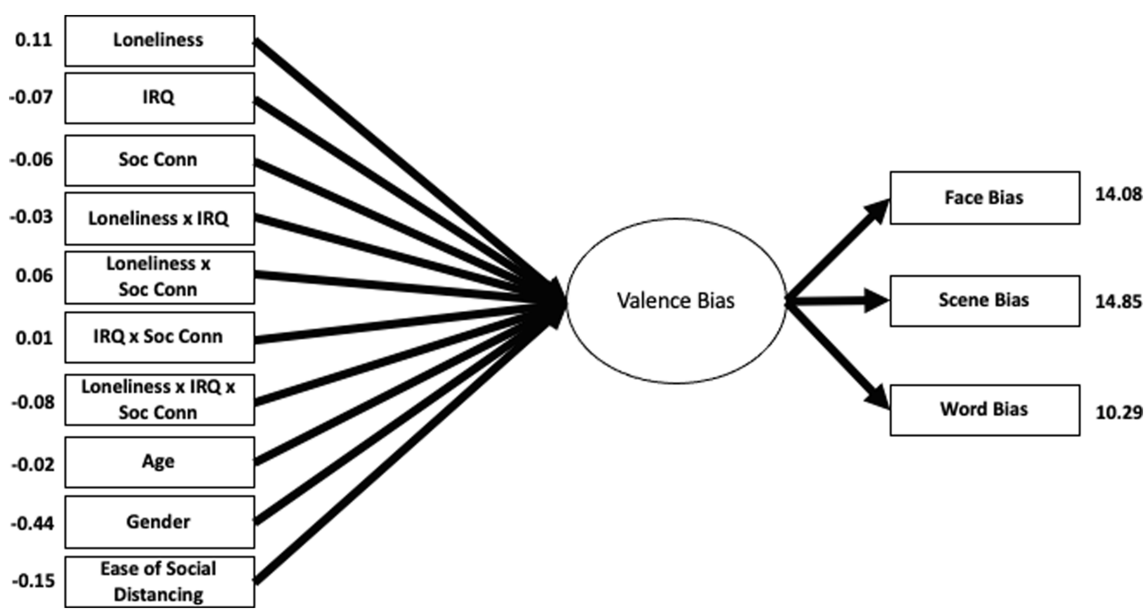

Fig. 1. Path Diagram of Structural Equation Model. Note: Factor loadings are shown for the indicators of valence bias and unstandardized estimates are shown for exogenous variables. Intercept and residual estimates are not shown. Soc Conn = Social Connectedness, Gender (0 = Female, 1 = Male).

et al., 2010; Wilson et al., 2007) with a more negative valence bias (Neta et al., 2019; Neta & Brock, 2021; Petro et al., 2021), it could be that exacerbated negativity represents a mechanism through which loneliness leads to these adverse outcomes. Thus, interventions that effectively reduce loneliness and its outcomes (e.g., exacerbated negativity bias; Jones et al., 1981; Qualter et al., 2013; Vanhalst et al., 2017) are sorely needed. Future research could integrate measurements of physical and psychological well-being throughout interventions that reduce loneliness and shift valence bias to tease apart directionality among the measures. For instance, mindfulness-based interventions are effective for both reducing loneliness (Creswell et al., 2012) and reducing a negative valence bias (Harp et al., 2022).

Additionally, the present findings corroborate previous research linking social connectedness to valence bias and underscore the importance of social connectedness for improving psychological well-being. Recent findings have shown that higher social connectedness predicts a more positive valence bias, even when accounting for differences in negative affect (Neta & Brock, 2021). The present findings support this earlier work, but also extend it to show that one's degree of social connectedness modulates the impact of interpersonal emotion regulation on the relationship of loneliness outcomes. More specifically, the beneficial effects of IER in buffering loneliness-related negativity early in the pandemic were only evident at average and above levels of social connectedness, suggesting that some minimal level of social connection may be necessary to reap the benefits of IER. Such a pattern suggests that individuals with higher levels of social connectedness may be better equipped to leverage and benefit from interpersonal regulation, ultimately strengthening psychological well-being. Indeed, social connectedness protected against increased internalizing symptoms (depression, anxiety) and decreased life satisfaction early in the pandemic (Magson et al., 2021), and the use of IER could serve as the underlying mechanism.

Table 3
Results of Moderation Analyses.

