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Subjective pain and reward in a social judgment paradigm

Judith Torzillo[1] · Selin Topel[2] · Anita Harrewijn[1] · Melle J. W. van der Molen[2] · Frederik van der Veen[1]

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Abstract
Affective problems such as social anxiety and depression theoretically involve negative cognitive biases that trigger and maintain symptoms during everyday experiences. This study employed a social judgment paradigm to investigate possible biases in expectation of social acceptance, and subjective feelings of pain and reward. Healthy adult participants ($N = 120$) were told their image had been judged by others. In 120 trials, they were shown photos of the judges and asked to anticipate whether they were liked by them or not, before being shown the judgment. Participants rated their level of pain and reward in each trial. Results indicated that social acceptance was expected less often by participants with higher levels of social anxiety. Self-reported pain was greatest after unexpected rejection. A greater likelihood of the presence of pain and higher self-reported pain were associated with higher levels of social anxiety and depression respectively. Self-reported reward was greatest after expected acceptance, and was not associated with social anxiety or depression. This study provides subjective experience information that has been missing from existing social judgment research. Moreover, these findings suggest that in social situations, those with social anxiety and depression more often expect rejection and experience rejection as more painful, respectively. These biases are potential maintaining factors and may be targets for further research and future intervention development.

Keywords Social judgment paradigm · Expectation · Pain · Reward · Depression · Anxiety

Introduction

Acceptance into social groups is of high importance from an evolutionary perspective as it provides safety (Baumeister & Leary, 1995). A crucial part of social interaction is the seeking of social connections, attempting to belong through acceptance while facing the threat of rejection. Moreover, the importance of social acceptance and rejection are embedded in our physical experience, as these events are marked with specific brain and cardiac responses (Gunther Moor et al., 2010a, b; van der Veen et al., 2014). Humans not only seek acceptance, they appear to expect it, and this tendency to expect social acceptance may be linked to a positivity bias in the general population, sometimes labeled the Pollyanna Principle (Gunther Moor et al., 2010a, b; Matlin & Stang, 1978; Van Der Molen et al., 2014; van der Veen et al., 2016). However, our expectations and processing of social judgment may differ according to personality traits and psychopathology (Harrewijn et al., 2018; van der Molen et al., 2018; van der Veen et al., 2016). These differences may make socializing harder for some of the population, who may find socializing less rewarding or more painful than others. Cognitive theories of psychopathology identify a person's subjective experience of the world – the internal processing of stimuli and the interpretations made of processed information – as the key mechanism for 'normal adaptive reactions' to transform to disorders (Beck & Haigh, 2014). To investigate processing of social judgement experiences, the Social Judgment Paradigm (SJP; Somerville et al., 2006) has previously been used to investigate neurobiological and cardiac responses as neurophysiological correlates for the theoretical reward of social acceptance and pain of social rejection (van der Veen et al., 2016). However, the subjective experience of reward and pain has not yet been explicitly measured in this paradigm. The present study aims to

Anita Harrewijn and Melle J. W. van der Molen contributed equally to this work.

✉ Judith Torzillo
j.r.e.torzillo@gmail.com

[1] Erasmus School of Social and Behavioral Sciences, Erasmus Universiteit, Rotterdam 3062 PA, The Netherlands

[2] Institute of Psychology, Universiteit Leiden, Leiden 2311 EZ, The Netherlands

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extend previous research, addressing this gap in the current literature, by examining the relationship between measures of personality and psychopathological symptoms and the expectations and subjective experiences of social judgment.

In the SJP, participants provide a photo of themselves, and are led to believe that a panel of peers will 'like' or 'dislike' them. After at least a week, participants are shown portraits with neutral expressions and told that these people were their judges. Participants are asked for their expectation of who liked them and are then presented with the (computer generated) judgments. This paradigm enables examination of how often participants expect to be liked, and it distinguishes between condition congruence (whether expectations are met) and condition valence (acceptance or rejection). Previous research with the SJP has predominantly found an expectation bias towards acceptance in adult samples, in line with the Pollyanna Principle (Matlin & Stang, 1978), such that they expected to be accepted more often than they expected to be rejected (Gunther Moor et al., 2010a, b; Van Der Molen et al., 2014; van der Veen et al., 2016), while some studies indicate no bias or a decreasing bias over time (Hofman et al., 2021; van der Veen et al., 2014). There is evidence suggesting individual differences in personality and psychopathological symptoms may be associated with changes in this expectation of acceptance. Both social anxiety and neuroticism (levels) have been found to be positively associated with peer rejection expectancies (Cao et al., 2015; Harrewijn et al., 2018; van der Molen et al., 2018; van der Veen et al., 2016).

Regarding the body's response to social rejection in the SJP, a significant cardiac deceleration, or 'heartbreak', has been identified after unexpected rejection compared to all other conditions (Gunther Moor et al., 2010a; van der Veen et al., 2014). This finding has been explained with the suggestion that unexpected rejection is the most negative condition, as it is both incongruent and negatively valent, that these features are painful, and additive, and indicated by cardiac deceleration. This explanation is consistent with evidence that cardiovagal control shares neural regions with both emotional and physical pain processing (Eisenberger et al., 2003; Gunther Moor et al., 2010a). Moreover, cardiac deceleration has been identified as part of a parasympathetic nervous system response to rejection (Gunther Moor et al., 2010a). However, an explicit association between unexpected rejection, cardiac deceleration, and a heightened subjective experience of pain has not yet been established in the SJP. The lack of subjective measures of reward or pain in previous studies using the SJP is a key limitation of these findings on the 'brain wave' of expected social acceptance and the 'heartbreak' of unexpected social rejection.

A study of the SJP by Hofman et al. (2021) further links social rejection with pain. These researchers found that participants' expectancy of acceptance reduced over the time of the task, however, this reduction was absent in participants given pre-task pharmaceutical pain relief. Hofman et al. (2021) interpreted their behavioral findings to mean that the reduction of expectations of acceptance over time in unmedicated participants was a learning effect, such that participants learned that unexpected rejection was more painful than expected rejection and adapted their predictions to reduce their experience of pain accordingly (Hofman et al., 2021). From the lens of operant conditioning, the pain of unexpected rejection was an aversive reinforcer shaping participants' behavior to expect acceptance less often (Skinner, 1937). The presence of pain was deduced through the behavioral difference between medicated and unmedicated groups and the measurement of cardiac deceleration as a physiological correlate of pain. However, it remains unclear how the pain of rejection was experienced by the participants, as no subjective measures of pain were recorded.

Anxiety has been implicated as a potential moderator in the experience of social rejection. For example, socially anxious females seem to display a blunted threat response after unexpected rejection as indexed by feedback-related theta reactivity (van der Molen et al., 2018). One potential explanation for this finding is a reduced external focus due to increased attention to internal somatic responses after rejection. Despite cognitive theories of depression suggesting an increased focus on negative stimuli in those with symptoms of depression or neuroticism (Beck & Haigh, 2014), only one study has investigated the relationship of depressive symptoms or neuroticism with responses to social rejection in the SJP, contrary to expectations, no significant relationships were found (van der Veen et al., 2016).

