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The Role of Cognitive Reappraisal and Expectations in Dealing with Social Feedback

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Abstract

Whereas emotion regulation (ER) in response to distressing events is widely studied, the mechanisms underlying adaptive ER while anticipating these events are still unknown. In this study, we investigated how ER strategies and expectation influence (1) individuals' anticipatory and online processing of self-relevant events, and (2) their affective response to them. Sixty-one healthy female participants were exposed to bogus positive and negative social feedback under reappraisal and watch instructions (no regulation). During the anticipatory period, participants were either expecting negative feedback or they had no expectation regarding the valence of the upcoming self-relevant feedback. Hence, negative feedback was, respectively, expected or unexpected. Participants' affective responses were collected via self-report and electromyographic activity over the corrugator muscle. Results showed that participants' negative affect (based on both self reports and EMG) was reduced by the instructions to reappraise as compared to the watch condition. Yet, such beneficial effect of reappraisal was: 1) not observed during the anticipation phase; and 2) less effective when social feedback was expected (as compared to not expected) prior to its presentation. Possibly, cognitive reappraisal might be less able to overcome the influence of negative forecasting of self-relevant negative emotional stimuli. Research findings are discussed in light of potential mechanisms underlying impaired adaptive emotion regulation in patients vulnerable for mood disorders.

Keywords: *Social feedback; corrugator EMG; emotion regulation; expectation*

Introduction

When expecting a potentially unpleasant or self-threatening event to occur, we have to cope with these anticipatory feelings of anxiety or uneasiness. In other words, we often have to deal with emotions elicited by the sole anticipation of a future event. The involvement of brain areas such as prefrontal regions, insula, and amygdala during anticipation of unpleasant or negative stimuli has been documented (e.g., De Raedt & Hooley, 2016). Luckily, individuals can, to a certain extent, regulate the quality, intensity, and duration of their emotions in order to achieve their goals. This ability goes under the name of emotion regulation (ER) and has been widely studied as it plays an essential role for our (psychological) health. Particular attention has been given to *cognitive reappraisal*, an emotion regulation strategy that consists of modifying the meaning (i.e., appraisal) given to a situation in order to alter its emotional impact. The habitual use of this strategy has been repeatedly associated with less negative affect and higher well-being (e.g., Gross & John, 2003; Kanske, Heissler, Schönfelder, & Wessa, 2012; Mauss, Cook, Cheng, & Gross, 2007; Moore, Zoellner, & Mollenholt, 2008; Richards & Gross, 2000; Urry, van Reekum, Johnstone, & Davidson, 2009; Vanderhasselt, Koster, et al., 2014). Yet, most of these studies have investigated emotion regulation in response to an event (i.e., after the event eliciting such emotions has occurred), but recent research also started to focus on cognitive reappraisal in the emotion anticipation phase. This is because expectations concerning an upcoming emotional event have the power to shape one's subsequent affective response, and cognitive reappraisal seems to influence this association (Denny, Ochsner, Weber, & Wager, 2014).

The association between expectation and reappraisal has been investigated before. Prior studies, for example, have used imbalanced designs in which a "Look" instruction (watch condition) preceded negative or neutral pictures, whereas a "Change" instruction (reappraisal condition) only preceded negative pictures (Denny et al., 2014; Goldin, McRae, Ramel, & Gross, 2008; McRae et al., 2012). Other studies have looked at the anticipation phase, and observed that prefrontal activity during this phase predicts amygdala activity during the picture presentation phase, which is in turn related to reappraisal ability (Denny et al., 2014). Moreover, researchers have reported brain activations to be similar when participants were anticipating emotional pictures – from the International Affective Picture System (IAPS) database (Lang, Bradley, Cuthbert, 2008) – of unknown valence and those of negative valence (Herwig, Kaffenberger et al., 2007), and no overlap with the activated brain areas elicited by the anticipation of positive valence pictures (Herwig, Kaffenberger, Baumgartner, & Jancke, 2007). In a subsequent study of this research group, participants were tested while they exerted 'reality checking' – a cognitive technique to down-regulate emotional responses – during anticipation of negative and "unknown" stimuli (again IAPS pictures). It was found that, during anticipation of unpleasant events, the exertion of reality checking (compared to no reality checking) resulted in higher activity in left medial and dorsolateral prefrontal cortex areas but reduced activity in the left amygdala (Herwig, Baumgartner, et al., 2007). Reality checking during the anticipation of unknown stimuli was associated with reduced amygdalar activity as well as reduced insular and thalamic activity. Hence, individuals seem able to reappraise their emotional responses during the anticipation of negative emotions (see also Seo et al., 2014, where a preparatory control strategy was used during the anticipation phase). Yet the direct comparison between expected versus unexpected emotional stimuli – and the influence of cognitive reappraisal – has never been investigated. Moreover, uncertainty – especially regarding self-relevant, emotion-eliciting stimuli – is characterized by greater arousal (Grupe & Nitschke, 2011; Moor et al., 2010; Sarinopoulos et al., 2010), which would allow less regulatory abilities during this anticipation phase. However, using self-relevant material is of utmost importance to understand mechanisms underlying (mal)adaptive emotion regulation, as these social self-relevant stimuli are exactly those where patients with mood disorders experience difficulties with (e.g., Hooley et al., 2005; 2009). To our knowledge, no previous research has explored how individuals' ER strategies and anticipatory expectations interact when dealing with self-relevant emotion eliciting events (i.e., rejection and praise).

The goal of the present study was to investigate whether emotional responses elicited by the anticipation and reception of self-relevant social feedback can be down-regulated by cognitive reappraisal. Hence, using a paradigm developed in our lab (Vanderhasselt et al., 2015; 2018; Nasso et al., in preparation; Allaert et al., under review), we exposed participants to positive and negative social feedback and used informative and uninformative cues to manipulate their expectation regarding its valence. In addition, we introduced a within-subject manipulation of ER strategies (i.e., watch vs. reappraisal). Participants' affective responses were collected via self-reports as well as electromyographic activity (EMG)[1] over the corrugator muscle. Electromyographic corrugator (EMG) responses to emotional stimuli have been used to index affective responses and to differentiate subtle shifts in positive and negative emotional states. Specifically, when compared to neutral stimuli, these psychophysiological responses are larger for negative and smaller for positive stimuli (e.g., Lang, Greenwald, Bradley, & Hamm, 1993; Larsen, Norris, & Cacioppo, 2003; Schönfelder, Kanske, Heissler, & Wessa, 2013). Moreover, a positive effect of cognitive reappraisal on EMG responses has been reported, for example the down-regulation of negative affect using cognitive reappraisal can lead to decreased corrugator responses measured during the affective experience (e.g, Ray, Mcrae, Ochsner, Gross, 2014).

Based on the literature, we hypothesized that participants' negative affect (as measured by both self-report ratings and corrugator EMG activity during anticipation and feedback receipt) would be reduced under reappraisal compared to watch instructions (Shafir, Schwartz, Blechert, & Sheppes, 2015; Uchida et al., 2014; Urry, 2009; Yang, Gu, Tang, &

[1] Pupil dilation was also measured during the experiment. The results can be found in the supplementary material.

Luo, 2013), and after expected compared to unexpected negative social feedback (Bar-Anan, Wilson, & Gilbert, 2009; Buckley, Winkel, & Leary, 2004; Grupe & Nitschke, 2011). Even though no prior studies investigated the interaction between cognitive reappraisal and expectation of the upcoming emotional event on individuals' affective responses, we could predict an additive effect of ER and expectancy. Hence, participants should experience the least negative affect in response to an expected negative feedback in the reappraisal condition and experience the most negative affect following an unexpected negative feedback under watch instructions.

Method

Participants

Sixty-six healthy female undergraduates at Ghent University between 18 and 29 years old were recruited via Experimetrix Momentum™ experiment scheduling system. Participation was restricted to female volunteers, as emotional processing is subject to sex differences (e.g., Montagne, Kessels, Frigerio, de Haan, & Perrett, 2005; Stroud, Salovey, & Epel, 2002). Volunteers were selected according to the following criteria: native Dutch speakers, right handed, normal or corrected-to-normal vision, and no current (or history of) neurological or psychiatric illness. The data of five participants could not be used due to technical problems during data collection, leaving a final sample of 61 participants (mean age 21 years, *SD* = 2.5)[2]. Sample size was determined before data collection and based on available resources (no formal *a priori* power analysis was conducted).

All participants signed an informed consent (protocol approved by the local Ethical Committee) and were compensated with a payment of € 20.

Procedure

[2] Out of the total sample, 11 participants did not entirely believe our cover story. Moreover, this information was not reported for 3 participants. However, the pattern of results did not qualitatively differ when excluding these 14 participants from the confirmatory analyses (see Supplementary Materials). Therefore, we report the results of the analyses conducted on the whole sample.

To deliver social feedback, we modified an experimental paradigm developed in our lab, which has been shown to influence affect as well as emotional and cognitive processing (Vanderhasselt et al., 2015; Nasso et al., in preparation; Allaert et al., under review). As a cover story, participants were told that the aim of this study, run in collaboration with a foreign university, was to investigate the development of first impressions across cultures. In reality, no foreign volunteers were recruited, and the social feedback participants received was bogus.

The whole procedure consisted of two phases, the first of which was conducted at home, whereas the other took place in an experimental room of the Faculty of Educational and Psychological Sciences at Ghent University.

Phase 1: First impression of foreign volunteers

Immediately after subscription, participants were required to send us a head-shot picture of themselves via email. Afterwards, they received a link to a series of 24 head-shot pictures of foreign students (12 males and 12 females) and were asked to provide their first impression regarding the person depicted on each picture (see *Figure 1*)[3]. To this end, participants had to choose between two antinomical personality-trait descriptors (i.e., a positive and a negative adjective): the one that, in their opinion, better described the portrayed foreign volunteer. This first task had the sole purpose of increasing the credibility of our cover story.

[3] Picture stimuli were obtained from volunteers between 22 and 33 years old who agreed to send their picture for the purpose of our research.

Figure 1. Forming first impressions of foreign volunteers: an example. Picture reproduced with permission.

