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BRIEF ARTICLE

Lonely adolescents exhibit heightened sensitivity for facial cues of emotion

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ABSTRACT

Contradicting evidence exists regarding the link between loneliness and sensitivity to facial cues of emotion, as loneliness has been related to better but also to worse performance on facial emotion recognition tasks. This study aims to contribute to this debate and extends previous work by (a) focusing on both accuracy and sensitivity to detecting positive and negative expressions, (b) controlling for depressive symptoms and social anxiety, and (c) using an advanced emotion recognition task with videos of neutral adolescent faces gradually morphing into full-intensity expressions. Participants were 170 adolescents (49% boys; $M_{age} = 13.65$ years) from rural, low-income schools. Results showed that loneliness was associated with increased sensitivity to happy, sad, and fear faces. When controlling for depressive symptoms and social anxiety, loneliness remained significantly associated with sensitivity to sad and fear faces. Together, these results suggest that lonely adolescents are vigilant to negative facial cues of emotion.

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Human beings have a fundamental need to belong, as evidenced in numerous studies indicating that a satisfied need to belong contributes to well-being, whereas a frustrated need to belong impairs health (Baumeister & Leary, 1995). Particularly in adolescence, forming and maintaining positive social relationships is a key developmental task. During this period in life, social relations are very salient and powerful, and a frustrated need to belong may be particularly harmful for one's well-being (Prinstein & Giletta, in press). Indeed, feeling lonely—a key indicator of a frustrated need to belong—marks an increased risk for psychopathology and health problems in adolescence (Heinrich & Gullone, 2006).

Previous work indicated that lonely people may lack certain social skills that are necessary to initiate and maintain social relations (Jones, Hobbs, & Hockenbury, 1982). Specifically, it has been proposed that this lack in social skills reflects an underlying deficit in attending to and decoding social cues (Hall, Andrzejewski, & Yopchick, 2009). Indeed, a meta-analysis indicated that the ability to understand relatively unambiguous cues of discrete emotions was negatively related to a range of internalising problems, including loneliness, in childhood and adolescence (Trentacosta & Fine, 2010). Moreover, loneliness was found to be related to a lower ability to identify emotions in a series of still images and video clips in a sample of college students in Israel (Zysberg, 2012). By contrast, the social monitoring system theory posits that loneliness triggers enhanced attunement to positive and negative social information in the environment, and suggests that lonely people would be better rather than worse than their non-lonely peers on social cue detection tasks. For example, individuals with high belongingness needs (Pickett, Gardner, & Knowles, 2004) and individuals with fewer friends (Gardner, Pickett, Jefferis, & Knowles, 2005) were more accurate (but not faster) in labelling pictures of low-intensity facial emotions. Thus, although prior work has not examined this for loneliness, evidence suggests that loneliness-related constructs (e.g., few friends and high belongingness

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needs) are associated with better emotion recognition. Finally, in addition to studies supporting positive and negative associations between loneliness and emotion recognition, some studies found no association. For example, a recent study in Dutch college students indicated that loneliness was unrelated to emotion recognition using an emotion recognition task with dynamic stimuli and a micro-emotion expression recognition task (Lodder, Scholte, Goossens, Engels, & Verhagen, 2015).

Together, it remains unclear whether lonely adolescents are better or worse in emotion recognition. The present study aims to contribute to this debate by examining the association between adolescent loneliness and the ability to recognise sad, afraid, and happy facial expressions. In addition to examining accuracy (i.e., whether or not the emotion being expressed was correctly identified), the present study focuses on sensitivity to facial emotions (i.e., the level of emotion signal strength needed for correct identification). The contradicting findings from previous work call for more advanced methodologies to examine the association between loneliness and facial emotion recognition.

First, many previous studies have employed pictures of prototypical full-intensity facial emotional expressions, which offers limited sensitivity and limited ecological validity, given that facial emotional expressions in everyday social life are typically far less intense (Joormann & Godlib, 2006). To address this limitation, participants in the current study watched a series of neutral faces that gradually morphed into a full-intensity happy, sad, or fear expression. They were asked to press any key on the keyboard as soon as they detect an emotion, and then to identify the emotion they detected, allowing us to investigate differences in the emotional intensity needed to correctly identify an emotion.

