Research in Brief

Expressions of interest: Exploring cognitive biases in facial emotion processing in loneliness

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Abstract

The current pilot study aimed to explore cognitive biases in lonely individuals, particularly in facial emotion processing. We recruited 20 participants (60% female, Mage = 36.8 years) to test the feasibility of two online tasks that assess the relationship between loneliness and facial emotion perception and interpretation, using age-matched faces. Task 1 measured the speed of emotion onset perception and decoding accuracy using morphed videos, while Task 2 examined the interpretation of neutral faces using static images. These complementary tasks allowed for a nuanced assessment of temporal dynamics of emotion perception and the interpretation of ambiguous facial emotion cues. Importantly, we controlled for depression, phobia and alexithymia. Loneliness was measured with the UCLA loneliness scale, and feedback on task experience was collected from participants. Findings indicated no significant effect of loneliness on emotion onset perception, however, social phobia and alexithymia emerged as predictors, suggesting these factors may impact on emotional processing in lonely individuals. Additionally, participants interpreted neutral faces as sad significantly more than other emotions, but loneliness did not reach significance. While pilot participants suggested useful changes overall, the study supported the feasibility of this online setup for further investigation into cognitive biases in loneliness.

Introduction

Loneliness is characterized by a perceived gap between desired and actual social relationships (Zysberg, 2012). In the UK, around 3.7 million people report feeling lonely often or always (Campaign to End Loneliness, 2023). Chronic loneliness is linked to mental health issues such as depression and anxiety, and physical health problems like elevated blood pressure, poor sleep, and even increased mortality (Office for National Statistics, 2022).

Cacioppo et al. (2014) proposed that loneliness evolved to act as a signal to repair social connections necessary for survival, yet it also triggers hypervigilance for social threats. A greater understanding of how loneliness affects emotional and cognitive processes is therefore relevant to facilitate social interactions (Rosenberg et al., 2020). Typically, these processes were studied with facial emotional processing paradigms, yielding mixed results so far. Some studies reported that lonely individuals were better at correctly recognising angry faces (Lodder et al., 2016), and demonstrated increased sensitivity to negative faces, such as sad and fear (Vanhalst et al., 2017). Meanwhile Bangee & Qualter (2018) reported that lonely adults demonstrate no attention biases to negative facial expressions or towards other emotional faces, however loneliness was associated with an initial orientation to angry faces rather than happy faces. Studies also suggested that lonely individuals misattribute neutral faces as sad (Cheeta et al., 2019).

Given these mixed findings, a pilot study was conducted employing both morphed videos and static images, enabling an in-depth investigation into the temporal dynamics of emotion

perception and the interpretation of ambiguous facial expressions. This evaluation provided a more robust investigation into the specific cognitive biases associated with loneliness. We addressed the following research questions:

RQ1: Are high-lonely individuals faster and more accurate in identifying negative facial emotion expressions (fear and sad) than positive facial emotion expressions (happy) when viewing morphed videos compared to low-lonely individuals?

RQ2: Are high-lonely individuals negatively biased in interpreting neutral facial expressions?

RQ3: How satisfied are participants with their experience in participating in this study?

Methods

Participants

20 participants (12 females, M_{age} = 36.8, *SD* = 11.5; range 25-79 years) with a minimum age of 25 and maximum age of 79 were recruited online on a web-based experiment software *"Gorilla.sc".* Participants were allocated to age-matched facial emotion tasks (young: 18 – 35 years old; 36 – 62 years old: middle aged; 63 and over: older). Eligibility criteria were being over 18 years old, and fluency in English. The study was approved by the UEA PSY ethics committee *(Ethic ID: ETH2223-1331)* and adhered to APA ethical guidelines (Young, 2017) and the Declaration of Helsinki (World Medical Association, 2013).