Phase 2: Baseline and Emotion Regulation (ER) task

Once in the lab, participants were first asked to relax for five minutes, after which we collected a baseline measure of affect by using the Evaluative Space Grid (ESG; Larsen, Norris, McGraw, Hawkley, & Cacioppo, 2008; see below for details)[4]. Participants were then told that the picture they had sent us via email had been shown to other foreign students (which we will call *evaluators*). Via the same procedure described in phase 1 (i.e., first impression of foreign volunteers), these evaluators had formed their first impression about the participants (based on each individual's head-shot picture) and sent us their feedback[5].

Ninety personality-trait descriptors selected from Hermans and De Houwer (1994) were used to create bogus social feedback. Of these, 30 were positive and 60 negative. Arousal, obtained by calculating the distance of affective from neutral ratings (i.e., for

[4] At their arrival in the experimental room, participants also filled in the Mood and Anxiety Symptoms Questionnaire, the Rosenberg Self-Esteem Scale, the Cognitive Emotion Regulation Questionnaire, the Rejection Sensitivity Questionnaire, the Ruminative Responses Style scale State Worry Questionnaire, and the Momentary Ruminative Self-focus Inventory. However, none of these measures showed a relationship with our dependent variables. We surmise that the ER instructions may have overpowered the effect of small individual differences in our sample of healthy participants.

[5] After informing participants that other foreign students had evaluated their pictures, an extra task was run to measure participants' primary emotional responses to social feedback (thus, before the ER task). Moreover, we collected participants' self-generated expectations on the valence of each upcoming social feedback. All participants performed the same task. However, most participants expected to receive almost solely positive feedback, therefore creating a substantial imbalance between expected negative/unexpected positive and unexpected negative/expected positive social feedback. Due to this problematic difference, we do not report the analyses carried out on these data. For more information, please contact the corresponding author.

positive adjectives, affective rating – 4; for negative adjectives, 4 – affective rating), was higher for positive (M = 1.91, SD = 0.37) than for negative (M = 1.56, SD = 0.53) personality-trait descriptors, $t(78.58) = 3.7$, $p < .001$, $r = 0.39$. A list of the Dutch personality-trait descriptors can be found in the Supplementary Materials. Different personality-trait descriptors were employed during phase 1.

Social feedback was presented under two within-subject conditions. In the *Watch* condition, participants were asked to attend to the stimuli and to experience their emotions naturally, trying not to change them (instruction “watch”). In the cognitive reappraisal condition, participants were instructed to reinterpret the situation by focusing on thoughts such as “this person does not know me, whatever he/she says, it does not mean anything about the person I am”, or “if the evaluator would get to know me, he/she would think differently” (instruction “reappraise”). This means that participants were trained to positively reappraise the situation, and not using a detached readiness period. The training was comprehensive, all participants rehearsed many examples, and the experiment started when the experimenter decided that the participant was well aware of the instructions (both during anticipation phase and feedback phase). Yet, the experimenter emphasized that the purpose of the study was to get more insights in emotional processes to first impressions, and that no right or wrong answer existed. Moreover, the experimenter acknowledged that down-regulating emotions is difficult and participants were encouraged to do their best and be honest in their verbal reports of emotion.

The ER task consisted of four blocks (two watch and two reappraisal blocks), each comprising 45 trials, interleaved by short breaks. At the beginning of each block, we showed participants a picture of themselves to induce self-referential thoughts. Afterwards, either the instruction “reappraise” or “watch” appeared in the centre of the screen indicating which ER strategy had to be applied during the upcoming block (respectively, cognitive reappraisal or watch). The same ER instruction was shown in two consecutive blocks in order to maximize participants' ability to deploy each ER strategy. The order between the two strategies was counterbalanced across participants (i.e., half of the participants started with two reappraisal blocks while the other half started with two watch blocks).

Each trial (see *Figure 2*) started with a 1-second fixation screen, then continued with an anticipation period (displayed in the centre of the screen for 6 seconds), and ended with positive or negative social feedback (presented for 6 seconds). To prompt a specific emotion during the anticipation phase, we presented an emoticon with a sad expression, which always preceded negative feedback ("*Expectation*"). On the other hand, a question mark was presented that did not give any indication of the valence of the upcoming social feedback: a positive or a negative adjective could follow it with equal probability ("*No Expectation*"). This resulted in three trial types, one in which participants expected negative social feedback (trial type *Expected Negative*, *Figure 2a*) and two in which they had no expectations about its valence (trial types *Unexpected Positive*, *Figure 2b*, and *Unexpected Negative*, *Figure 2c*). Participants were explicitly told to apply the appropriate ER strategy both in anticipation of and during social feedback. However, they were also asked not to reappraise positive feedback. To clarify, the trial type *Unexpected Positive* was included in the procedure only to increase the ecological validity of the paradigm and to provide an alternative, credible type of feedback after *No Expectation* anticipation. For this reason, and because our interest lays in the regulation of the emotional response to negative feedback, participants were instructed to always respond naturally to positive feedback. Hence, no analyses were executed on trial type Unexpected Positive (except as a manipulation check of the effect of feedback valence on participants' affect) as they did not match the trial types with negative feedback either for expectation conditions or for ER instructions.

In total, participants were exposed to 180 trials, 30 for each condition (3 trial types x 2 ER strategies). Throughout the whole task, we recorded pupil dilation (see Supplementary Materials) and corrugator EMG activity. Moreover, participants rated their affect via the ESG after one-third of the trials (i.e., 10 per condition). The evaluative space grid (see *Measures* section below) appeared after social feedback presentation (i.e., target offset) and stayed on the screen until a response was recorded. The next trial started normally with a one-second fixation screen. Perceived contrast (calculated as the ratio of luminance standard deviation to luminance mean) was kept constant at 0.10 across stimuli.

Upon completion of the ER task, to check whether participants believed our cover story, we asked them – using open questions - what they thought we were investigating in our study. Based on their answers, two categories were created: “Yes, believed that the task was about first impressions” or “No, did not believe that the task was regarding first impressions”.

Participants were then debriefed on the real purpose of our research and assured that the social feedback they had received was bogus.

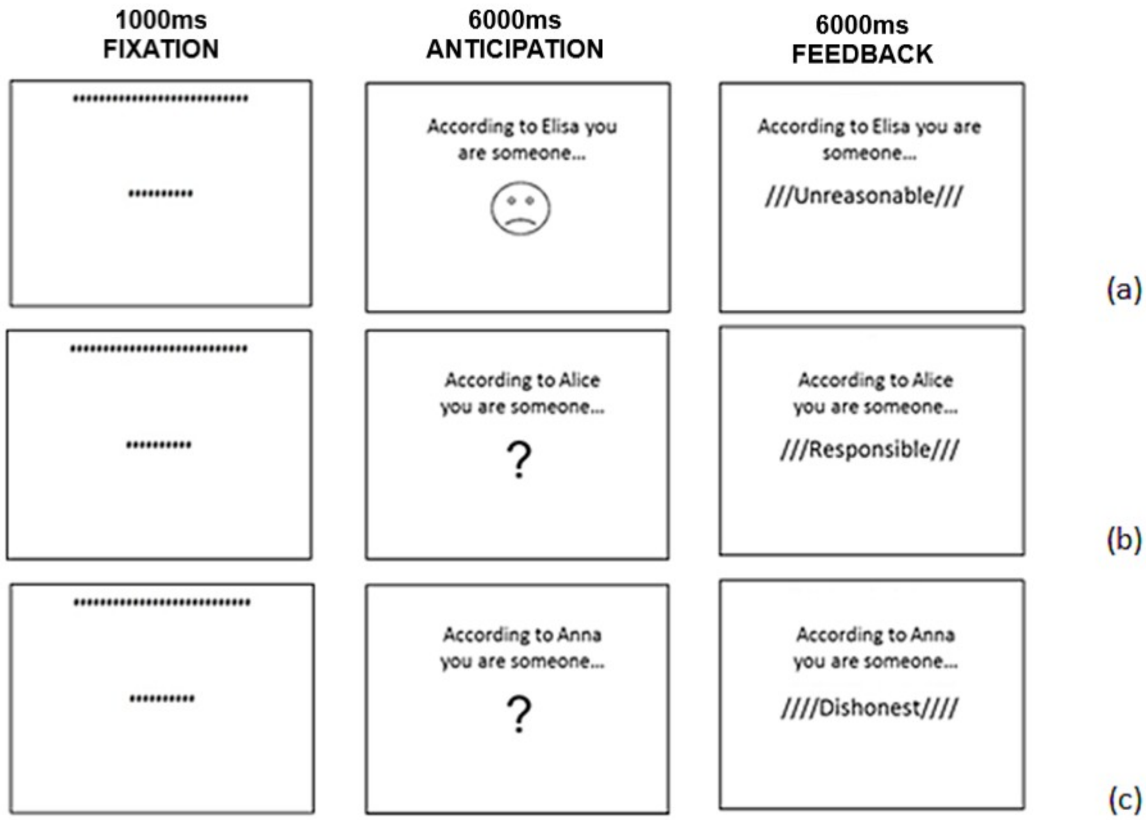

Figure 2. Structure of a trial in the emotion regulation task and overview of the trial types: a) trial type Expected Negative (i.e., negative expectation followed by negative feedback); b) trial type Unexpected Positive (i.e., no expectation followed by a positive feedback); c) trial type Unexpected Negative (i.e., no expectation followed by negative feedback).

Measures

Self-reported affective responses

The Evaluative Space Grid (ESG; Larsen, Norris, McGraw, Hawkley, & Cacioppo, 2008) is a self-report, single-item measure of positive (PA) and negative (NA) affect. Participants are presented with a 5x5 grid and are asked to indicate, respectively on the x- and y-axes, how positive and how negative they feel about a stimulus. From the origin to the extremities of the grid, the cell anchors are: *not at all*, *slightly*, *moderately*, *quite a bit*, and *extremely*. To report their affective state, participants are required to click (in the computerized version) on the cell that best describes their feelings.