Second, little attention has been dedicated to social cue detection in adolescence, which is surprising, given the developmental task of forming and maintaining positive social relationships in this period in life. Moreover, the majority of previous work with children or adolescents used pictures or videos of adult faces. Given that differences in neural processing of facial emotions on adult versus adolescent faces have been documented in adolescents (Marusak, Carré, & Thomason, 2013), and given the increased attunement to peers in adolescence (Prinstein & Giletta, in press), this study made use of a recently developed and validated picture set of emotional expressions in adolescents (Egger et al., 2011).

Third, an additional confounding factor is that deficits in facial emotion recognition have been linked to psychopathological symptoms that are highly correlated with loneliness, particularly depression and social anxiety (Collin, Bindra, Raju, Gillberg, & Minnis, 2013; Joormann & Gotlib, 2006), although those associations have also not consistently been replicated (Schofield, Coles, & Gibb, 2007; Smoller & Brosgole, 1993). Given that loneliness is a core feature of both social anxiety and depression, it could be that previous findings linking depression and social anxiety to social information processing biases are driven by loneliness. Therefore, by simultaneously examining loneliness, social anxiety, and depressive symptoms, the present study aimed to disentangle shared versus unique associations of those three variables with emotion recognition.

Finally, the role of gender and race was examined, given that women are generally better at facial emotion recognition than men (Montagne et al., 2005) and that participants are generally better at discriminating faces from their own race (Walker & Tanaka, 2003).

Method

Participants and procedure

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. All students in Grade 7 and 8 from three rural, low-income, schools in the southeastern USA were invited to participate. Participants were recruited using active parental consent and student assent. Of 1463 youths recruited to participate, 82.4% returned consent forms, and 74.4% of these parents provided consent. Among the group of students with parental consent, 96.4% of students provided assent, resulting in a sample of 868 students. Due to time constraints, the facial emotion recognition task was administered only in a random subsample ($n = 201$) of 8th grade students. In this subsample, 170 students completed both the depression and loneliness measures. Thus, data from 170 students were used in the present study. This final subsample did not differ from the total sample in terms of gender, race, and the main variables assessed at a previous time point (i.e., depression, anxiety, and a single-item loneliness measure). All participants in this study

were in Grade 8 (49% boys; M_{age} = 13.65 years, SD = 0.57, range = 13–15 years), and the sample was racially diverse (25% African–American, 38% Caucasian, 24% Hispanic, and 13% mixed race/other).

All measures were completed on computers in a classroom setting with groups of approximately 30 students, supervised by trained research assistants. Participants first completed the facial emotion recognition task, followed by the self-report questionnaires. Each participant was compensated with a $10 gift card. The university institutional review board approved all study procedures.

Measures

Facial emotion recognition task

Participants completed 3 practice trials (1 for each emotion) and 36 test trials (12 for each emotion) of computer-morphed faces that gradually transformed from a neutral to a full-intensity emotional expression (happy, afraid, or sad). Faces were taken from the validated NIMH Child Emotional Faces Picture Set (NIMH-ChEFS; Egger et al., 2011). A total of 6 female models (F3, F11, F19, F35, F39, F40; M_{age} = 13.00 year, SD = 1.79) and 6 male models (M3, M4, M7, M10, M14, M16; M_{age} = 14.17 year, SD = 1.47) were selected from this set, and each model represented each of the three emotions. Grey-scale images of the direct gaze pictures from each model were used to create the neutral-afraid, neutral-happy, and neutral-sad morph movies. To create each morph, we established 84 reference points across both of the images to be morphed (32 for face/neck/hairline, 20 for eyes, 20 for the mouth, 8 for eyebrows, and 4 for the nose). We used Morpheus software to create a movie displaying a continuously morphing image from 100% neutral to 100% emotional. Each movie lasted 20 seconds and the order of the movies was fully randomised across participants. The movies were presented in the middle of a 10.1-inch screen of an Acer Netbook. The size of each picture on the screen was 2.25″ (width) by 3″ (height). Each time, a fixation point appeared in the middle of the screen, followed by the movie. Participants were instructed to press the space bar as soon as they saw an emotion they could identify. As soon as participants pressed the space bar, the movie stopped and disappeared, and a rating screen appeared asking to identify the emotion as afraid, sad, or happy.