Regarding the body's response to social acceptance in the SJP, van der Veen et al. (2014, 2016) examined electrical activity in the brain through electroencephalogram (EEG) and found that a positive event-related potential peaking between 300 and 400 ms after stimulus onset (P3; Sutton et al., 1965) was greatest after expected acceptance. Van der Veen et al. (2014, 2016) explained this P3 'brainwave' as an indication of the cumulative reward experienced after expected acceptance, a condition that is both congruent with respect to participants' expectation and positively valenced. This finding contrasts the conceptions of the P3 as either a response to uncommon stimuli (Dekkers et al., 2015; Nieuwenhuis et al., 2005) or a response to emotionally salient stimuli (Hajcak et al., 2012; Harrewijn et al., 2018). However, van der Veen et al.'s (2014) proposed relationship between the P3, expected social acceptance, and reward is consistent with suggestions that the P3 tracks stimuli that are motivationally significant (Hajcak et al., 2012; Nieuwenhuis et al., 2005). Moreover, the relationship is plausible as a large P3 has been associated with both reciprocated romantic interest (van der Veen et al., 2019; Zhang et al., 2022) and financial reward (Van den Berg et al., 2012). However, an

explicit association between the P3, expected social acceptance, and a heightened subjective experience of reward has not yet been established in the SJP.

This study aimed to examine trial-by-trial expectations and subjective experiences of social judgment, and furthermore, their relationship with personality and psychopathological symptoms. This study addresses the lack of subjective measures in the current literature on the SJP; and holds the promise of further explaining neurophysiological sensitivity and reactivity towards social judgment as it relates to subjective experiences. A healthy sample of male and female adults participated in the SJP to examine both expectancy and subjective experience of reward and pain. We hypothesized an overall bias towards expecting acceptance (Dekkers et al., 2015; Matlin & Stang, 1978; Van Der Molen et al., 2014; van der Veen et al., 2014, 2016). Moreover, we hypothesized that expectation of acceptance would reduce over the time of the experiment, as participants learn that they can avoid the pain of unexpected rejection[1] (Hofman et al., 2021; Skinner, 1937). Regarding subjective measures of reward, we hypothesized that ratings will be highest for expected acceptance, compared to all other conditions, in line with some previous neurobiological findings of P3 activity (van der Veen et al., 2014, 2016). Regarding subjective measures of pain, we hypothesized that ratings will be highest for unexpected rejection, compared to all other conditions, in line with previous neurophysiological findings of prolonged cardiac deceleration (Gunther Moor et al., 2010a; van der Veen et al., 2014, 2016) and brain responsivity (van der Molen et al., 2018). Given that recent research using the SJP has often focused on investigating individual differences, the current study also considered the role of gender and measured the trait of neuroticism, and symptoms of depression, anxiety, and social anxiety (Harrewijn et al., 2018; van der Molen et al., 2018; van der Veen et al., 2016). Exploratively, we examined whether these individual differences were related to expectation of acceptance and subjective experiences of reward and pain in the SJP.

Method

Participants

Participants were recruited online within the university and the social networks of the researchers. Informed consent was collected during the sign-up procedure. The study initially recruited a total of 266 participants to sign up. By the end of the data-collection period 147 participants had completed both the questionnaires and the SJP task. Subsequent correspondence with participants indicated that attrition was predominantly due to personal computers being incompatible with the task software. Of the 147 responders, participants were removed due to missing data resulting from uniform expectation responses, such as always expecting acceptance ($n=7$); reported or suspected software failure which disabled subjective responses ($n=7$); and diagnoses of neurological or psychological disorders, or use of cognition-affecting medication ($n=13$). Of 120 participants, the majority were female (=70.83%), and age ranged from 18 to 35 years ($M=22.84$, $SD=3.70$). Participants enrolled in a Bachelor of Psychology were rewarded with a research credit that contributed to the achievement of their degree.

Materials

Procedure and social judgment paradigm

This study used a procedure approved by the Erasmus University Rotterdam Research Ethics Review Committee and was performed in compliance with their guidelines and regulations. Participants were asked to provide a photo of themselves with a neutral facial expression and background. They were falsely led to believe that this photo would be judged by a different group of participants. Specifically, participants were told: 'in this experiment, we want to see how people make judgements of others in a social context and examine our own expectations about being judged by others.' And that their photo would be 'sent to a selected panel of participants who will judge whether they like or dislike you, based upon a brief exposure to your image.' A week after submission of their photo, participants received a link to a set of questionnaires hosted on Qualtrics (https://www.qualtrics.com). This link also led them to download E-Prime Go software (Version 3.0). This software gave participants access to the online experimental SJP task. All stimuli and questionnaires were presented in English language, digitally, and participants completed the questionnaires and SJP task in their own time, on their own computers.

The SJP task involved three practice trials and 120 experimental trials wherein participants were exposed to a black and white image of a face with a neutral expression for 6 s. The faces were derived from the Chicago Face Database (Ma et al., 2015) with 50% portraying females, 50% portraying males, and ages ranging from 18 to 40 years. Participants were told that these faces belonged to the people who had judged the participant's photo. In a subsequent 5 s interval, participants were asked to predict the person's judgment: "Did they like you?" with possible

[1] Other studies using SJP also repeatedly found this effect despite it being unreported given that this was not the primary focus of these papers. For instance, this effect was also found in an unpublished bachelor's thesis from our lab which combined 8 data sets with SJP ($N=399$) such that expectations of acceptance decreased from the beginning to the end of the task.

responses of "yes" or "no," designated to response keys 1 and 2 respectively. This prediction was shown to the left of the face. After 1 s, the judgment was presented to the right of the face. Judgments were quasi-randomly, computer-generated into a sequence of 50% "yes" (like) and 50% "no" (dislike). All participants were presented with the same sequence of faces and judgments. In a novel modification of the SJP, subsequent to every trial, the participant was asked to rate the relative reward and pain of the judgment they just experienced. These two subjective scales were presented on sequential untimed slides and were devised based on a visual analogue scale of pain. A horizontal line, labeled "0%" on the far left and "100%" on the far right, was presented underneath the questions "How rewarding was this?" and "How painful was this?" These scales were used with an icon that could be dragged and placed along the line to represent subjective experience as a percentage of affect intensity. The order of scale presentation was randomized by participant. On average, participants completed the SJP in 30.36 minutes ($SD = 11.93$, range = 20.64–161.69). Data was collected over a period of 5 weeks in April and May of 2021, after which, all participants were debriefed via an email explaining the experimental deceit and experimental goals.

Questionnaires

Neuroticism Neuroticism was assessed using a subscale of the revised Eysenck Personality Questionnaire short scale (EPQ-rss; Eysenck et al., 1985). Example items include: "Do you take much notice of what people think?" and "Do you often worry about things you should not have done or said?" This 12-item (yes, no) subscale has good internal consistency in a healthy adult population ($\alpha_{Males} = 0.84$, $\alpha_{Females} = 0.80$; Eysenck et al., 1985).