Electromyographic (EMG) responses

Electromyographic activity over the corrugator muscle was acquired using the Biopac MP150 system following current guidelines (Blumenthal et al., 2005; Van Boxtel, 2010; Fridlund & Cacioppo, 1986). After cleaning the participant's skin, two shielded Ag–AgCl (4 mm diameter) reusable electrodes were placed above the participant's left eyebrow, along the corrugator muscle fiber[6]. As reference, an unshielded Ag–AgCl (4 mm diameter) reusable electrode was attached in the middle of the participant's forehead (Fridlund & Cacioppo, 1986). To minimize movement artifacts, we taped the electrode leads to the participant's body. EMG signal was recorded at 1000 Hz sampling rate, amplified with a 5000 gain, and submitted to three online filters: a 10 Hz high-pass filter, a 500 Hz low-pass filter, and a 50 Hz notch filter (Blumenthal et al., 2005; van Boxtel, 2001). Using LabVIEW (National Instruments Corporation), we applied an offline 20-200 Hz band-pass FIR filter (Blackman-Harris window, 1499 coefficients or higher; van Boxtel, 2001). We then rectified and integrated the EMG signal via the root mean square (RMS) technique with a 100 ms time window (Fridlund & Cacioppo, 1986).

Data Analysis

The main analyses on the effects of ER and expectation in the emotion regulation task were conducted on anticipation and feedback phases of trial types *Unexpected Negative* and *Expected Negative*. Concerning trial type *Unexpected Positive*, its cues were completely excluded from the analyses, whereas the targets were employed uniquely in the Task Validity Check analyses.

To investigate the main effects of expectation and ER strategy, we collapsed trials (separately for anticipation and feedback) belonging to the same ER blocks or trial types,

[6] It is important to note that surface electrodes have poor spatial selectivity and therefore record the activity of the neighboring muscles as well (Fridlund & Cacioppo, 1986). However, as it is common practice to refer to the specific muscle fiber targeted by the electrodes placements sites, we label the recorded data as corrugator EMG activity.

respectively. This resulted into four conditions: Reappraisal, Watch, Expectation, and No Expectation. Based on our hypothesis of an additive effect of ER and expectation, the interaction effects were analysed, separately for anticipation and feedback, by comparing trial type *Unexpected Negative* versus *Expected Negative*, within the Watch and Reappraisal condition. Moreover, the *Unexpected Negative* and *Expected negative* trials were compared between Watch and Reappraisal conditions. All pairwise comparisons are two-tailed, and the reported *p*-values of the post hoc comparisons are corrected for multiple comparisons via Bonferroni-Holm procedure (Holm, 1979).

Self-reported affective responses

From the origin to the extremities of the ESG grid, each cell was assigned a value ranging from 0 (*not at all*) to 4 (*extremely*). Self-reported affect ratings were calculated as the net difference between the values assigned to positive and negative affect of the selected cell (i.e., PA minus NA). This derived value has been shown to strongly correlate with traditional bipolar ratings and hence conveys all the necessary information (J. Larsen et al., 2008)[7]. We used the delta scores from the baseline self-reported affect ratings.

First, to ensure that the task elicited the desired affective responses (more positive self-reported affect after positive than negative feedback), we ran a paired-sample *t*-test to compare affect ratings after positive and negative unexpected social feedback within the watch blocks (“task validity check”). Second, to explore the effect of ER strategy and expectation on the participants’ self-reported affect ratings after negative feedback, we ran a 2(Reappraisal, Watch) x 2(Expectation, No Expectation) repeated measures ANOVA. Paired *t*-tests were employed to follow-up and further explore the nature of the significant main effects and interaction. We calculated Pearson’s *r* as a measure of effect size (Field, Miles, Field, 2012).

[7] Similar results were obtained in a control analysis on PA and NA separately; we therefore report only the net difference for conciseness.

Electromyographic responses

To quantify the EMG signal amplitude in response to social feedback, we averaged the RMS values (in μV) over the whole stimulus duration (i.e., from 0 to 6000 ms). The choice to analyze an averaged measure of EMG amplitude is justified by a vast literature showing that average EMG responses are sensitive to affect (e.g., Kim & Hamann, 2012; J. T. Larsen et al., 2003; Ray, McRae, Ochsner, & Gross, 2010; Schneider, Hempel, & Lynch, 2013; Urry, 2009; Weinreich & Funcke, 2014). Moreover, previous studies taking into account the temporal unfolding of EMG corrugator activity showed a sustained effect of the experimental variable and no interaction with time (Künecke, Hildebrandt, Recio, Sommer, & Wilhelm, 2014; Neumann, Schulz, Lozo, & Alpers, 2014; Schönfelder et al., 2013; Urry, 2009). We then subtracted the 100ms pre-stimulus baseline, thus obtaining difference scores (ΔμV) which were then averaged per trial type. Because neither the corrugator EMG data nor the residuals were normally distributed, and the application of transformations[8] could not correct for such deviation, we resorted to the use of non-parametric tests (Jäncke, 1996).

Similarly to the procedure applied to the ESG data, we ran a task-validity check by comparing, via a Related-Sample Wilcoxon Signed Rank Test, EMG activity during positive and negative unexpected social feedback (i.e., feedback Unexpected Positive vs. feedback Unexpected Negative) within the watch blocks. We then investigated, separately for anticipation and feedback, the effects of ER strategy and expectation on corrugator EMG activity by means of a nonparametric repeated measures ANOVA via Aligned Rank Transform (Wobbrock, Findlater, Gergle, Higgins, 2011). We ran a 2 (ER instruction: Reappraisal vs. Watch) x 2 (Expectation: Expected vs. Unexpected) x 2 (Phase: Anticipation vs. Feedback) ANOVA. Statistically significant effects were followed up by Related-Samples Wilcoxon Signed Rank Tests (Bonferroni-Holm correction for multiple comparison). As a

[8] Namely: logarithmic transformation on base 10, square root transformation, reciprocal transformation, and within-subject Z transformation (Bush, Hess, & Wolford, 1993; Kordik, Eska, & Schultheiss, 2012; J. T. Larsen et al., 2003; Mathersul, McDonald, & Rushby, 2013).

measure of effect size, we used *r* as calculated in Field et al. (2012, par. 15.4.6; see also Rosenthal, 1991) and its bootstrapped bias-corrected and accelerated 95% confidence intervals (5,000 samples with replacement). Data manipulation and analysis were performed in *R* v.3.6.1 via Rstudio IDE and packages *tidyverse* v1.3.0 (Wickham, 2019), *rcompanion* v2.3.7 (Mangiafico, 2019), and *ARTool* v0.10.6 (Kay & Wobbrock, 2019).

Results

Task Validity Check of Valence

To test whether participants responded differently to negative versus positive stimuli (as measured by both self-report ratings and corrugator EMG activity), we compared trial types *Unexpected Positive* and *Unexpected Negative* social feedback within the watch blocks[9]. Participants rated their affect as more positive after *Unexpected Positive* (M = 0.88, SD = 1.93) than after *Unexpected Negative* (M = -1.3, SD = 2.14) social feedback during the watch blocks, $t(60) = 12.7$, $p < .001$, $r = .85$, $CI_{95\%}$ [1.88, 2.64]. Similarly, participants' corrugator EMG responses during the watch blocks were significantly lower during feedback belonging to trial type *Unexpected Positive* (Mdn = -0.94 μV) than *Unexpected Negative* (Mdn = 1.53 μV), $V = 600$, $p = .003$, $r = .37$, $CI_{95\%}$ [.12, .55]. Hence, both behavioural and physiological affect indexes suggest that the use of (bogus) social feedback stimuli elicited the expected affective responses.

Emotion Regulation Task

Self-reported affective responses

Results of the omnibus 2 (ER strategy: Watch, Reappraisal) x 2 (Expectation: Expected, Unexpected) repeated measures ANOVA revealed significant main effects of ER strategy, $F(1, 60) = 65.43$, $p < .001$, $\eta_p^2 = .52$, $CI_{95\%}$ [.63, 1.04], and Expectation, $F(1, 60)$ =

[9] Using ER block as a between-subject factor confirmed that counterbalancing the ER instructions did not significantly affect participants' self-reported affect (all *p*s > .17) or EMG corrugator activity (see Supplementary Materials).

5.25, p = .026, η_p^2 = .08, $CI_{95\%}$ [.01, .17], but no significant interaction between these factors, $F(1, 60)$ = 1.01, p = .317, η_p^2 = .02. Specifically, participants' affect was less negative after negative feedback during the reappraisal (M = -.53; SD = 2.25) as compared to the watch (M = -1.37; SD = 2.17) blocks, and less negative after unexpected (M = -.91; SD = 2.16) than expected (M = -1.00; SD = 2.19) negative feedback. See *Figure 3* for an illustration of these effects.