Two sets of summary variables were obtained from this task: accuracy (the proportion of each emotion type correctly identified) and sensitivity (the average amount of time/morph required to correctly identify each emotion, based only on trials for which the participant responded with the correct target emotion). Standardised residual scores were calculated to detect outliers. For 10 participants, outliers were identified and these scores were recoded into missing values (7 participants had a score <−3.00 on at least one of the accuracy variables, 3 participants had a score >3.00 on at least one of the sensitivity variables).[1] Sensitivity originally ranged from 0 to 20,000 ms, but was rescaled towards a 0–100 scale (by dividing by 20,000), as this scale provides a more useful metric in terms of percentage morph required for an individual to identify an emotion.

Loneliness

A 5-item adaptation of the Loneliness and Social Dissatisfaction Questionnaire (LSDQ, Cassidy & Asher, 1992) was used to measure loneliness. Three "pure" loneliness items from the LSDQ (e.g., Are you lonely at school?) were selected (cf. Parker & Asher, 1993) and combined with two additional loneliness items developed by Ladd and Burgess (1999) (e.g., Are you sad and alone at school?). This 5-item loneliness scale has previously shown good validity and reliability (Ladd & Burgess, 1999). Internal consistency in this sample was excellent (Cronbach's alpha = .95).

Social anxiety

Social anxiety was measured using the 8-item Fear of Negative Evaluation subscale of the Social Anxiety Scale for Adolescents (SASA; La Greca & Lopez, 1998), which has been shown to have good construct validity (Inderbitzen-Nolan & Walters, 2000). All items (e.g., I worry about what others think of me) are answered on a 5-point scale ranging from 1 (*not true at all)* to 5 (*always true*). Internal consistency was good (Cronbach's alpha = .91).

Depressive symptoms

Participants completed the Short Mood and Feeling Questionnaire (SMFQ; Angold et al., 1995), which consists of 13 items (e.g., "I felt miserable or unhappy") describing depressive symptoms during the past 2 weeks. The SMFQ has been shown to have good construct and concurrent validity in samples of early

[1]Main analyses were also conducted with all outliers included and with winsorised values, which yielded highly similar results and conclusions.

Table 1. *Correlations and partial correlations between internalising problems and facial emotion recognition*

	Loneliness		Social anxiety		Depressive symptoms	
	r	Partial	*r*	Partial	*r*	Partial
Happy—Accuracy	−.03	.06	−.01	.07	−.04	−.09
Sad—Accuracy	.07	.00	.09	.00	.06	.01
Afraid—Accuracy	.11	−.10	.10	−.03	.16*	.16*
Happy—Sensitivity	−.20*	−.12	−.18*	−.06	−.14	.04
Sad—Sensitivity	−.19*	−.17*	−.15	−.10	−.06	.14
Afraid—Sensitivity	−.18*	−.19*	−.11	−.08	−.04	.12

Note: Partial *r* for loneliness represents correlations controlled for social anxiety and depressive symptoms; partial *r* for social anxiety represents correlations controlled for loneliness and depressive symptoms; partial *r* for depressive symptoms represents correlations controlled for loneliness and social anxiety.
*$p < .05$.

adolescents (Angold et al., 1995; Sharp, Goodyer, & Croudace, 2006). Each item was rated on a 3-point scale (0 = *not true*, 2 = *true*). To avoid item overlap with the loneliness measure, the item "During the past two week, I felt lonely" was dropped and all analyses were conducted with a 12-item version. Internal consistency was good (Cronbach's alpha = .92).

Results

The proportion of facial expressions correctly identified (i.e., accuracy) in this sample was .86 ($SD = .14$) for sad, .93 ($SD = .11$) for fear, and .97 ($SD = .05$) for happy. An exponential transformation was applied to correct for negative skewness in the accuracy variables, and all further analyses were conducted with these transformed variables. The accuracy of recognising happy faces was significantly higher than the accuracy of recognising sad faces (t (162) = 9.44, $p < .001$) and fear faces (t (162) = 4.44, $p < .001$), and the latter two also significantly differed from one another (t (162) = 5.85, $p < .001$). Regarding sensitivity, the proportion morph required for an individual to correctly identify happy faces was .37 ($SD = .13$), .50 for fear faces ($SD = .15$), and .61 for sad faces ($SD = .19$). Indeed, adolescents were more sensitive towards happy faces compared to sad faces (t (166) = 24.93, $p < .001$) and fear faces (t (165) = 17.90, $p < .001$), and adolescents were more sensitive towards fear faces compared to sad faces (t (165) = 17.90, $p < .001$).