Materials and Measures

Face Dataset: We used a face dataset with colourful morphed videos and static images from the Center for Lifespan Psychology, Max Planck Institute for Human Development, Berlin, Germany (Ebner et al., 2010). The dataset included 18 actors (6 young, 6 middle-aged, 6 older), each presenting four facial emotions (happy, sad, fear, neutral).
Demographic Variables: Participants completed a questionnaire collecting socio-demographic information on biological sex, age, education level, employment status, relationship status, living condition, and ethnicity.
Loneliness: The UCLA Loneliness scale with 20 items (Version 3; Russell, 1996) was used to measure loneliness (α = .91). High and low levels of loneliness were determined by categorizing individuals based on a median split of their total scores.
Depression: We used the Center for Epidemiologic Studies-Depression scale (Ces-D; Radloff, 1977), which comprises of 20 items assessing the experience of depressive symptoms during the past week (α = .86).
Social phobia: We used the Social Phobia Inventory (SPIN; Connor et al., 2000), which consists of 17 items that measure characteristics of social anxiety consisting of fear, avoidance, and physical reactions (α = .97).
Alexithymia: We used the Toronto Alexithymia Scale (TAS-20; Bagby et al., 1994), which includes 20 items covering difficulty identifying feelings, difficulty describing feelings to others, and externally oriented thinking (α = .79).

Procedure

After consenting and responding the demographic questionnaire, participants completed the facial emotion processing tasks, followed by the loneliness, depression, social phobia and

alexithymia scales (Fig 1). The randomization was generated by the software at the beginning of each block, ensuring that each participant experienced a unique trial sequence.

Figure 1. The experiment flow

Task 1 – Facial Emotion Perception: Participants were presented with a balanced set of facial emotion expressions to mitigate potential overexposure bias: 12 happy (positive) faces, 6 fear and 6 sad (negative) faces. Each trial began with a 250 ms fixation cross, followed by a 10 second morphed video where a neutral face morph into a full emotion. Participants were asked to press the spacebar as soon as detecting an emotion to measure "emotion perception onset (reaction time)", and subsequently report if the expression was "Positive" or "Negative" to measure "decoding accuracy" (Fig 2). They completed 28 trials (4 practice, 24 test).

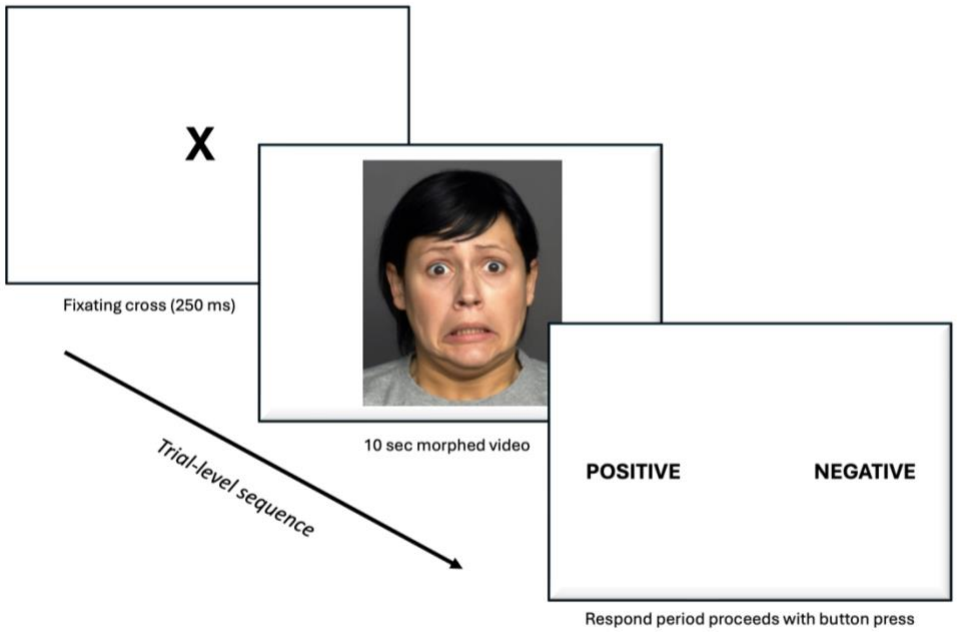

Figure 2. Schematic presentation of the experimental procedure for Task 1

Task 2 – Facial Emotion Interpretation: Participants were presented with four different facial emotion expressions: 48 happy (positive) faces; 24 fear and 24 sad (negative) faces; and 24 neutral faces. Each trial began with a 250 ms fixation cross, followed by a 400 ms static image of an emotion. Subsequently, the participants selected the emotion they think they saw among four options, "Happy", "Surprised", "Fear", and "Sad" (Fig 3). They completed 124 trials (4 practice, 120 test).