Figure 3

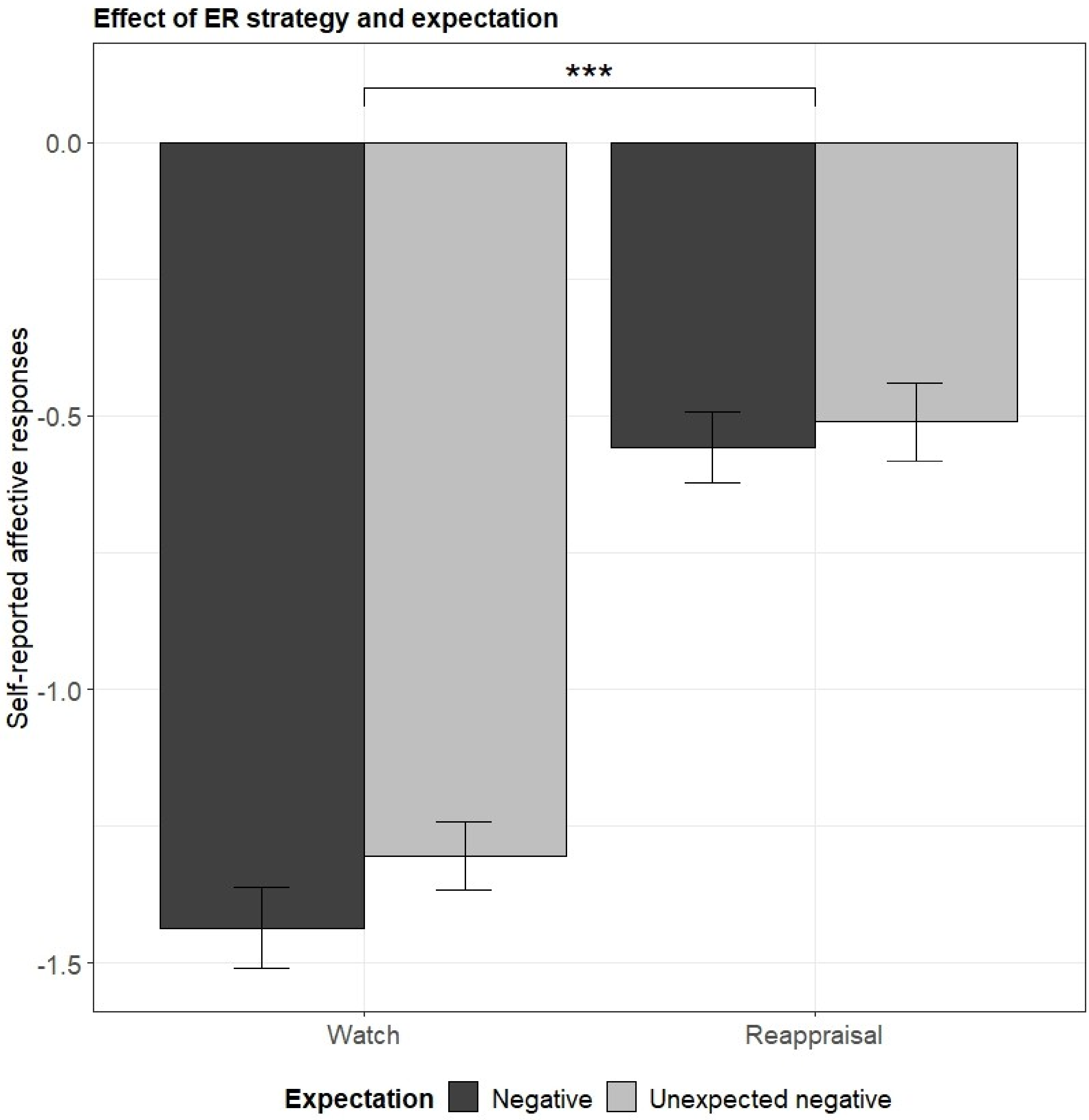

Figure 3. Self-reported mood responses illustrating the main effect of Expectation and the main effect of Emotion regulation strategy. Only one main effect could be indicated on the figure.

Electromyographic responses

Results of the omnibus 2 (phase: Cue, Target) x 2 (ER strategy: Watch, Reappraisal) x 2 (Expectation: Expected, Unexpected) nonparametric repeated measures ANOVA only revealed a statistically significant *phase* × *expectation* × *ER strategy* interaction, $F(1, 420) = 11.20$, $p = .001$, $\eta^2_p = 0.026$. Decomposition of these interaction effects were carried out using separate nonparametric ANOVAs for Anticipation and Feedback phases, as the significant comparisons were found within both phases.

Anticipation phase. Results of the omnibus 2 (ER strategy: Watch, Reappraisal) x 2 (Expectation: Expected, Unexpected) nonparametric repeated measures ANOVA did not reveal a main effect of ER strategy ($F(1, 180) = 0.36$, $p = .552$, $\eta^2_p = 0.002$), but only revealed a main effect of Expectation ($F(1, 180) = 4.51$, $p = .035$, $\eta^2_p = 0.024$). This main effect showed that EMG during anticipation when negative social feedback was expected was more negative ($M = .0084$; $SD = .037$) as compared to anticipation when there was no expectation regarding the valence of the upcoming feedback ($M = .00365$; $SD = .0269$). Yet, this main effect was superseded by a significant interaction between ER strategy and Expectation, $F(1, 180) = 7.86$, $p = .006$, $\eta^2_p = 0.042$.

Post-hoc analyses of this interaction revealed higher EMG responses to expected relative to unexpected anticipations during the watch blocks, $V = 1{,}369$, $p = .008$, $r = -.39$, $CI_{95\%}$ [-.58, -.15]. In contrast, expected and unexpected anticipation did not elicit EMG responses that were significantly different within the reappraisal blocks, $V = 919$, $p = .853$, $r = .02$, $CI_{95\%}$ [-.24, .27]. Over expected anticipation (i.e., Expectation condition), no statistically significant difference between watch and reappraisal blocks was observed, $V = 1{,}144$, $p = .312$, $r = -.18$, $CI_{95\%}$ [-.41, .07], which was also the case in the No Expectation condition (V = 660, p = .120, r = .26, $CI_{95\%}$ [.001, .47]). See *Figure 4A* for an illustration of this effect.

Feedback phase[10]. Results of the omnibus 2 (ER strategy: Watch, Reappraisal) x 2 (Expectation: Expected, Unexpected) nonparametric repeated measures ANOVA revealed a main effect of ER strategy, $F(1, 180) = 5.70$, $p = .018$, $\eta^2_p = 0.031$. This main effect showed that the EMG activity was significantly lower in the reappraisal as compared to the watch blocks. On the contrary, we found no significant main effect of Expectation on EMG corrugator responses, ($F(1, 180) < 0.01$, $p = .987$, $\eta^2_p < 0.001$). In addition, a significant interaction effect, ($F(1, 180) = 7.30$, $p = .007$, $\eta^2_p = 0.039$), was observed.

Post-hoc analyses revealed statistically similar corrugator responses between Expected Negative and Unexpected Negative trials in the watch (V = 778, p = .593, r = .15, $CI_{95\%}$ [-.10, .39]) as well as reappraisal blocks (V = 1,126, p = .593, r = -.17, $CI_{95\%}$ [-.40, .09]). Yet, in the Unexpected Negative condition, EMG corrugator responses were larger during the watch as compared to the reappraisal blocks, V = 1,377, p = .007, r = -.40, $CI_{95\%}$ [-.59, -.15]. However, such difference in EMG activity due to ER strategy was not statistically significant in the Expected Negative condition, V = 1,038, p = .593, r = -.08, $CI_{95\%}$ [-.34, .18]. See Figure 4B for an illustration of this effect.

Figure 4

[10] Because the feedback baseline corresponded to the last 100ms of the anticipation phase, we ran Wilcoxon Signed Ranked tests to ensure that the effects at feedback were not significantly influenced by differences at baseline (all ps > .150).

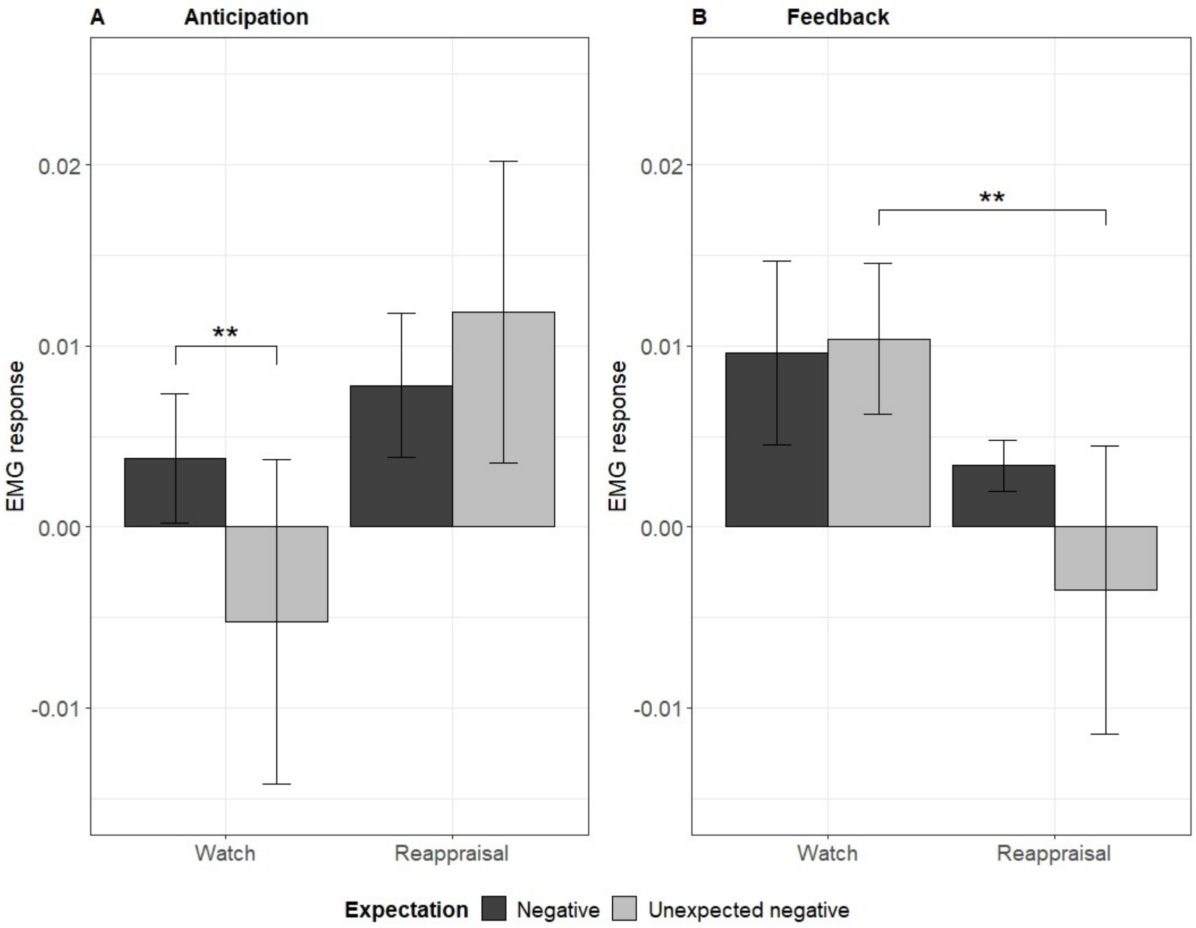

Figure 4. EMG responses for the different condition for the Cue (left) and Target (right).

Sensitivity Analysis

Sensitivity analysis in G*Power (Faul et al., 2007) revealed that the present study was able to detect, with $\alpha = 0.05$ and 80% power, a minimum effect size of:

- $f = 0.18$ when conducting 2 x 2 repeated measures ANOVAs;
- Cohen's $d_z = 0.37$ when conducting Related-Sample Wilcoxon Signed Rank Tests.

Readers are invited to keep this information in mind when interpreting the results.