Depressive symptoms Depressive symptoms was assessed using the Beck Depression Inventory (BDI-II; Beck et al., 1996). This 21-item self-report measure uses a 4-point Likert scale. For example, regarding dislike of self, the respondent is asked to choose which of the following statements is most relevant to them based on the previous two weeks: "I don't feel disappointed in myself", "I am disappointed in myself", "I am disgusted with myself", or "I hate myself". This measure has high test-retest reliability ($r = 0.93$; Beck et al., 1996), addressing both psychological and somatic symptoms of depression. Recommended cut-off scores for interpreting the BDI-II indicate depressive symptoms that are minimal (0–13), mild (14–19), moderate (20–28), and severe (29–63). A score of 13 or above is widely used as an indicator of depression in healthy populations (Wang & Gorenstein, 2013).

Social anxiety Social anxiety was assessed with the Liebowitz Social Anxiety Scale (LSAS), which includes 24-items using a 4-point Likert scale (Liebowitz, 1987). The respondent is asked to rate their fear/anxiety and avoidance from "none/never" to "severe/usually" in 24 imaginary scenarios including: "telephoning in public", "talking to people in authority", and "working when being observed". When used as a self-report measure in adult samples with social anxiety, this scale has excellent internal consistency ($\alpha = 0.95$–0.96; Forni dos Santos et al., 2013). Scores above 30 on the LSAS can be interpreted as indicating social anxiety, with symptoms limited to particular scenarios, like performing in front of others. Scores above 60 indicate generalized social anxiety, characterized by broader impairment as fear is present in most social situations (Mennin et al., 2002).

Anxiety General anxiety was measured using a 4-point Likert scale as both a state and trait through both 20-item subscales of the State and Trait Anxiety Inventory (STAI; Spielberger et al., 1983). State anxiety is rated from "not at all" to "very much so" and is measured by items such as: "I feel calm", "I feel jittery", and "I feel nervous". Trait anxiety is rated from "almost never" to "almost always" and is measured by items such as: "I wish I could be as happy as others seem to be" and "Some unimportant thought runs through my mind and bothers me." Both subscales have high internal consistency ($\alpha\text{-}_{State} = .92$, $\alpha\text{-}_{Trait} = .90$; Spielberger et al., 1983). Scores of 40 or above on the state subscale of the STAI can be interpreted as indicating a high level of anxiety.

Statistical analyses

Statistical analyses to assess expectancy and subjective ratings of pain and reward were conducted with R software (R Core Team, 2021) using the *lme4* package (Bates et al., 2015) for modeling (generalized) linear mixed models. Given this study's repeated measures design with between-subjects measures of individual differences, multilevel models were used to simultaneously assess within- and between-subjects factors.

To examine the variables that might contribute to participants' likelihood of reporting acceptance vs. rejection expectation (and thus binary choice variables), we used a generalized linear mixed effects model with "logit" link function and binomial outcome distribution. The random effects structure included a random intercept term for participants and random slopes for trial number and judgment received in the previous trial. Fixed effects were included in a stepwise manner based on variables of greatest interest and the best model was chosen for further examination. First, task effects were entered into the model (previous judgment and trial number), then individual differences in psychopathology and

personality (either social anxiety, depressive symptoms, or neuroticism), and finally, gender.

Visual inspection of the response data revealed zero-inflated distribution patterns for the subjective ratings of pain and reward (see Supplementary Figs. S1-S4). Thus, we decided to use a two-step approach for the analyses where the outcome variables were subjective pain or reward ratings (see Dildine et al., 2020 for a similar approach). That is, to analyze the ratings of pain, first, a generalized linear mixed model using a binary distribution family was employed to examine whether the fixed effects of interest (i.e., participant's expectation; judgment received; individual differences in social anxiety, depressive symptoms, or neuroticism; and gender) explain the variance in the presence of subjective pain (none = 0 or any = 1-100), including random effects. The random effect structure included random intercepts for participants and trial number and random slopes for the interaction between expectation and judgment. Compared to the method for examination of expectations, the treatment of trial number differed in this random effect structure where it was representative of stimuli, as changes in subjective pain and reward across the time of the experiment was not a focus of our research. Second, the data describing the magnitude of experienced pain (ratings of 1-100), was log-transformed and modeled using a linear mixed model approach with the same random and fixed effects tested in a stepwise manner. We employed the bound optimization by quadratic approximation optimizer (Powell, 2009) in order to avoid convergence issues. Likelihood ratio tests were conducted using the *anova* function from the *lme4* package (Bates et al., 2015) with nested models to build the models incrementally and determine the most appropriate global model structure for both the first and second step. The same two-step procedure was utilized to analyze subjective ratings of reward. Any interaction effects identified through multilevel modeling were subsequently visually examined using the *sjPplot* package (Lüdecke et al., 2022), and pairwise comparisons and simple slopes analyses were conducted using the *emmeans* package (Lenth et al., 2022). Significance of fixed effects in generalized linear mixed models was assessed using the *Anova* function in the *car* package (Fox & Weisberg, 2019). For the linear mixed models, Type-III F-tests were computed using the *anova* function of the *lmerTest* package (Kuznetsova et al., 2017).

Results

Expectation of acceptance

Descriptive statistics for subjective measures are shown in Table 1. It is noteworthy that the internal consistency of the STAI scale measuring trait anxiety is low (α = 0.23).

Table 1 Descriptive statistics: measures of neuroticism and psychopathology in 120 healthy adults

Scale	*M (SD)*	Min.	Max.	Cut off [a]	Cronbach's alpha
EPQ-rss (N)	6.19 (3.23)	0	12	-	0.62
BDI-II	10.35 (8.01)	1	36	13	0.77
LSAS	40.02 (24.5)	0	107	30; 60 [b]	0.93 (fear); 0.92 (avoidance)
STAI (S)	37.47 (11.24)	20	71	40	0.53
STAI (T)	40.46 (10.5)	21	66	-	0.23

BDI-II Beck Depression Inventory-second edition, *EPQ-rss (N)* Eysenck Personality Questionnaire-Revised short scale (neuroticism subscale), *LSAS* Liebowitz Social Anxiety Scale (total score), *STAI* The State-Trait Anxiety Inventory, (S) = (state subscale), (T) = (trait subscale). [a] Cut off scores indicate clinical levels of symptoms for depression (BDI-II; Beck et al., 1996), social anxiety and generalized social anxiety (LSAS; Mennin et al., 2002), and anxiety (STAI [S]; Spielberger et al., 1983). [b] LSAS cut off scores indicate social anxiety at 30 and generalized social anxiety at 60 (Mennin et al., 2002)

This may indicate that our sample population is not well described by this scale's unidimensional construct of trait anxiety. However, high internal consistency for the measure of social anxiety (α = 0.92–0.93) indicates a reliable measure of this construct in the current sample. The rate of expectation of acceptance ranged between participants from 3.36–84.82%. On average, participants expected to be accepted on 50.09% of trials ($SD = 16.68$, $SE = 1.52$). A one-sample *t*-test revealed no bias in the percentage of expectation of acceptance as compared to random chance, i.e. 50%, ($t(119) = 0.06$, $p = .955$, $d = 0.005$). Moreover, when the first and last twenty trials were separately considered for each participant, one-sample *t*-tests revealed no bias towards expecting acceptance at either the start ($M = 52.20$, $SD = 18.24$, $t(119) = 1.32$, $p = .189$, $d = 0.121$) or the end of the task ($M = 49.06$, $SD = 20.26$, $t(119) = -0.51$, $p = .614$, $d = -0.046$). When compared, however, a two-sided paired *t*-test revealed that the mean expectation of acceptance in the first twenty trials differed significantly from the expectation in the last twenty trials such that the expectation of acceptance was lower in the last 20 trials compared with the first 20 trials of the task (mean of differences = 3.14, 95% CI: 0.06, 6.22, $t(119) = 2.02$, $p = .046$, $d = -0.163$).