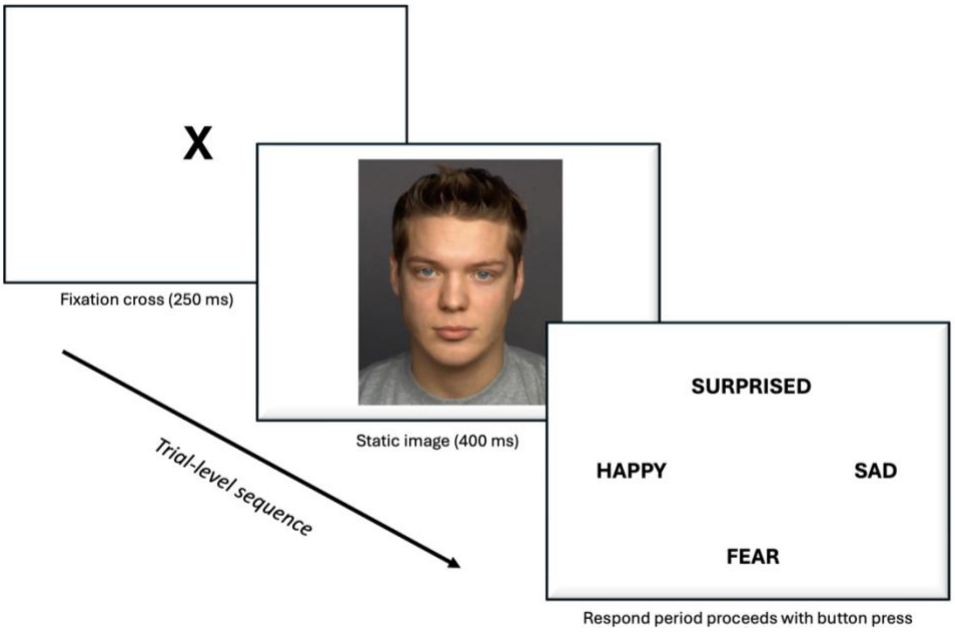

Figure 3. Schematic presentation of the experimental procedure for Task 2

Analysis: For Task 1, a 2x2 mixed-design ANOVA, with the loneliness group (High-lonely vs. Low-lonely) as the between-subjects factor and emotion type (positive vs. negative or fear vs. sad) as the within-subjects factor, was conducted to analyse emotion onset perception (reaction times for detecting emotion onset) and decoding accuracy (the percentage of correctly identified target emotion). For Task 2, a 2x4 mixed-design ANOVA assessed neutral face interpretation (the percentage of each emotion reported when seeing neutral faces), with loneliness group as the between-subjects factor and emotion type (happy, surprised, fear, sad) as the within-subjects factor. Depression, social phobia, and alexithymia scores were controlled as confounding variables in both analyses.

Results

Emotion onset perception (reaction time): The analysis revealed no significant interaction between emotion and loneliness, F (1, 15) = 0.65, p = 0.434, nor a main effect of emotion on reaction time, F (1, 15) = 0.03, p = 0.868. Moreover, neither loneliness, F (1, 15) = 0.02, p = 0.887, nor depression, F (1, 15) = 0.002, p = 0.968, affected reaction times. However, social phobia and alexithymia were significant predictors, yielding F (1, 15) = 5.35, p = 0.035 and F (1, 15) = 8.27, p = 0.012, respectively. No significant interaction was found between fear and sad faces in relation to loneliness, F (1, 15) = 0.930, p = 0.350, however, social phobia F (1, 15) = 8.847, p = 0.009 and alexithymia F (1, 15) = 8.561, p = 0.010 remained significant (see Fig 4 and 5).