Discussion

We investigated how the expectation about an upcoming self-relevant emotion eliciting stimulus and the use of cognitive reappraisal interact to influence affective responses. Affective responses were assessed via self-reports and EMG corrugator activity.

First, a main effect of ER strategy on affective responses confirmed that our ER manipulation was effective. In fact, both self-reports of affect as well as EMG corrugator responses suggested that reappraising negative social feedback (as compared to the watch condition) decreased participants' negative affect. This result observed in multimodal assessments (i.e., self-reports and EMG) is consistent with previous findings showing the beneficial effects of reappraisal over emotional responses (Shafir et al., 2015; Uchida et al., 2014; Urry, 2009; Yang et al., 2013).

Second, contrary to our a priori hypothesis, a main effect of expectation on self-reported affect revealed that participants felt less negative after unexpected (as compared to expected) negative feedback. This is in contrast with previous findings showing rather consistently that uncertain (i.e., unexpected) negative events are perceived as more aversive than certain (i.e., expected) negative events (e.g., Bar-Anan et al., 2009; Buckley, Winkel, & Leary, 2004; Grupe & Nitschke, 2011). Our results – using social feedback stimuli – may suggest that participants might have developed some kind of positive expectation when anticipating social feedback for which the valence was still unknown (as compared to when they knew the upcoming feedback would be negative). Possibly, this effect in the anticipation phase (also supported by the EMG data; see below) is a reflection of the well-known positivity bias in healthy volunteers (Mezulis et al., 2004), and might explain why healthy individuals report to feel less negative after unexpected (as compared to expected) negative social feedback.

Third, most interestingly for our research question, a significant interaction of ER strategies and expectation on affective responses was observed at the level of EMG corrugator activity, with a different pattern during the anticipation and feedback phase. The core finding is that there is an effect of expectation (but not reappraisal) during anticipation phase, and an effect of reappraisal (that interacts with expectation) during feedback phase.

During the anticipation phase, we observed greater EMG activity in the ‘expectation’ as compared to the ‘no expectation’ condition, but only during the watch blocks. In other words, higher corrugator responses (indirectly indicating less negative responses) were observed when anticipating social feedback of yet unknown valence (i.e., which could be either positive or negative) as compared to the anticipation of known negative social feedback. Interestingly, no statistically significant main effect of emotion regulation was observed during the anticipation phase, possibly suggesting that cognitive reappraisal might be unable to override the effect of expectation on emotional responses. In other words, the down-regulation of emotional responses based on a cognitive regulation strategy might not be possible when individuals are forecasting and attending to a particular emotional stimulus. On the other hand, when receiving the *feedback*, we found larger EMG corrugator response in the watch as compared to the reappraisal blocks (the well-known effect of reappraisal versus watch on affect), but this effect was most pronounced in response to unexpected (as compared to expected) negative feedback. In other words, the typical beneficial effect of reappraisal on affective responses was observed, but more strongly when participants had not expected to receive negative feedback. Taken together, these results might indicate that the use of cognitive reappraisal is particularly useful in response to unexpected negative feedback, which is typically highly aversive (Buckley et al., 2004). Consequently, similar to the anticipation phase, cognitive reappraisal may be unable to override prior expectations that continue to have a dominant effect on the emotional response when actually confronted with the expected social feedback.

What are the implications of this observation? A better understanding of the mechanisms underlying adaptive emotion regulation strategies when dealing with negative social feedback would avail the identification of protective factors against the onset and maintenance of affective psychopathology. Research has shown that patients with mood disorders have a general tendency to expect or attend to negative self-referential events (Wisco, 2009), and the anticipation of aversive events has been found to increase amygdala activity in depressed patients (Abler, Erk, Herwig, & Walter, 2007). The current data seems to suggest a detrimental effect of negative expectations on the ability to use cognitive reappraisal. In other words, this might suggest that antecedent beliefs and dominant thoughts would limit the inherent ability to use cognitive reappraisal to down-regulate emotional responses. Hence, inherent self-referential beliefs, attitudes, and expectations are crucial to be challenged when patients are learning to reappraise negative self-referential negative thoughts and emotions.

It should be noted that previous research has linked EMG corrugator activity not only to arousal, but also to cognitive effort (Van Boxtel & Jessurun, 1993). However, these latter tasks were primarily cognitive and did not use emotional stimuli. In addition, it has been shown that EMG corrugator activity is largest when reappraisal was used to increase negative affect, and smallest when used to decrease it, and that reappraisal instructions decreases EMG corrugator responses compared to watch (Kim & Hamann, 2012; Ray et al., 2010). Moreover, corrugator EMG activity provides an indirect index of affective responses, with smaller biases as compared to self-report measures, such as social desirability and lack of introspective emotional awareness (Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005). Another note is that the interaction of ER strategies and expectation on affective responses was not observed at the level of self-reported mood. We speculate that, by providing a categorical output, the ESG might have been less sensitive to smaller interaction effects than the EMG, which can be seen as a continuous and more fine-grained outcome measure. In addition, EMG corrugator activity recorded participants' affective responses to social feedback online, whereas affect self-report collected them after feedback offset.

Limitations of the current study should be discussed. A first limitation is that, as we wanted to limit the number of trials, the Expectation Positive condition was absent. Positive feedback was only provided when participants had no expectation regarding the upcoming feedback, which enabled to compare responses to unexpected positive and negative social feedback. Yet, direct comparisons of affective responses associated with the regulation of positive versus negative emotion are limited. As the influence of expectation is important to understand the effects of cognitive reappraisal in patients vulnerable for mood disorders, future studies should include this condition of positive expectation as well. Second, prior research has linked EMG corrugator activity not only to arousal, but also to cognitive effort (Van Boxtel & Jessurun, 1993). However, the tasks used in these experiments were primarily cognitive and did not use emotional stimuli. In addition, it has been shown that EMG corrugator activity is largest when reappraisal is used to increase negative affect, and smallest when it is used to decrease it, and that reappraisal instructions decreases EMG corrugator responses as compared to watch conditions (Kim & Hamann, 2012; Ray et al., 2010). Moreover, EMG is vulnerable to different sources of bias such as demand effects, although the latter was reduced as much as possible (combination self-reports and explicit training at the start). Another limitation is the use of a single-item measure of positive and negative affect. As such, affect ratings were computed as the difference between positive and negative mood. This calculation does not take into account mixed emotional experiences, as responses characterized as ‘low on both’ and ‘high on both’ would have similar difference scores. Further research should operationalize emotion in terms of experience, expression, but also based on physiology such as heart rate and/or skin conductance, which are all prone to different sources of biases (McRae et al., 2010). Finally, our experiment was sensitive to effects of medium magnitude; therefore, the non-significant findings reported here might also be due to the fact that our experimental design was not adequately powered to detect smaller effects.

To conclude, participants' negative affect was reduced by the instructions to reappraise (as compared to appraise), even though the effect of reappraisal was not observed during the anticipation phase and less effective when social feedback was expected prior to its presentation. Overall, it seems to be that cognitive reappraisal cannot overcome the detrimental effects of negative expectations in the context of self-relevant negative emotional stimuli.

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Author Contributions

Author contributions are coded according to the CRediT taxonomy.

Conceptualization: SN, MAV, RDR. **Data curation**: SN, MAV, AS. **Formal analysis**: SN, AS, MAV. **Funding acquisition**: MAV, RDR. **Investigation**: SN. **Methodology**: SN, MAV, RDR. **Project administration**: SN, MAV. **Resources**: RDR. **Software**: SN, MAV, AS. **Supervision**: MAV, RDR. **Validation**: AS, SN, MAV. **Visualization**: MAV, AS. **Writing – original draft**: SN, MAV, AS, RDR. **Writing – review & editing**: MAV, AS, SN, RDR.

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The Role of Cognitive Reappraisal and Expectations in Dealing with Social Feedback - Supplementary Materials: Pupil Data

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Recording and preprocessing

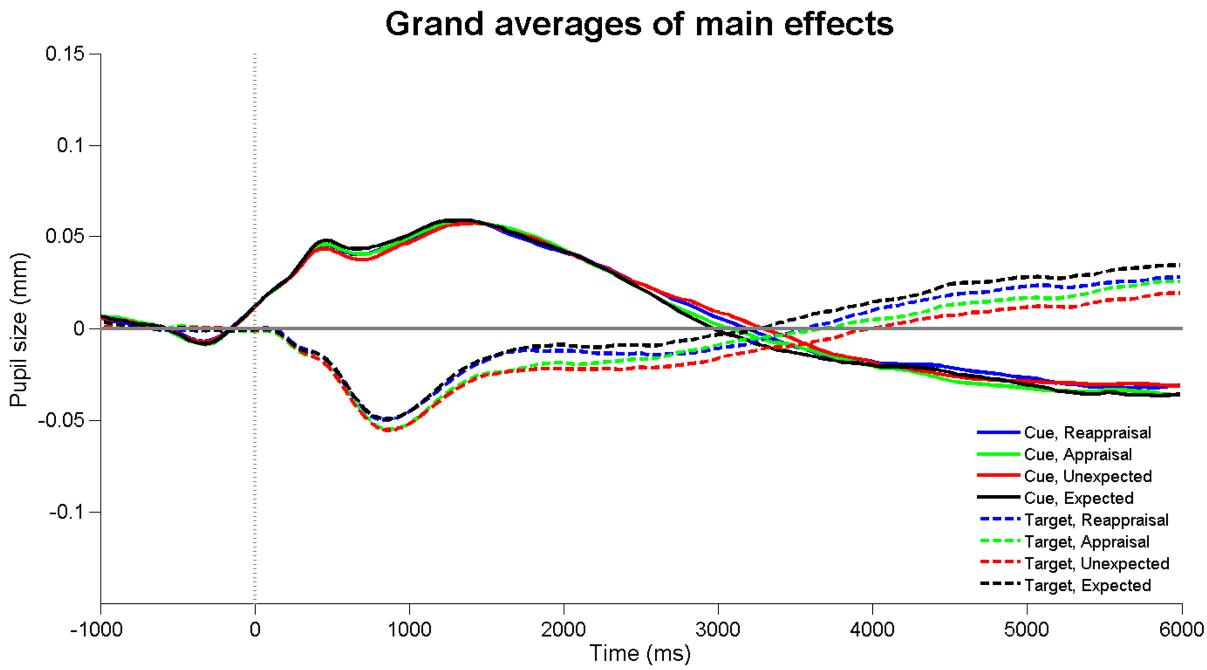
Pupil dilation (PD) was recorded by means of Tobii TX-300 (Tobii AB, Danderyd, Sweden). Via a video camera and an infrared light source pointed at the participant's eye, the eye-tracker tracked the position and size of the pupil at a sampling rate of 300 Hz. Data was digitally transferred from the pupillometer to a computer together with markers signaling stimulus onset and offset. Participants sat circa 60 cm from the screen; to calibrate the eye tracker, they were asked to orient their gaze towards five dots, one at each corner of the screen and one in its center.