Before conducting our primary analyses, we first examined whether there were any demographic differences in the study variables. A repeated-measures ANOVA with accuracy of the three emotions as repeated factors and with gender and race as fixed factors indicated no main effect of gender (F (2,158) = 0.68, $p = .51$, $\eta_p^2 = .01$) or race (F (4,276) = 0.92, $p = .45$, $\eta_p^2 = .01$) on accuracy of facial emotion recognition. Similarly, a repeated-measures ANOVA with sensitivity to the three emotions as repeated factors and with gender and race as fixed factors indicated no main effect of gender (F (2,163) = 0.04, $p = .96$, $\eta_p^2 = .00$) or race (F (4,280) = 1.68, $p = .28$, $\eta_p^2 = .02$) on sensitivity to facial emotion recognition. Further, a MANOVA with loneliness, social anxiety, and depressive symptoms as dependent variables and gender and race as fixed factors indicated no main effect of race (Wilks' $\lambda = .93$; F (6,282) = 1.78, $p = .10$, $\eta_p^2 = .04$), but strong gender differences (Wilks' $\lambda = .82$; F (3,163) = 12.01, $p < .001$; $\eta_p^2 = .18$). Specifically, univariate follow-up analyses indicated that girls were more lonely ($M = 2.37$, $SD = 1.21$), more socially anxious ($M = 2.37$, $SD = 0.91$), and more depressed ($M = 0.57$, $SD = 0.54$) than boys ($M = 1.54$, $SD = 0.81$, F (1,168) = 27.29, $p < .001$, $\eta_p^2 = .14$ for loneliness; $M = 1.75$, $SD = 0.63$, F (1,168) = 26.25, $p < .001$, $\eta_p^2 = .14$ for social anxiety; and $M = 0.23$, $SD = 0.32$, F (1,168) = 23.79, $p < .001$, $\eta_p^2 = .12$ for depressive symptoms).

Correlations indicated that loneliness was strongly related to depressive symptoms ($r = .76$, $p < .001$) and social anxiety ($r = .59$, $p < .001$). Also depressive symptoms and social anxiety were strongly interrelated ($r = .57$, $p < .001$). Moreover, accuracy and sensitivity were positively related for fear faces ($r = .21$, $p < .01$) and sad faces ($r = .28$, $p < .001$), but not for happy faces ($r = .02$, $p = .78$). As displayed in Table 1, loneliness, social anxiety, and depressive symptoms were not associated significantly with adolescents' *accuracy* in detecting facial displays of emotion. One exception, however, was the positive correlation between depressive symptoms and the accuracy of detecting fear faces, which remained significant after controlling for loneliness and social anxiety (i.e., partial correlation). Notably, loneliness was associated with greater *sensitivity* in detecting happy, sad, and fear faces. Specifically, adolescents reporting higher levels of loneliness were able to correctly identify facial displays of all three emotions at a lower morph level (i.e., signal

strength). Partial correlations indicated that the association between loneliness and increased sensitivity to fear and sad faces remained significant after controlling for social anxiety and depressive symptoms, whereas the association between loneliness and sensitivity to happy faces was no longer significant. Furthermore, social anxiety was associated with greater sensitivity to detecting happy faces, but this association was no longer significant when levels of loneliness and depressive symptoms were taken into account.

Finally, three regression analyses were conducted to further examine the effect of loneliness on sensitivity to facial cues of emotion (see Table 2).[2] In Step 1, gender was entered as a control variable, given the significant gender differences in loneliness, depression, and social anxiety. Also accuracy was entered as a control variable, to ensure that the association between loneliness and sensitivity to facial cues of emotion was not due to differences in accuracy. In Step 2, loneliness (mean-centred) was entered as an independent variable. In Step 3, depression and social anxiety (both mean-centred) were added as independent variables. In Step 4, finally, interaction terms were added between loneliness, on the one hand, and gender, depression, and social anxiety, on the other hand. Results of Step 2 were mostly in line with the bivariate correlations. Specifically, loneliness was associated with sensitivity to sad and fear faces, whereas the association with sensitivity to happy faces became non-significant after controlling for gender and accuracy. Results of Step 3, however, were not completely in line with the partial correlations. Although the effects of loneliness on sensitivity to fear and sad faces remained significant and the effect on sensitivity to happy faces disappeared (as was the case in the partial correlations), a suppressor effect emerged. Specifically, the effects of loneliness became stronger when controlling for social anxiety and depressive symptoms, whereas the non-significant (negative) correlation between depression and sensitivity to fear faces became positively significant when controlling for loneliness and social anxiety. Hence, we decided not to interpret the latter effect, and focus on the correlations and partial correlations to interpret unique versus shared effects of loneliness, depressive symptoms, and social anxiety. Results of Step 4, finally, indicated no interactions between loneliness, gender, depression, and social anxiety in the prediction of sensitivity to facial cues of emotion.