	Unstandardized Coefficient	95 % CI		z	p
Model #1: IRQ Total					
Loneliness	0.11	−0.02	0.24	1.65	0.10
IRQ	−0.07	−0.19	0.05	−1.17	0.24
Soc Conn	−0.06	−0.18	0.07	−0.92	0.36
Loneliness × IRQ	−0.03	−0.13	0.07	−0.60	0.55
Loneliness × Soc Conn	0.06	−0.05	0.16	1.02	0.31
IRQ × Soc Conn	0.01	−0.09	0.11	0.18	0.86
Loneliness × IRQ × Soc Conn	−0.08	−0.16	0.01	−1.85	0.06
Age	**−0.02**	**−0.02**	**−0.01**	**−4.05**	**< 0.001**
Gender	**−0.44**	**−0.67**	**−0.22**	**−3.85**	**< 0.001**
Ease of Social Distancing	**−0.15**	**−0.25**	**−0.04**	**−2.70**	**0.007**
Model #2: IRQ-PT					
Loneliness	**0.12**	**0.00**	**0.23**	**1.96**	**0.05**
IRQ-PT	−0.11	−0.22	0.01	−1.84	0.07
Soc Conn	−0.06	−0.17	0.05	−1.05	0.30
Loneliness × IRQ	0.06	−0.03	0.16	1.28	0.20
Loneliness × Soc Conn	−0.06	−0.16	0.04	−1.21	0.23
IRQ × Soc Conn	−0.02	−0.11	0.08	−0.36	0.72
Loneliness × IRQ × Soc Conn	**−0.14**	**−0.22**	**−0.05**	**−3.19**	**0.001**
Age	**−0.02**	**−0.02**	**−0.01**	**−4.13**	**< 0.001**
Gender	**−0.43**	**−0.66**	**−0.21**	**−3.78**	**< 0.001**
Ease of Social Distancing	**−0.14**	**−0.25**	**−0.04**	**−2.60**	**0.009**
Model #3: IRQ-PE					
Loneliness	**0.14**	**0.01**	**0.27**	**2.06**	**0.04**
IRQ-PE	**−0.14**	**−0.26**	**−0.02**	**−2.27**	**0.02**
Soc Conn	−0.02	−0.15	0.11	−0.31	0.76
Loneliness × IRQ	0.06	−0.05	0.17	1.11	0.27
Loneliness × Soc Conn	−0.04	−0.14	0.07	−0.71	0.48
IRQ × Soc Conn	0.04	−0.06	0.14	0.79	0.43
Loneliness × IRQ × Soc Conn	−0.08	−0.17	0.01	−1.85	0.06
Age	**−0.02**	**−0.03**	**−0.01**	**−4.21**	**< 0.001**
Gender	**−0.44**	**−0.66**	**−0.22**	**−3.94**	**< 0.001**
Ease of Social Distancing	**−0.15**	**−0.26**	**−0.04**	**−2.78**	**0.01**
Model #4: IRQ-NT					
Loneliness	0.03	−0.09	0.15	0.52	0.60
IRQ-NT	**0.14**	**0.03**	**0.25**	**2.48**	**0.01**
Soc Conn	**−0.14**	**−0.27**	**−0.02**	**−2.32**	**0.02**
Loneliness × IRQ	0.05	−0.06	0.16	0.94	0.35
Loneliness × Soc Conn	0.01	−0.09	0.11	0.17	0.86
IRQ × Soc Conn	−0.06	−0.16	0.04	−1.19	0.24
Loneliness × IRQ × Soc Conn	0.01	−0.08	0.09	0.16	0.88
Age	**−0.01**	**−0.02**	**−0.01**	**−3.44**	**0.001**
Gender	**−0.39**	**−0.62**	**−0.17**	**−3.39**	**0.001**
Ease of Social Distancing	**−0.14**	**−0.25**	**−0.03**	**−2.54**	**0.01**
Model #5: IRQ-NE					
Loneliness	0.11	−0.02	0.24	1.65	0.10
IRQ-NE	**−0.16**	**−0.29**	**−0.03**	**−2.36**	**0.02**
Soc Conn	−0.05	−0.17	0.07	−0.78	0.43
Loneliness × IRQ	0.07	−0.04	0.18	1.28	0.20
Loneliness × Soc Conn	−0.09	−0.22	0.03	−1.50	0.13
IRQ × Soc Conn	0.03	−0.07	0.13	0.58	0.56
Loneliness × IRQ × Soc Conn	−0.03	−0.13	0.06	−0.68	0.50
Age	**−0.02**	**−0.02**	**−0.01**	**−3.94**	**< 0.001**
Gender	**−0.48**	**−0.71**	**−0.25**	**−4.13**	**< 0.001**
Ease of Social Distancing	**−0.13**	**−0.24**	**−0.02**	**−2.40**	**0.02**

Note: Soc Conn = Social Connectedness, IRQ = IRQ Total, IRQ-PT = IRQ Positive Tendency, IRQ-PE = IRQ Positive Efficacy, IRQ-NT = IRQ Negative Tendency, IRQ-NE = IRQ Negative Efficacy, Gender (0 = Female, 1 = Male). Statistically significant effects ($p < .05$) are bolded.