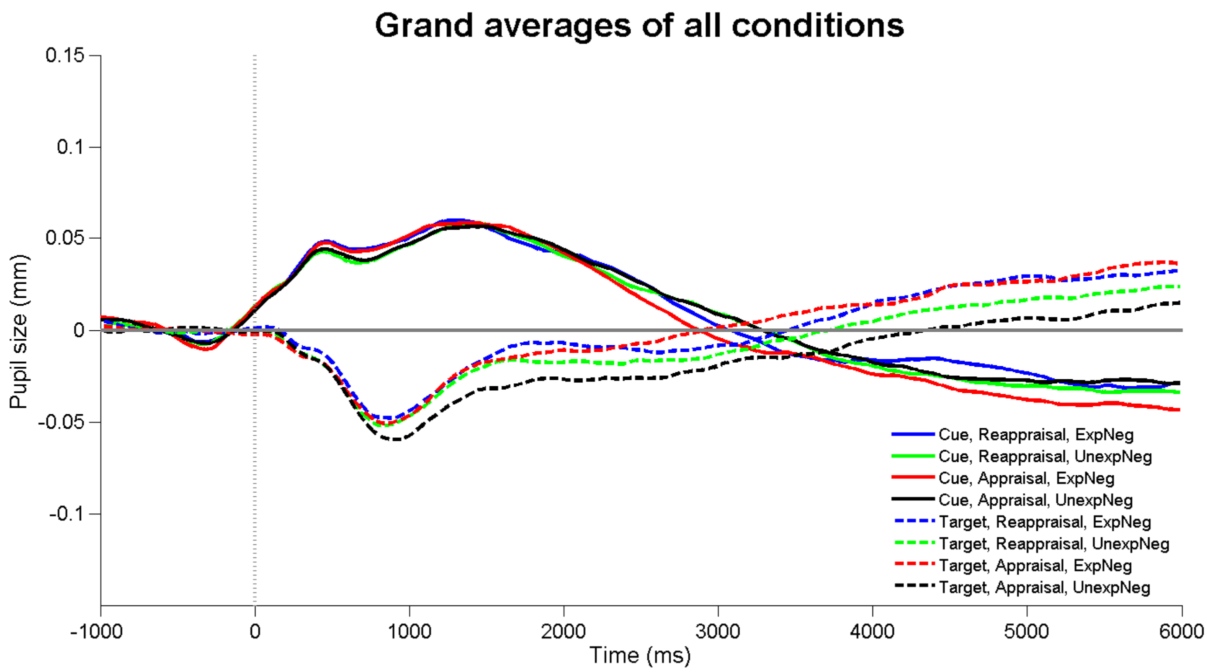
PD data preprocessing was carried out in BrainVision Analyzer 2.0 (Brain Products GmbH, Munich, Germany). First, data points were down-sampled from 300 Hz to 60 Hz. Blinks were replaced by linear interpolation, and trials with blinks forming more than 30% of their total length were excluded from the analyses. A 5-point moving average was applied twice and linear trends over blocks were removed. Finally, we created segments extending from −1000 to +6000 ms after cue and target onset, and baseline correction was applied using the prestimulus interval.

Time domain analyses

Grand-average waveforms were calculated using MATLAB® R2012b (The MathWorks, Inc., Natick, MA) and functions included in EEGLAB v13.2.1 (Delorme & Makeig, 2004). Eight waveforms were created to investigate the main effects of expectation and ER strategy (Cue Reappraisal, Cue Appraisal, Cue Expectation, Cue No Expectation, Target Reappraisal, Target Appraisal, Target Expectation, Target No Expectation; see *Supplementary Figure 1*, upper panel), and eight to explore their interaction (Cue Expected Negative Appraisal, Cue Unexpected Appraisal, Cue Expected Negative Reappraisal, Cue Unexpected Reappraisal, Target Expected Negative Appraisal, Target Unexpected Negative

Appraisal, Target Expected Negative Reappraisal, Target Unexpected Negative Reappraisal; see *Supplementary Figure 1*, lower panel).





Supplementary Figure 1. Changes in pupil size relative to baselines across time for cues (continuous lines) and targets (dotted lines). The upper panel displays the PD waveforms segregated by expectation and ER strategy. the lower panel displays the PD waveforms of each condition separately.

To detect the precise onset and offset time of the differences in pupil size across conditions, we employed the Mass Univariate ERP Toolbox (Groppe, Urbach, & Kutas, 2011a, 2011b) to conduct point-by-point *t*-tests with Benjamini-Hochberg control of the false discovery rate (FDR; Benjamini & Hochberg, 1995) and identify the time windows in which two waveforms differed significantly from each other ($p_{FDR} < .05$). We opted for such a procedure because it is suitable for "exploratory studies of focally and/or broadly distributed effects" in which it is critical not to have Type II errors (Groppe et al., 2011a, Table 2). This method has already been used in the analyses of PD when it was deemed important to explore time-dependent PD modulations as a function of experimental manipulations while statistically controlling for the proportion of false positives (e.g., Stone et al., 2015). Since, for the present study, it was particularly relevant to investigate pupillary responses as an index of sustained emotional/cognitive processing, analysis of PD peaks or averages would not have been suitable. These analyses were run on the whole time-window (i.e., 0 to 6000 ms after cue or target). Similarly to our previous study (Nasso et al., 2015), we also investigated the interplay between anticipatory and online social feedback processing.

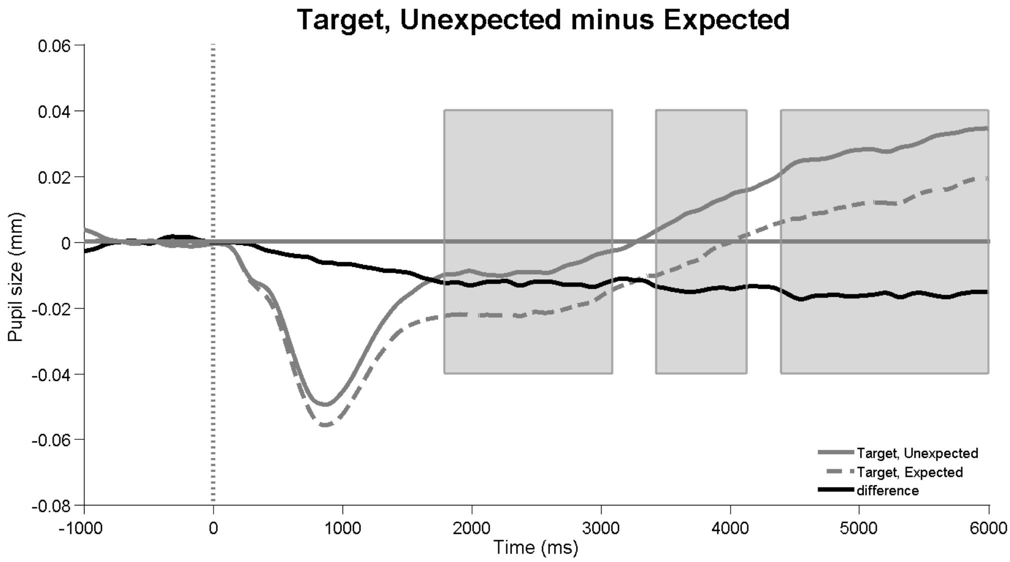
Results

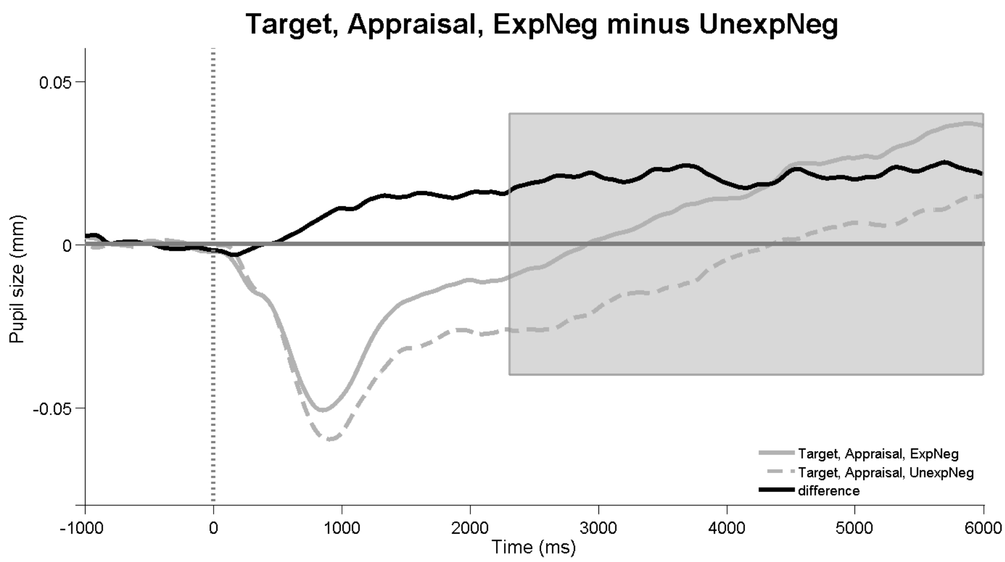
Cue. No significant results were observed at the level of the cue. Specifically, PD during feedback anticipation was not affected by our manipulation of ER strategy, expectation, or by their interaction.

Target. At the target level[1], we found no main effect of ER strategy on PD in response to negative social feedback, while expectation significantly influenced pupillary changes (see *Supplementary Figure 2*, upper panel). Specifically, PD was significantly larger in response to expected as compared to unexpected negative feedback approximately between 1780 and 3080 ms, 3420 and 4120 ms, and 4380 and 6000 ms.