However, given the multi-level nature of the experimental design, the expectation of acceptance (acceptance vs. rejection) was further examined using generalized linear mixed modeling. The best model included the fixed effects of previous judgment received, trial number, and social anxiety, as well as a random intercept term for participants and random slopes for the previous judgment and trial number. Models including measures of depressive symptoms or neuroticism, and gender did not show significant improvement (see

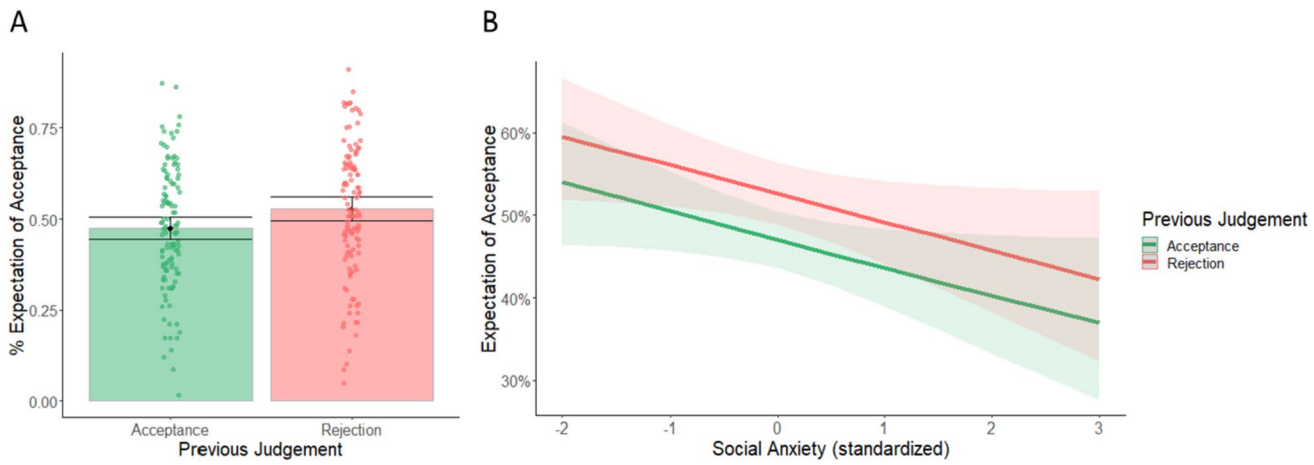

Fig. 1 **A** Barplot showing acceptance was more often expected after a previous judgment of rejection. **B** Predicted expectations by the generalized linear mixed model showing that increased social anxiety is associated with less frequent expectation of acceptance regardless of previous judgment

Supplementary Table S1 for model comparisons and Supplementary Table S2 for variance inflation factors [VIFs] of the best model).

The analyses revealed a main effect of the previous judgment on expectation, $\chi^2(1) = 24.21$, $p < .001$. Participants expected to be accepted more often when the previous judgment had been rejection vs. acceptance (see Fig. 1a), $b = 0.22$, $SE = 0.05$, $z = 4.92$, $p < .001$, OR = 1.25, 95% CI[1.144, 1.367]. Follow up analyses on the estimated marginal means for previous acceptance and rejection judgments showed no significant differences from chance for either judgment ($ps > .18$). A main effect of trial number was found, $\chi^2(1) = 9.08$, $p = .003$. As trial numbers increased, the expectation of acceptance reduced, b = -0.07, $SE = 0.02$, z = -3.01, $p = .003$, OR = 0.93, 95% CI[0.890, 0.976]. With a measure of social anxiety included in the model, social anxiety scores predicted participant expectations, $\chi^2(1) = 4.11$, $p = .043$. As the level of social anxiety increased, participants' expectations of acceptance decreased (see Fig. 1b), b = -0.14, $SE = 0.07$, z = -2.03, $p = .043$, OR = 0.87, 95% CI[0.761, 0.995].

Presence of pain

The average subjective rating of pain across all conditions and participants was 13.44 ($SE = 0.18$), ranging from 0 to 100. Within conditions, visual inspection indicated that the distributions of pain ratings were right-skewed and zero-inflated (42% zero ratings). Due to this zero-inflation, a two-step approach was utilized (see Method). Generalized linear mixed modelling revealed that the best model included expectation, judgment, and social anxiety and their interaction as fixed effects, random intercepts for the participant and trial, and random slopes for the interaction between expectation and judgment. The models including measures of depressive symptoms, neuroticism or gender did not show a significant improvement in the prediction of the presence of pain (see Supplementary Table S3 for model comparisons and Supplementary Table S4 for VIFs of the best model). The analyses identified a main effect of expectation, $\chi^2(1) = 8.95$, $p = .003$, such that pain was more likely present when the participant expected to be accepted, $b = 1.65$, $SE = 0.17$, $z = 9.75$, $p < .001$, OR = 5.19, 95% CI[3.726, 7.224]. A main effect of judgment was found, $\chi^2(1) = 116.59$, $p < .001$, as pain was less likely present when participants were accepted, b = -1.13, $SE = 0.26$, z = -4.42, $p < .001$, OR = 0.35, 95% CI[0.197, 0.535]. A significant interaction effect was found between expectation and judgment, see Fig. 2a, $\chi^2(1) = 106.28$, $p < .001$. Being rejected was more likely painful than being accepted, but more so when expecting to be accepted. This is supported by the comparison of the differences between the expected rejection and unexpected acceptance, and unexpected rejection and expected acceptance, b = -2.65, $SE = 0.26$, z = -10.31, $p < .001$, OR = 0.07, 95% CI[0.043, 0.117]. Post hoc testing also revealed that all conditions differed with respect to reporting pain (see Supplementary Table S5). Additionally, a main effect of social anxiety was found, $\chi^2(1) = 4.11$, $p = .043$. As scores of social anxiety increased, trials were more likely to be painful, $b = 0.96$, $SE = 0.32$, $z = 3.05$, $p = .002$, OR = 2.62, 95% CI[1.410, 4.872]. Furthermore, an interaction effect was found between social anxiety and judgment, $\chi^2(1) = 5.62$, $p = .018$. It appears that the likelihood of pain increased as social anxiety increased, but only when rejected, visible in Fig. 2b, b = -0.74, $SE = 0.25$, z = -2.94, $p = .003$, OR = 0.48, 95% CI[0.291, 0.781]. This was supported by a *post hoc* simple slopes analysis, $b = 0.53$, $SE = 0.22$, $z = 2.37$, $p = .018$. No interaction effect was