4.2. Mitigating adverse loneliness-related outcomes during shared adversity

One of the unique and defining features of the COVID-19 pandemic is its ubiquity; it impacted lives across the globe (albeit some were impacted more – and in different ways – than others). As a result, the early pandemic provides a crucial context for the present findings through its creation of a shared adversity. This shared adversity allows for a unique context with which to explore the effectiveness of IER strategies (e.g., IER of negative vs positive affect). Though IER of both negative and positive affect could plausibly mitigate loneliness-associated outcomes during shared adversity, we found evidence of a specific role for sharing positive emotions. One explanation for this is that, although expressing negative emotions is generally beneficial in interpersonal contexts (e.g., improving communication; Butler et al., 2003), the sharing of negative emotions also spurs vicarious experience sharing and empathic concern in others (Zaki, 2020). In the context of a shared and uncontrollable adversity, experience sharing and empathic concern could have unintended downsides, like motivating others to avoid the individual expressing negative affect (Lerner & Simmons, 1966). Certainly, sharing negative emotions with others that are experiencing similar hardships can spread such feelings (i.e., peer contagion; Stevens & Prinstein, 2005) rather than provide comfort to anyone in a context of shared adversity.

Conversely, the sharing of positive emotional experiences can provide myriad benefits, including the up-regulation of one's own positive emotions (e.g., higher state- and trait-level positive affect; Langston, 1994; Livingstone & Srivastava). Likewise, sharing positive emotion promotes stronger social ties (Lakey & Orehek, 2011), which would likely alleviate feelings of loneliness as individuals grow closer. Indeed, the "social reconnection hypothesis" posits that excluded or lonely individuals exhibit an increased motivation to see others as positive or friendly, and that such a drive is more profound for individuals who are more socially optimistic (Maner et al., 2007). In line with the social reconnection hypothesis, our results show that individuals who share positive emotions with others more often – perhaps reflecting greater social optimism – also see others in a more positive (or at least less negative) light. The strengthening of social ties in this manner might be particularly adaptive in the context of shared adversity because it bolsters social support systems. Such a bolstering of social support during adversity can lead to desirable outcomes (e.g., creativity/innovation among teammates; Bastian et al., 2018), perhaps explaining why interpersonal emotion regulation is linked to improved coping efficacy during COVID-19 (Arbel et al., 2020). Thus, a more fruitful direction than many current approaches for targeting loneliness, especially during shared adversity, is encouraging individuals to share positive emotions.