[1] As for the EMG corrugator responses, the baseline used to correct PD during the target period corresponded to the PD during the last 1000 ms of the cue period. However, because no significant differences were observed across cues of different conditions at any time-point, such overlap should not influence the analyses on the target period.

A more detailed exploration of our data revealed that PD was significantly larger, approximately between 2300 and 6000 ms, after expected as compared to unexpected negative feedback within the appraisal blocks (*Supplementary Figure 2*, lower panel). In contrast, expected and unexpected negative feedback did not differ significantly in PD within the reappraisal blocks. Finally, pupillary responses in response to expected as well as unexpected negative feedback were not significantly affected by appraisal and reappraisal instructions.





(b)

Supplementary Figure 2. The gray-shaded areas indicate the time windows in which the difference waves (black lines) differ significantly from zero when using the FDR method. The difference wave is calculated by subtracting one waveform from the other (grey lines). The upper panel displays the main effect of expectation during the target period (Unexpected minus Expected, respectively, continuous and dotted line). The lower panel displays the effect of expectation during the target period within the appraisal blocks (Appraisal Expected Negative minus Appraisal Unexpected Negative, respectively, continuous and dotted line).

Discussion

In contrast with our hypothesis, the cognitive/emotional processing deployed *in anticipation of social feedback* (i.e., cue phase) was not affected by our manipulation of ER strategy, expectation, or by their interaction. Instead, the cognitive/emotional processing deployed *in response to social feedback* (i.e., target phase) was sensitive to the interaction of these two factors. Specifically, PD was larger during expected as compared to unexpected negative feedback during the appraisal (but not during the reappraisal) blocks.

Because of the increased cognitive load associated with uncertainty (maintenance of different outcomes and coping strategies), we predicted that participants would need greater emotional/cognitive processing during feedback anticipation when having no expectations about its valence (Nasso et al., under review). However, even though two outcomes were possible after an uninformative cue (i.e., negative and positive feedback), no preparation was needed in anticipation of positive emotional events (i.e., the ER instructions applied only to negative feedback). Therefore, participants needed to prepare to deal only with negative social feedback, just like during an informative cue. It is thus possible that informative and uninformative cues (independent of ER strategy) elicited similar proactive cognitive effort.

During the target phase, PD did not differ significantly between expected and unexpected negative feedback during the reappraisal blocks. It is possible that, because participants prepared to deal with negative social feedback during the anticipation phase independent of the informative value of the cue, they might have been able to regulate expected and unexpected negative social feedback equally well. In contrast, instructions not to control one's emotional response (i.e., during the appraisal blocks) led to larger pupil size in response to expected than unexpected negative feedback. Hence, more emotional/cognitive processing was deployed to negative feedback when it was expected. Even though no difference was observed at the cue level, it appears that contextual information allowed participants to deploy more resources to its processing.

It could also be argued that greater PD during expected vs. unexpected negative feedback during the appraisal blocks may be a correlate of higher arousal (Bradley et al., 2008). Conversely, pupillary constriction during unexpected negative feedback processing may indicate cognitive overload (van Steenbergen, Band, & Hommel, 2015) and therefore a hindered coping ability. However, neither of these propositions is supported by the participants' EMG corrugator responses (see main text), which failed to reveal any significant impact of expectation on the participants' affective responses.

Concerning the lack of effect of ER strategy at the cue as well as at the target level, a possible explanation is that pupil dilation, associated with both arousal and cognitive effort, might not be sensitive enough to discern them in a paradigm that investigates the regulation of emotional responses. In other words, while pupil size was mostly influenced by cognitive effort under reappraisal instructions, under appraisal instructions arousal was its main influencing factor. As a consequence, no statistical difference in pupil size could be observed between ER blocks. Alternatively, PD can be interpreted as an index of the cognitive effort exerted by participants to comply with the ER instructions (both appraisal and reappraisal). It is plausible that not only reappraising, but also appraising negative social feedback required top-down cognitive effort. In other words, we could tentatively speculate that experiencing unpleasant emotions with the instruction not to change them requires inhibition of the individuals' natural tendency to regulate distress. Consistently with this hypothesis, Shafir and colleagues (2015) found that using counter preferential (compared to preferential) ER strategies required increased cognitive effort. In addition, other possibilities – e.g., the association between cognitive effort and arousal, methodological differences from previous studies, or low statistical power – might explain this lack of effect of emotion regulation on PD.

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Analysis EMG

Antonio Schettino

2020-03-23

Code can be inspected here: https://github.com/aschetti/reappraisal-expectation-nasso-2020.

Table 1: Descriptive statistics of EMG amplitude, separately for each condition.

Stimulus	ER_Strategy	Expectation	median	mad
cue	Reappraisal	Unexpected	0.00129	0.0033
cue	Reappraisal	Expected	0.00069	0.0027
cue	Appraisal	Unexpected	-0.00065	0.0042
cue	Appraisal	Expected	0.00114	0.0040
target	Reappraisal	Unexpected	-0.00022	0.0030
target	Reappraisal	Expected	0.00055	0.0027
target	Appraisal	Unexpected	0.00129	0.0053
target	Appraisal	Expected	0.00054	0.0040

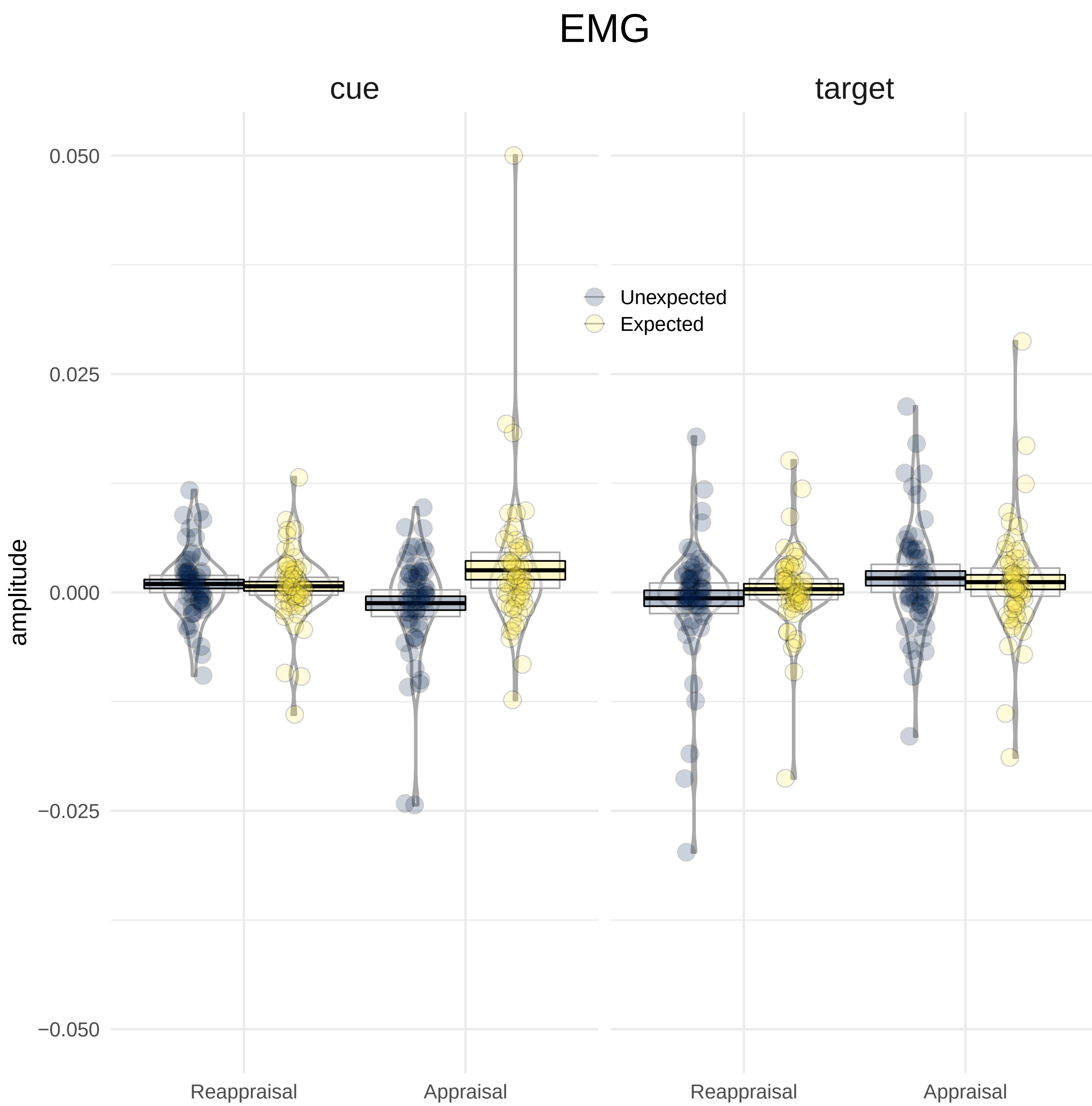

Figure 1: EMG amplitude in response to cue and target. *Note*: 18 values are outside the plot.

Table 2: Repeated measures nonparametric ANOVA (Aligned Rank Transform).