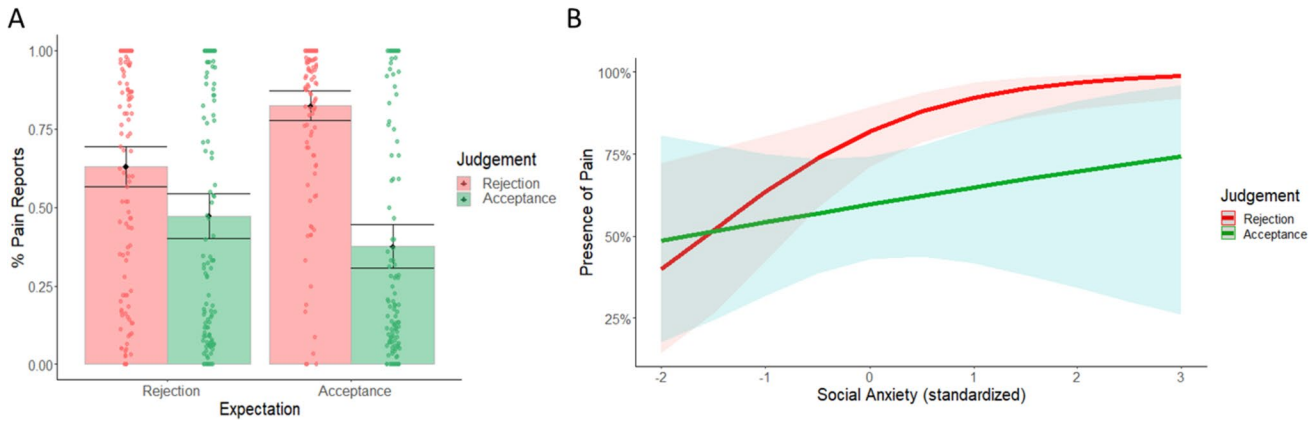

Fig. 2 **A** Barplot showing the proportion of reported pain following different trials varied based on expectation and judgment. Pain was most likely to be reported in the condition of unexpected rejection. **B** Predicted expectations by the generalized linear mixed model showing that the likelihood of reporting pain increased with higher levels of social anxiety, when rejected

found between expectation and social anxiety, $\chi^2(1) = 0.19$, $p = .666$, nor any three-way interaction between expectation, judgment, and social anxiety, $\chi^2(1) = 2.60$, $p = .107$.

Magnitude of pain

When pain was present, the effects of variables on the reported magnitude of pain was examined through linear mixed modeling, after log-transformation of non-zero pain responses. The best model included the interaction of expectation, judgment, and depressive symptoms, and the interaction of expectation, judgment, and gender as fixed effects. The random effects included random intercept terms for participants and trial, and random slopes for the interaction of expectation and judgment. Models including neuroticism or social anxiety did not perform better than the model including only the expectation, judgment, and their interaction as fixed effects in explaining the variance in the magnitude of pain (see Supplementary Table S6 for model comparisons and Supplementary Table S7 for VIFs of best model).

Full results of a model including depressive symptoms and gender are visible in Table 2. Overall, a main effect of expectation was found, $F(1, 78.49) = 5.42$, $p = .02$. Expecting to be accepted led to a more painful subjective experience than expecting to be rejected following the receipt of social judgment, $b = 0.7$, $SE = 0.07$, $t = 9.8$, $p < .001$. A main effect of judgment was found, $F(1, 118.34) = 67.81$, $p < .001$. Being accepted was less painful than being rejected, $b = -0.55$, $SE = 0.11$, $t = -4.88$, $p < .001$. There was a significant interaction effect between expectation and judgment, $F(1, 100.63) = 57.99$, $p < .001$, visible in Fig. 3a (see Table S8). Expecting to be accepted led to a more painful experience than expecting to be rejected, but only when judged to be rejected, $b = -0.97$, $SE = 0.13$, $z = -7.62$, $p < .001$. Furthermore, a main effect of depressive symptoms was found, $F(1, 112.81) = 6.57$, $p = .012$. Higher scores for depressive symptoms corresponded with higher ratings of pain, $b = 0.30$, $SE = 0.10$, $t = 3.03$, $p = .003$. An interaction effect between depressive symptoms and judgment was found, $F(1, 102.01) = 4.36$, $p = .039$. The difference in pain magnitude when rejected or accepted differed as depressive symptom scores increased such that higher levels of depression predicted a steeper increase in pain ratings following rejection compared to acceptance, visible in Fig. 3b, $b = 0.18$, $SE = 0.09$, $z = 2.09$, $p = .039$. Additionally, an interaction effect between gender and judgment was found, $F(1, 112.72) = 8.18$, $p = .005$. Being rejected was more painful than being accepted, but these magnitudes differed by gender (see Fig. 3c), $b = 0.46$, $SE = 0.22$, $t = 2.12$, $p = .04$. Post hoc tests revealed that while both genders rated rejection as

Table 2 Type III analysis of variance for a model including depressive symptoms and gender as predictors of magnitude of pain

Effect	*DF*	*F*	*p*
Judgment	1, 118.34	67.81	< .001*
Expectation	1, 78.49	5.42	.023*
Depressive symptoms	1, 112.81	6.57	.012*
Gender	1, 118.01	0.37	.542
Judgment X Expectation	1, 100.63	57.99	< .001*
Judgment X Depressive symptoms	1, 102.01	4.36	.039*
Expectation X Depressive symptoms	1, 66.09	0.26	.610
Judgment X Gender	1, 112.72	8.18	.005*
Expectation X Gender	1, 77.80	0.32	.571
Judgment X Expectation X Depressive symptoms	1, 87.08	0.00	.987
Judgment X Expectation X Gender	1, 99.98	0.55	.461

Analysis uses Satterthwaite's method. Depressive symptoms were measured with the Beck Depression Inventory-second edition. * $p < .05$