4.3. Limitations

One notable limitation of the present study is that it cannot address

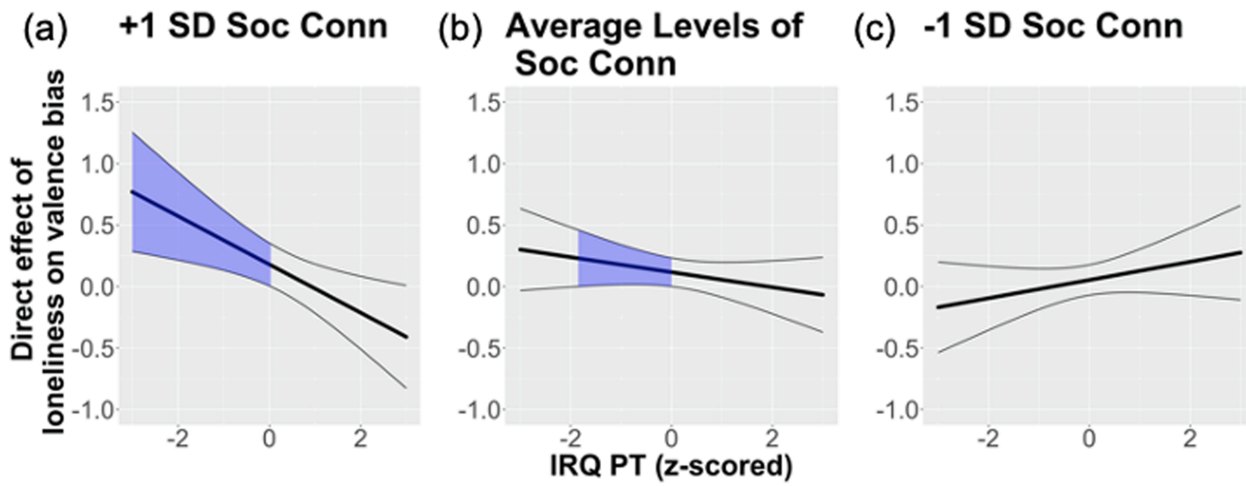

Fig. 2. Regions of significance for the relationship between loneliness and a more negative valence bias at each level of IRQ for (a) + 1 SD, (b) mean, and (c) −1 SD social connectedness.

causality within a single timepoint, so future work might consider teasing apart whether loneliness causes a more negative valence bias or vice-versa. Although social motivational accounts suggest that loneliness precedes an increase in sensitivity to negative social signals and threats (Cacioppo et al., 2014), it could be the case that individuals with a more negative valence bias find uncertainty in social situations aversive, and thus experience loneliness due to avoidance of such scenarios. This pattern could be especially evident in the context of the pandemic, where exposure to disease represents an added uncertainty. Of course, experimental studies manipulating loneliness or valence bias, perhaps in the context of a period of significant change in social networks and connections (e.g., the transition from high school to college/university to the workforce), would be better suited to tease apart directionality.

Further, the nature of the pandemic as a shared adversity is likely an important contextual factor for the present findings; that is, it may not be the case that sharing of positive emotions is as crucial for buffering loneliness-related negativity in other contexts. Indeed, our replication analyses suggest that our primary finding is likely specific to the onset of a recent shared adversity, like the COVID-19 pandemic. That said, moderation effects involving interpersonal emotion regulation did emerge both in the immediate context of the early pandemic (Spring 2020) as well as a year later (Spring 2021). Though not identical effects, the pattern of findings point to a more generalized role for interpersonal emotion regulation in moderating relationships between state affect (e.g., acute loneliness) and more trait-like measures (e.g., social connectedness) and individual differences in valence bias (see also Brock et al., 2022). More specifically, the replication analyses suggest that, just as a stronger tendency to share positive emotions buffered acute loneliness-related negativity in the early pandemic, so too did such tendencies enhance the association between the more trait-like social connectedness and an increasingly positive valence bias later in the pandemic. Nonetheless, future research should consider replicating this effect in additional contexts, and with multi-dimensional measures of loneliness (Gierveld & Tilburg, 2006; Russell, 1996), to examine the generalizability of the findings beyond the present context to other shared adversities as well as non-adverse contexts. Certainly, a more fine-grained measurement of loneliness, such as a scale capable of disambiguating emotional loneliness (e.g., absence of an intimate relationship) and social loneliness (e.g., lacking a broader social network), could provide additional insight into the nature of the present effects (Gierveld & Tilburg, 2006; Russell, 1996; Weiss, 1973).

It is also worth noting that the relationship between social connectedness and valence bias varied somewhat across stimuli. That is, there were some stimulus-specific differences when examining relationships among the unique indicators of the latent valence bias measure (i.e., faces, scenes, and words, separately); social connectedness was only statistically significant for the emotionally ambiguous scenes and for the three-way interaction; see Table S4). Likewise, the relationship with loneliness was only evident for the faces and scenes. Such a pattern is in line with other recent findings showing stimulus-specific differences in the relationship between neuroticism and valence bias at various levels of IER (Brock et al., 2022). As such, future research might consider exploring if the qualities of specific stimuli – like the presence of other people – modulates loneliness-driven effects.

5. Conclusion

The present findings provide a novel understanding of how two putative resilience factors interact to shape the prevalence of adverse loneliness outcomes. In addition to directly linking feelings of loneliness to a more negative valence bias, the findings offer insight into a possible mechanism whereby IER mitigates this loneliness-related negativity, particularly in the context of shared adversity. Given the particular focus on IER here, future work could also test interventions that promote sharing of positive emotions with others (e.g., leveraging social media to increase sharing of positive emotions, encouraging meditation practices that foster positive emotions for others). Ultimately, these avenues could help to better characterize the directionality of the present effects and to further refine and improve interventions targeting loneliness and its sequelae.

Open practices

The study in this article followed open practices. Pre-registration (but not analysis plan) for the study is available at: https://osf.io/t7sr6/. Materials, data, and code for the study are available at https://osf.io/t7sr6/.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jrp.2022.104333.

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