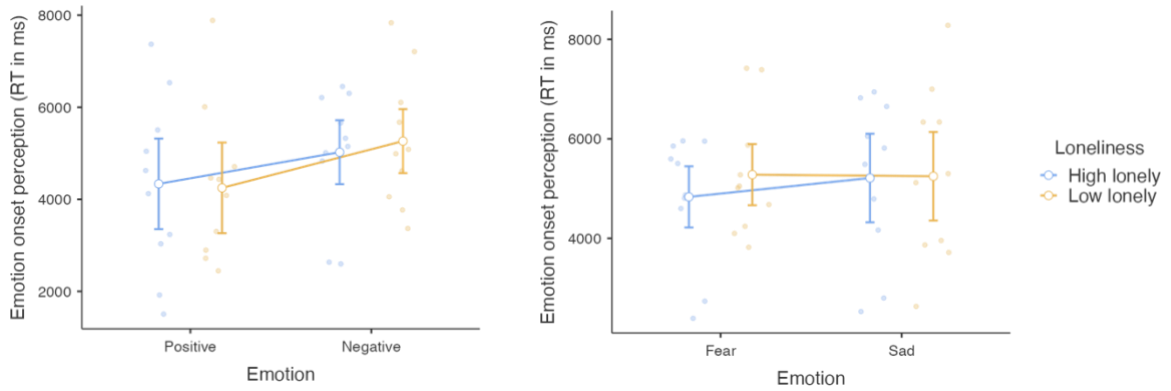

Figure 4 and 5. Reaction times in milliseconds to facial emotions by loneliness levels, comparing positive vs negative and fear vs sad emotions, with individual data points and 95% confidence intervals to illustrate participant variability and the precision of mean estimates

Decoding accuracy: There were no significant interaction between loneliness and facial emotion F (1, 15) = 1.898, p = 0.189, nor a main effect of emotion F (1, 15) = 0.189, p = 0.670, or loneliness F (1, 15) = 0.005, p = 0.944. However, social phobia emerged as a significant predictor, F (1,15) = 5.923, p = 0.028. Further analysis of difference between fear and sad also showed no significant main or interaction effects (all p > 0.3), with accuracy not differing between high and low lonely individuals (Fig 6 and 7).

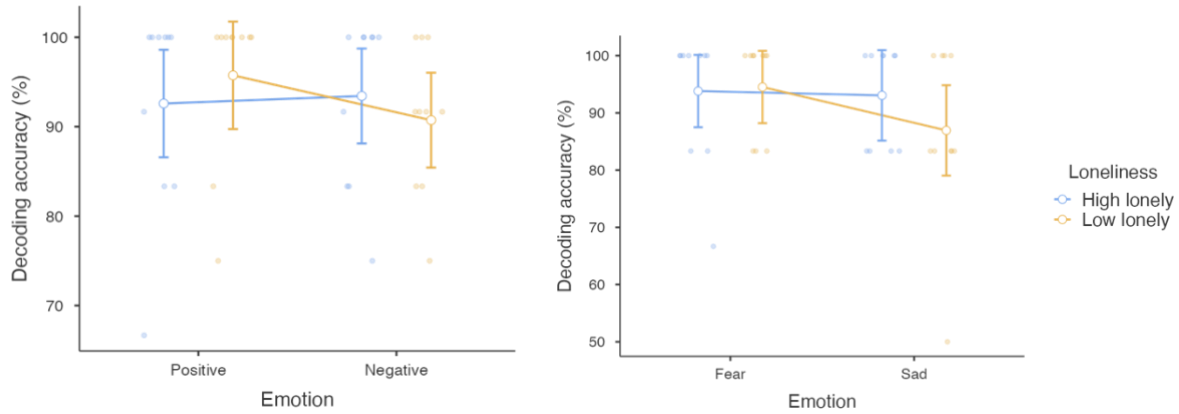

Figure 6 and 7. Decoding accuracy in percentages for facial emotions by loneliness levels, comparing positive vs negative and fear vs sad emotions, with individual data points and 95% confidence intervals to illustrate participant variability and the precision of mean accuracy estimates