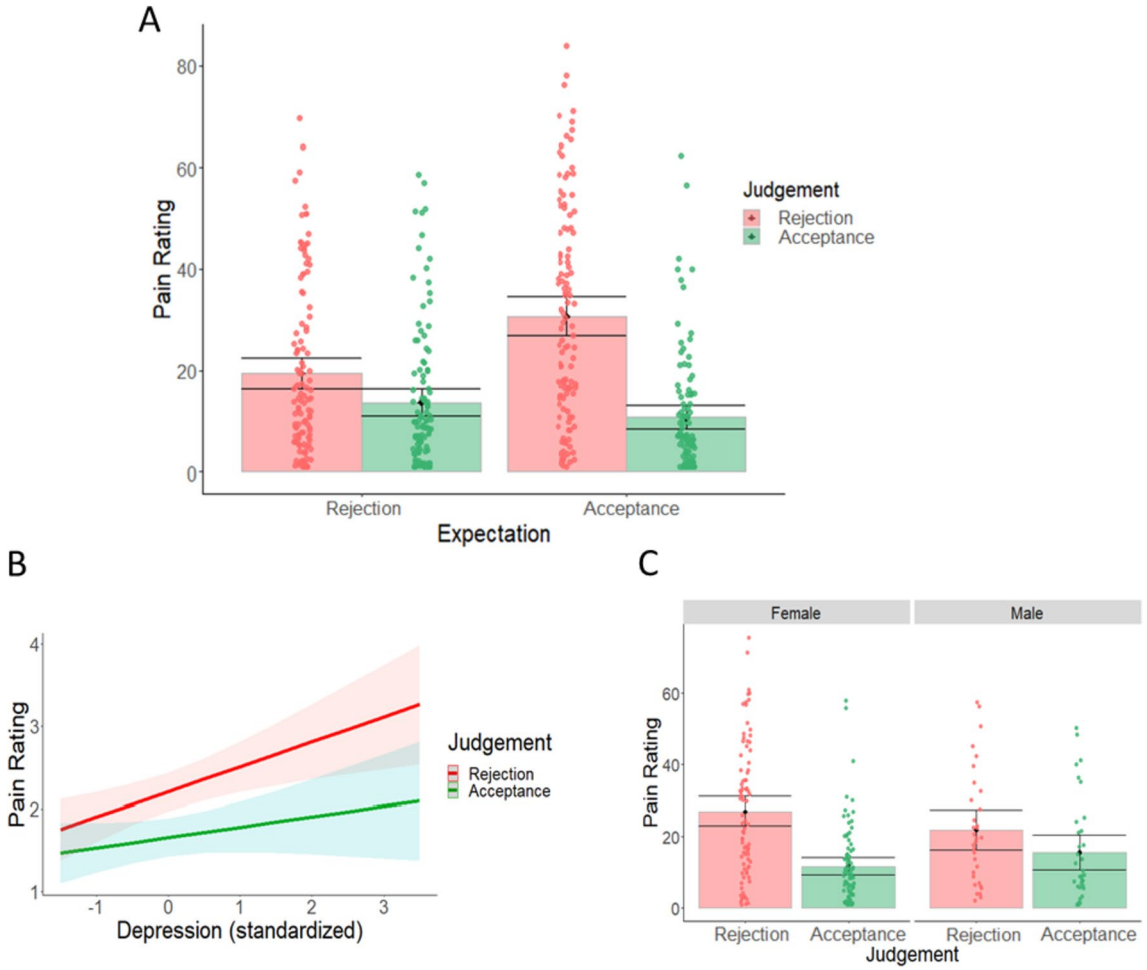

Fig. 3 **A** Barplot showing the mean pain ratings following trials that differed in expectation and judgment. Magnitude of pain was greatest in the condition of unexpected rejection. **B** & **C** Effects of judgment, depressive symptoms, and gender on ratings of pain magnitude

more painful than acceptance (females: $b = 1.09$, $SE = 0.10$, $z = 10.73$, $p < .001$; males: $b = 0.54$, $SE = 0.17$, $z = 3.26$, $p = .001$), the difference between ratings of rejection and acceptance was greater for females than males, $b = 0.55$, $SE = 0.19$, $z = 2.86$, $p = .004$. And females rated acceptance as less painful than males did, b = -0.38, $SE = 0.20$, z = -1.96, $p = .050$.

Presence of reward

The average subjective rating of reward across all conditions and participants was 25.05 ($SE = 0.25$), ranging from 0 to 100. Within conditions, visual inspection indicated that the distributions of reward ratings were right-skewed and zero-inflated (30% zero ratings). A two-step approach was utilized (see Method). Regarding the presence or absence of any reward, generalized linear mixed modeling was utilized and the best model included the interaction of expectation and judgment as fixed effects, considered their interaction as a random slope effect, and both participant and trial number as random intercept effects. Including measures of social anxiety, depressive symptoms, neuroticism, or gender did not significantly improve prediction of the presence of reward (see Supplementary Table S9 for comparisons and Supplementary Table S10 for VIFs for best model). The analyses identified a main effect of judgment, $\chi^2(1) = 104.62$, $p < .001$, such that reward was more likely to be reported when participants were accepted, $b = 1.83$, $SE = 0.34$, $z = 5.34$, $p < .001$, OR = 6.25, 95% CI[3.189, 12.243]. A significant interaction effect was found between expectation and judgment, $\chi^2(1) = 34.06$, $p < .001$. The likelihood of reward was higher when accepted than rejected, but this relationship differed according to expectation such that individuals were more likely to experience reward following acceptance when they had also expected acceptance than when they had expected rejection, visible in Fig. 4a, b = 2.66, $SE = 0.40$, $z = 6.61$, $p < .001$, OR = 14.34, 95% CI[6.508, 31.583] (see Table S11).

Table 3 Type III analysis of variance for a model including gender as a predictor of magnitude of reward

Effect	*DF*	*F*	*p*
Judgment	1, 124.03	104.74	< .001*
Expectation	1, 100.58	3.09	.082
Gender	1, 118.26	0.01	.936
Judgment X Expectation	1, 107.18	69.67	< .001*
Judgment X Gender	1, 111.62	18.13	< .001*
Expectation X Gender	1, 99.33	3.02	.085
Judgment X Expectation X Gender	1, 106.10	0.09	.761

Analysis uses Satterthwaite's method. * $p < .05$

Magnitude of reward

When reward was present, the effects of variables on the magnitude of reward was examined through linear mixed modeling, after log-transformation of non-zero reward responses. The best model included the interaction of expectation, judgment, and gender as fixed effects, considered the interaction of expectation and judgment as a random slope effect, and participant and trial number as random intercept effects. Full results of the model including gender are visible in Table 3. Including measures of social anxiety, depressive symptoms, or neuroticism did not significantly improve prediction of the magnitude of reward, (see Supplementary Table S12 for model comparisons and Supplementary Table S13 for VIFs of strongest model). Overall, a main effect of judgment was found, $F(1, 124.04) = 104.74$, $p < .001$. Being accepted was more rewarding than being rejected, $b = 0.65$, $SE = 0.09$, $t = 6.83$, $p < .001$. There was a significant interaction effect between expectation and judgment, $F(1, 107.18) = 69.67$, $p < .001$, visible in Fig. 4b. Expecting to be rejected was more rewarding when rejected, expecting to be accepted was more rewarding when accepted, $b = 0.87$, $SE = 0.09$, $t = 9.51$, $p < .001$. An interaction effect between gender and judgment was found, $F(1, 111.62) = 18.13$, $p < .001$. The effect of judgment on reward magnitude varied according to gender such that both genders rated acceptance more rewarding than rejection, however the difference between ratings of acceptance and rejection was greater for females than males (see Fig. 4c and Table S15), $b = -0.74$, $SE = 0.17$, $z = -4.26$, $p < .001$.