Table 2. *Standardised regression coefficients in predicting sensitivity to sad, happy, and fear faces*

	Sensitivity		
	Happy	Sad	Fear
Step 1			
Accuracy	.10	.30***	.22**
Gender	.18*	.10	.17*
Step 2			
Loneliness	−.13	−.16*	−.19*
Step 3			
Loneliness	−.19	−.28*	−.35**
Social anxiety	−.08	−.11	−.05
Depressive symptoms	.14	.24	.26*
Step 4			
Loneliness × Gender	.01	.08	.08
Loneliness × Social anxiety	.18	.00	.09
Loneliness × Depression	.04	.20	.15

*$p < .05$.
**$p < .01$.

Discussion

The goal of this study was to examine the unique association between loneliness and sensitivity to facial cues of emotion in adolescence while controlling for depressive symptoms and social anxiety. Results indicated that loneliness was associated with increased sensitivity to happy, sad, and fear faces. These findings provided partial support for the social monitoring system theory (Gardner et al., 2005; Pickett et al., 2004), given that lonely adolescents seem to outperform their non-lonely peers on facial emotion recognition. However, after controlling for internalising psychopathological symptoms or after controlling for accuracy and gender, lonely adolescents' advanced skills of recognising social cues at a lower intensity only occurred for negative, but not positive, expressions. Specifically, loneliness was uniquely associated with increased sensitivity to sad and fear faces, but not happy faces.

The latter result is in line with recent theories suggesting that the adaptive re-affiliation mechanisms inherently associated with loneliness, such as an increased focus towards positive and negative social cues in the environment, may turn into maladaptive biases, such as a hypervigilance for social threat in the environment (Cacioppo & Hawkley, 2009; Qualter et al., 2015). To date, most research supporting the hypervigilance for social threat theory focused on attention to, rather than detection of, emotional cues. Future work could extend this model by replicating our findings and by further examining whether lonely

[2]Tolerance varied between .87 and .88 and VIF varied between 1.13 and 1.15 in the regression analyses, suggesting no multicollinearity problems.

individuals are indeed more sensitive towards detecting negative rather than positive emotional cues.

Note that the aforementioned re-affiliation mechanisms are thought to be specific to loneliness (Qualter et al., 2015), and could potentially explain why the effects in this study are uniquely associated with loneliness, independent of depression and anxiety. Notably, unlike other studies (Collin et al., 2013), depressive symptoms and social anxiety were not consistently related to accuracy and sensitivity in facial emotion recognition in this sample. Although social anxiety was correlated with increased sensitivity to happy faces, this correlation disappeared when levels of loneliness and depressive symptoms were taken into account. Furthermore, correlations and partial correlations indicated that depressive symptoms were uniquely related to greater accuracy in detecting fear faces, but were unrelated to accuracy or sensitivity to sad and happy faces. Thus, despite the strong correlations between loneliness, depressive symptoms, and social anxiety, they were differently related to sensitivity to facial cues of emotion.

Some limitations should be considered when interpreting findings from this study. First and foremost, replication of these results is warranted in future work, particularly given the relatively modest effect sizes of the findings. Second, this study was cross-sectional in nature and no conclusions about directionality of effects can be drawn. Future longitudinal research could, for example, examine whether a history of chronic loneliness over time is associated with changes in sensitivity to emotional cues. Third, the design of our facial emotion recognition task implied that morph increment was perfectly correlated to the time needed to identify facial emotion. Thus, an alternate explanation of our findings is that loneliness is related to the time needed to identify facial emotion rather than sensitivity to emotional expression, per se. Fourth, no information was available about the race of the actors that provided the pictures for the facial emotion recognition task (Egger et al., 2011). Based on appearance, most actors were Caucasian, which represents a limitation of this study and which should be addressed in future research.

To conclude, this study indicated that loneliness is associated with increased sensitivity to facial emotions. Specifically, lonely adolescents needed less signal strength to detect sad and fear expressions. Whether and how this enhanced social information-processing skill is used to adjust social behaviour is a question to be addressed in future work.

Disclosure statement

No potential conflict of interest was reported by the authors.

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