Interpretation of neutral faces: There was a significant main effect of emotion on the interpretation of neutral faces, F (3,45) = 13.79, p < .001. However, there was no significant interaction between emotion and loneliness, F (3,45) = 1.20, p = .320, nor a significant main effect of loneliness on the emotions participants attributed to neutral faces, F (1,15) = -0.014, p = 1.000. Post-hoc tests showed that both high and low lonely participants attributed neutral faces as sad faces more significantly than happy (t (15) = -10.31, p < .001), surprised (t (15) = -10.20, p < .001), and fear faces (t (15) = -14.87, p < .001). The estimated marginal means further supported this finding, with sad being the most frequently attributed emotion to neutral faces in both high lonely (M = 78.84, SE = 5.59) and low lonely (M = 69.91, SE = 5.59) groups (Fig 8).

Figure 8. The interpretation of neutral faces by loneliness levels and emotions (happy, surprised, fear, sad), with rating frequencies in percentages, individual data points, and 95% confidence intervals to illustrate participant variability and the precision of mean estimates for each emotion across different loneliness levels

Qualitative analysis on the feasibility of the experiment: Most participants found Task 1 to be of moderate length, while opinions on Task 2 varied more, with several participants finding it too long. Participants reported that the need to click the 'next' button frequently disrupted their concentration and overall flow of the experiment on Task 2. Some participants mentioned the lack of option for certain emotions, such as a neutral face, indicating a potential flaw in the emotional categorisation used. The overall responses suggested a need to shorten Task 2 and introduce a "neutral" button option, to improve participant experience, while the instructions appear to be clear and effective. The questionnaires were described as overly lengthy and complex, further contributing to participant fatigue. In conclusion, while the study was acknowledged as interesting, these insights highlight critical areas for adjustment to improve participant experience and data reliability.

Discussion

This pilot study explored how loneliness impacts the perception and interpretation of facial emotions, focusing on emotion onset, decoding accuracy, and neutral face interpretation. The findings offer insights into the importance of taking related aspects into account, such as depression, social phobia, and alexithymia.

Based on a small sample-size, the results suggest no significant effect of emotion on reaction times, suggesting similar speed processing of positive and negative emotions across loneliness levels. This finding contrasts with research suggesting that negative emotions, especially anger and sad, are often detected faster than positive emotions (Cacioppo et al., 2014). Social phobia and alexithymia also predicted slower reaction times, aligning with research linking these factors to cautious emotional recognition due to social judgment fears (Lacombe et al., 2023; Grynberg et al., 2012).

Decoding accuracy results showed no significant main effect of emotion, indicating similar accuracy in recognizing positive and negative emotions across loneliness levels. This aligns with previous research suggesting loneliness does not impair the ability to recognise overt emotional cues (Bangee & Qualter, 2018). Moreover, social phobia significantly

predicted lower decoding accuracy, pointing to perceptual biases in emotional recognition (Heuer et al., 2007).

An interesting observation was the significant effect of emotion on interpreting neutral faces as sad. This could align with the "negativity bias" where lonely individuals often evaluate ambiguous facial expressions negatively (Cheeta et al., 2019). Prior research indicates lonely individuals may view neutral expressions as signs of rejection or hostility (Bangee & Qualter, 2018). However, the lack of an interaction between emotion and loneliness suggests this bias may be general rather than loneliness specific.

As a pilot study, the findings highlight both potential avenues and limitations for future research on loneliness and facial emotion perception. While the results offer preliminary insights, the small sample size likely reduced statistical power, limiting the generalizability of findings and the ability to detect nuanced interaction effects. Going forward, we plan to add a "neutral" button as an option for interpreting neutral faces and reduce the number of stimuli for Task 2, replace the questionnaires with shorter versions, and remove the "next" button between screens.

Conclusion

Overall, this pilot study is underpowered, and a larger sample size is necessary to obtain more reliable and generalizable results. However, the current results still underscore the complexity of facial emotion processing in lonely individuals. Future studies should continue to explore these dynamics, incorporating a larger and more diverse sample to enhance the generalizability of the findings.

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