Discussion

This study examined the expectations and subjective responses to social judgments in an online task, and their relation to individual differences in social anxiety, depressive symptoms, neuroticism, and gender. Performance in the online task was comparable to previous laboratory experiments with participants expecting about 50% positive evaluations and this percentage slightly decreased towards the end of the task. Receiving rejection on the previous trial predicted expectations of acceptance on the following trial and vice versa. Participants with high scores on social anxiety expected acceptance less often than those with low scores of social anxiety. Self-reported pain was greatest after unexpected rejection. Self-reported reward was greatest after expected acceptance. Higher social anxiety and depressive symptom scores were associated with a greater likelihood of the presence of pain and higher self-reported pain respectively, but were not associated with the self-reported reward, nor were higher neuroticism scores. Gender was associated with differing magnitudes of both pain and reward ratings.

Comparison with other studies, explanation of findings, and implications

For the first time, this study reports on the subjective experiences of participants during the SJP. As hypothesized, subjectively experienced pain strongly depends on both the participant's expectation and the actual judgment given. The pattern of subjective pain reported by our participants is in line with previous results on cardiac deceleration, and their interpretation that unexpected rejection is more 'painful' than expected rejection (Gunther Moor et al., 2010a; van der Veen et al., 2014). Regarding individual differences and the experience of social pain, our findings indicate that levels of social anxiety and depression are associated with subjective pain from social rejection. Specifically, higher levels of social anxiety were associated with a higher likelihood of the presence of pain. This result seems at odds with a previous finding that social anxiety was associated with blunted reactivity to unexpected rejection in the SJP as measured by theta oscillations (van der Molen et al., 2018). However, our findings are compatible with research indicating that social anxiety is associated with higher rejection sensitivity (Zimmer-Gembeck et al., 2021). Although, one would expect that rejection sensitivity would also be represented in higher magnitudes of pain for those high on social anxiety, which we did not find. Rather, our results indicated that higher levels of depressive symptoms, but not neuroticism, are associated with a greater magnitude of self-reported pain. These results contradict previous findings that depression was unrelated to pain measured through cardiac responses to rejection, and that higher neuroticism was associated with blunted cardiac deceleration after expected acceptance in the SJP (van der Veen et al., 2016). However, they are compatible with a model of depressive symptoms being associated with hyper-responsiveness to social rejection, a relationship demonstrated by researchers using the Cyberball paradigm and measuring neurophysiological outcomes (Kumar et al., 2017). It is notable that in the current

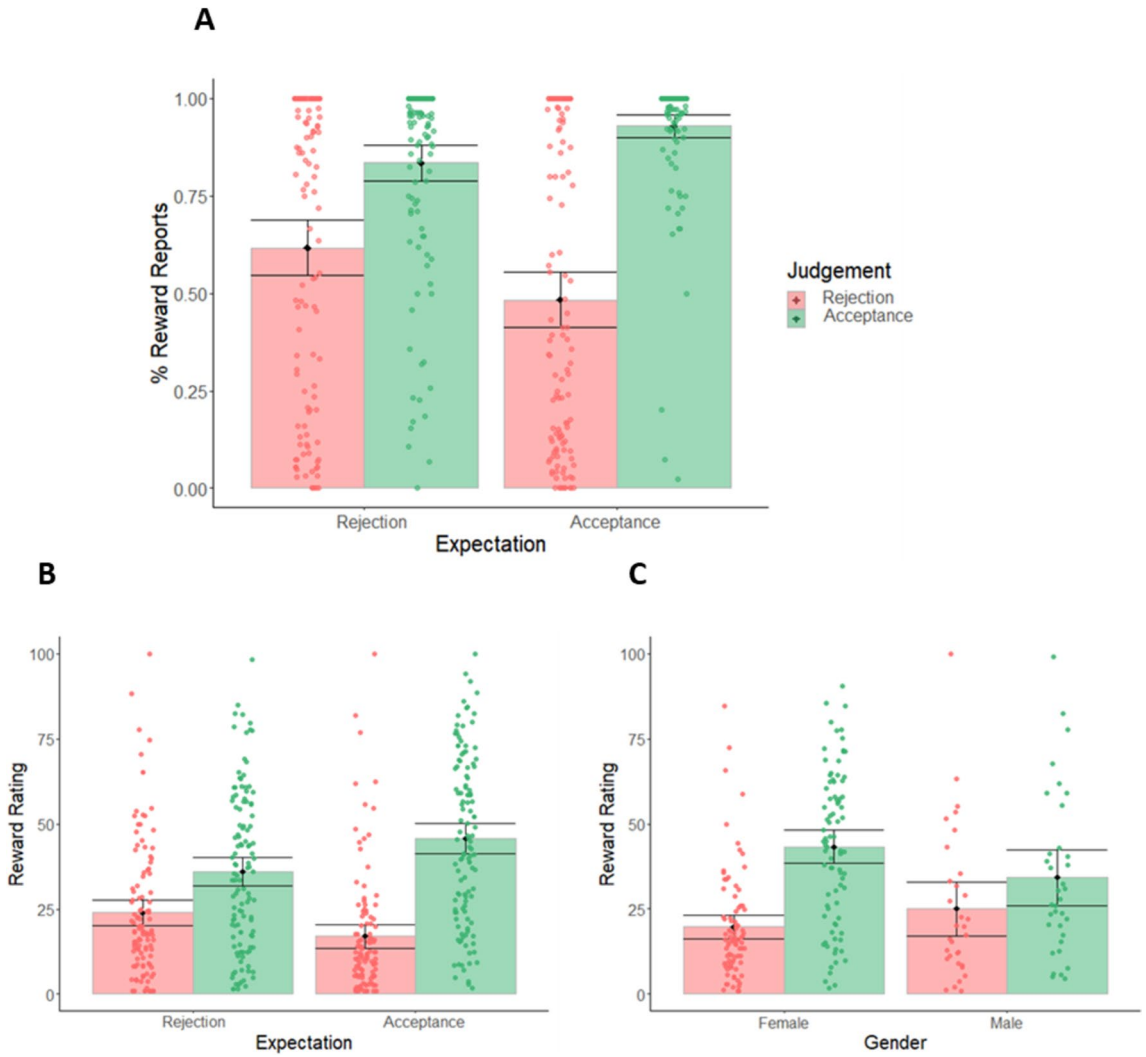

Fig. 4 **A** Barplot showing the effects of judgment and expectation on the presence of reward ratings. **B** Barplot showing the effects of judgment and expectation on the reward ratings. **C** Barplot showing the effect of judgment received on the previous trial by gender on the magnitude of reward ratings

study's sample, the internal consistency of the measurement of neuroticism ($\alpha = 0.62$) was less that has been previously reported for this measure ($\alpha = 0.80$–0.84; Eysenck et al., 1985). This may indicate that our sample population was not well described by this measure and our findings regarding neuroticism's relationship with social pain and reward may not be as reliable as other studies.

Our results indicate that subjective reward during social judgment is dependent on both the expectation of acceptance and the judgment given. This finding lends some credibility to the conclusions drawn in previous experiments using the SJP which exclusively measured neurophysiological responses and presupposed their relationship with reward. In particular, the pattern of reward experiences across conditions represented in our results mimic the pattern of neural responses found by van der Veen et al. (2014) and support their proposal that the increased amplitude of the late positive deflection in the EEG response to feedback (i.e., P3 amplitude) represents a response to social reward. Future research would benefit from including both subjective reports and neurophysiological correlates of pain and reward. Our study did not find a relationship between likelihood of reward or magnitude of reward and measures of psychopathological symptoms. These results contrast previous findings linking anxious and depressive symptoms with blunted affective responses to social acceptance and social reward (Caouette & Guyer, 2016; Cremers et al., 2015).

It is notable that there was an over-representation of participant reports of zero pain or reward experienced after receiving social judgements in this task. This result may indicate that participants were not sufficiently invested in the scenario to experience what they would consider pain

or reward. Future studies may target investment directly, varying conditions to investigate which task factors impact investment, e.g., including a condition with the possibility of participants later meeting each other. Future studies may examine whether differences in investment impact participants' report of subjective pain or reward. Even in the current study, where participants may have been under invested, our findings still indicated significant patterns of subjective experience dependent on participant's expectation and the actual judgement given. This outcome is congruent with a previous finding that, even in a situation of relatively low stakes, when participants were told they were being excluded by a computer and not by a person, they still felt a subjective experience of rejection (Jauch et al., 2022).

This study found that both male and female participants responded to the interaction of expectations and judgments, however the difference in subjective response between conditions was greater for females. This finding may indicate that females have a larger range of experiencing, or expressing, the magnitude of pain and reward. This interpretation is supported by evidence that females may be more reactive to social rejection than males, as measured by neurophysiological outcomes (Gunther Moor et al., 2014). Females are also known to score higher on rejection sensitivity (Maiolatesi et al., 2022). Alternatively, the finding may indicate that female participants were paying more attention or taking the task more seriously.

This study's results contribute evidence to the growing literature that associates high levels of social anxiety with lower expectations of social acceptance (Cao et al., 2015; Harrewijn et al., 2018; van der Molen et al., 2018). Moreover, they indicate decreasing expectations of acceptance over time, confirming previous findings of the same phenomenon in multiple experiments using the SJP (Hofman et al., 2021). Hofman et al. (2021) have hypothesized that expectations of acceptance lower over the time of the task as a form of adaptation to reduce the pain of unexpected rejection. Alternatively, it is also possible that participants' naivety reduces over repeated trials, that they guess the random nature of the judgment responses, and therefore, that their expectations of acceptance lowered to more closely resemble a 50/50 chance of being accepted. This rationale may be supported by our finding that participants were more likely to expect rejection after they had been accepted[2]. Our results did not show an asymmetry in the expectations about judgements following previous rejection or acceptance, but instead showed that following rejection participants expected acceptance and following acceptance they expected rejection more. This might suggest that learning about the likelihood of getting accepted by peers takes place throughout the task. However, to further clarify this behavior, future studies should incorporate more explicit checks of naivety.

It is important to note that our study did not find evidence for an overall positivity bias, which has been reported by most other studies employing the SJP (Dekkers et al., 2015; Hofman et al., 2021; Van Der Molen et al., 2014). A possible explanation for this slightly more neutral bias in our study is the special circumstances under which the described experiment took place. Our participants performed the SJP in a private home situation, mostly in a period in which strict social distancing rules applied due to the Covid-19 pandemic, which might have led to more feelings of depression and anxiety, and therefore a more negative bias. It should be noted that on average, our sample is above the cut-off for social anxiety, which could explain the lower bias scores. It is also notable that our study did not investigate the assumptions made by participants regarding the basis for judgements from others, i.e., what factors/traits did our participants assume that others would judge their photo upon? Future studies may investigate this by asking participants further questions before and/or after the task.

Limitations and strengths

This study was limited by a lack of control over the testing environment. For example, participants were given a link to complete the task in their own time, without control over the level of distraction present during their task, nor the time of day they participated. Future studies may benefit from more detailed instructions for the conditions of task participation, a contractual agreement to the conditions of participation, a check of participant's concentration, or requests for reporting on their environment. In addition, the online nature of the task presented some technical problems (predominantly variable compatibility of the task across multiple personal computers) which led to attrition. Future research may benefit from a testing period to identify potential technical errors that could be avoided. It is also noteworthy that the duration of stimuli exposure was slightly lengthened for use in the online setting. This difference may limit comparison with previous laboratory measures of neurophysiological responses in the SJP, although our findings are in line with previous results. This study was conducted in English at a culturally diverse institution, however participant ethnicity and English language proficiency were not recorded. Therefore, it was not possible to examine the possible confounds of culture and language on responses to the questionnaires or the task. For example, individual interpretations of the terms reward and pain may have varied. Future studies may clarify whether social reward and pain are impacted by cultural or linguistic differences. It is noteworthy that in the current

[2] Although not reported, this is indeed a finding that seems to be consistent in other studies using SJP ($N = 459$) from our lab (manuscript in preparation).

study, the terms did not seem to be interpreted as simply binary constructs, indicated by low correlation between ratings of pain and reward across the sample (see Supplementary Tables S16 and S17). Additionally, no attempt was made to compare the racial characteristics of the judges to those of the participants, differences may have impacted responses, and may have limited the strength of the experimental deceit of peer-judgment.

One advantage of this study was the novel inclusion of subjective measures of pain and reward in the SJP, which contributes to the existing literature by supporting the previous research with this paradigm that has presupposed subjective experiences and only explicitly examined neurophysiological responses. A second advantage is the novel online format for the SJP. Despite some technical difficulties, this study indicates that the SJP can be used online, as our findings regarding decreasing expectation over time, and the impact of both trial valence and congruence on outcome measures, are in line with previous research conducted in person.

Conclusion

Overall, this study has successfully implemented the social judgment paradigm in an online format and, for the first time, included trial-by-trial subjective measures of pain and reward as outcomes of interest. The results indicate that both expectations and judgments influence the subjective experience of pain and reward during social judgment. Regarding individual differences, we found that greater symptoms of social anxiety are associated with lower expectations of social acceptance and a higher likelihood of pain when rejected. Greater symptoms of depression were associated with a greater magnitude of pain when rejected. This study provides subjective experience information that has been missing from the existing research utilizing the SJP and contributes to an understanding of the relationships between symptoms of anxiety and depression with subjective experiences of pain and reward during social judgment.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12144-023-05599-6.

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Author contributions J.T. and F.V. conceived the experiment, J.T conducted the experiment. J.T., S.T., and F.V. analyzed the results. J.T. drafted the manuscript. S.T. revised the description of statistical analyses and created the figures. A.H. and M.M. contributed to the contextualizing and interpretation of results. All authors reviewed the manuscript.

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Data availability The dataset generated and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval This study used a procedure approved by the Erasmus University Ethics Review Committee and was performed in compliance with their guidelines and regulations.

Consent Informed consent was obtained for all individual participants included in this study.

Competing interests The authors declare no competing interests.

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