Term	Df	Df.res	F	p.value	eta.sq.part
Stimulus	1	420	1.7	0.199	0.004
ER_Strategy	1	420	1.5	0.223	0.004
Expectation	1	420	2.0	0.156	0.005
Stimulus:ER_Strategy	1	420	3.7	0.056	0.009
Stimulus:Expectation	1	420	1.3	0.248	0.003
ER_Strategy:Expectation	1	420	0.0	0.947	0.000
Stimulus:ER_Strategy:Expectation	1	420	11.2	0.001	0.026

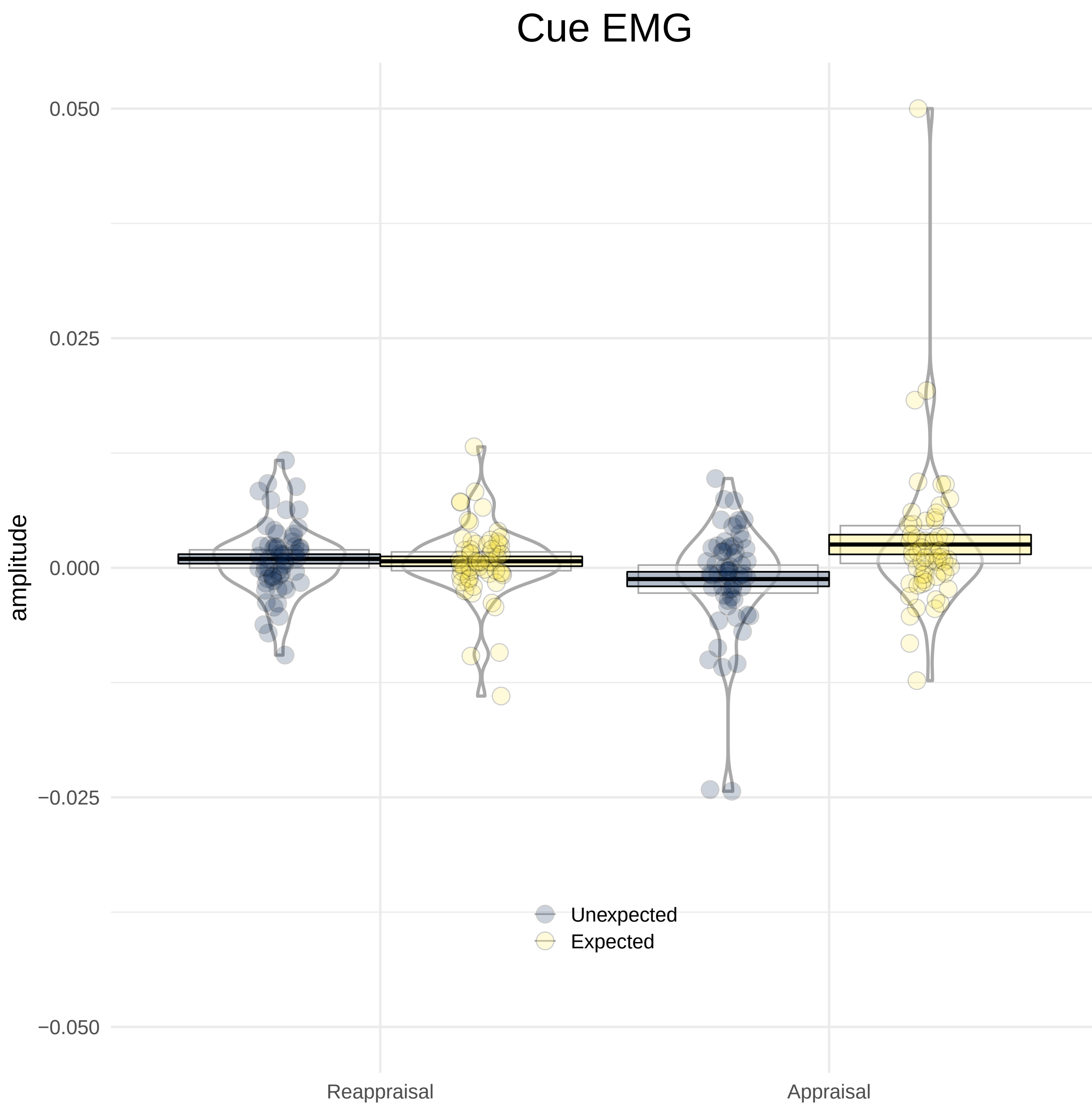

Figure 2: EMG amplitude in response to cue. *Note*: 9 values are outside the plot.

Table 3: Responses to Cue. Repeated measures nonparametric ANOVA (Aligned Rank Transform).

Term	Df	Df.res	F	p.value	eta.sq.part
ER_Strategy	1	180	0.36	0.552	0.002
Expectation	1	180	4.51	0.035	0.024
ER_Strategy:Expectation	1	180	7.86	0.006	0.042

Table 4: Responses to Cue. Post-hoc Repeated Samples Wilcoxon tests (Bonferroni-Holm p-value correction), bootstrapped effect size.

comparison	V	p	r	CI95_lower	CI95_upper
Appraisal, Expected vs. Unexpected	1369	0.008	-0.39	-0.58	-0.15
Reappraisal, Expected vs. Unexpected	919	0.853	0.02	-0.24	0.27
Expected, Appraisal vs. Reappraisal	1144	0.312	-0.18	-0.41	0.07
Unexpected, Appraisal vs. Reappraisal	660	0.120	0.26	0.00	0.47

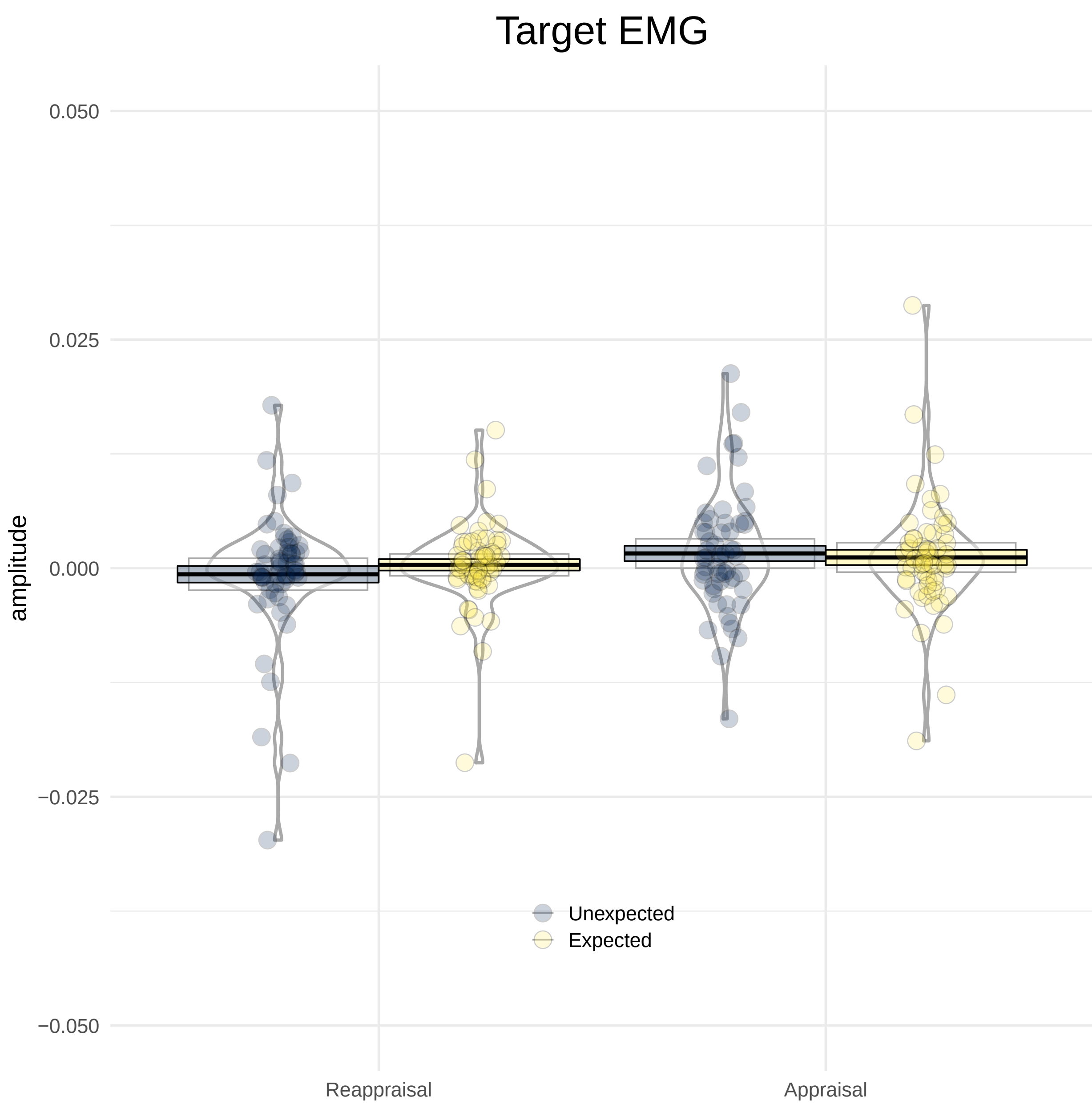

Figure 3: EMG amplitude in response to target. *Note*: 9 values are outside the plot.

Table 5: Responses to Target. Repeated measures nonparametric ANOVA (Aligned Rank Transform).

Term	Df	Df.res	F	p.value	eta.sq.part
ER_Strategy	1	180	5.7	0.018	0.031
Expectation	1	180	0.0	0.987	0.000
ER_Strategy:Expectation	1	180	7.3	0.007	0.039

Table 6: Responses to Target. Post-hoc Repeated Samples Wilcoxon tests (Bonferroni-Holm p-value correction), bootstrapped effect size.

comparison	V	p	r	CI95_lower	CI95_upper
Appraisal, Expected vs. Unexpected	778	0.593	0.15	-0.10	0.39
Reappraisal, Expected vs. Unexpected	1126	0.593	-0.17	-0.40	0.09
Expected, Appraisal vs. Reappraisal	1038	0.593	-0.08	-0.34	0.18
Unexpected, Appraisal vs. Reappraisal	1377	0.007	-0.40	-0.59	-0.15

Table 7: Split-plot ANOVA, control for block order (Appraisal first or Reappraisal first).

Effect	p	p<.05
start_block	0.701	
Stimulus	0.811	
ER_Strategy	0.112	
Expectation	0.936	
start_block:Stimulus	0.473	
start_block:ER_Strategy	0.411	
Stimulus:ER_Strategy	0.657	
start_block:Expectation	0.318	
Stimulus:Expectation	0.433	
ER_Strategy:Expectation	0.539	
start_block:Stimulus:ER_Strategy	0.097	
start_block:Stimulus:Expectation	0.954	
start_block:ER_Strategy:Expectation	0.734	
Stimulus:ER_Strategy:Expectation	0.015	*
start_block:Stimulus:ER_Strategy:Expectation	0.807	

Table 8: Correlation: difference between Appraisal and Reappraisal during anticipation vs. difference between Appraisal and Reappraisal during target.

rho	p-value
40138	0.64

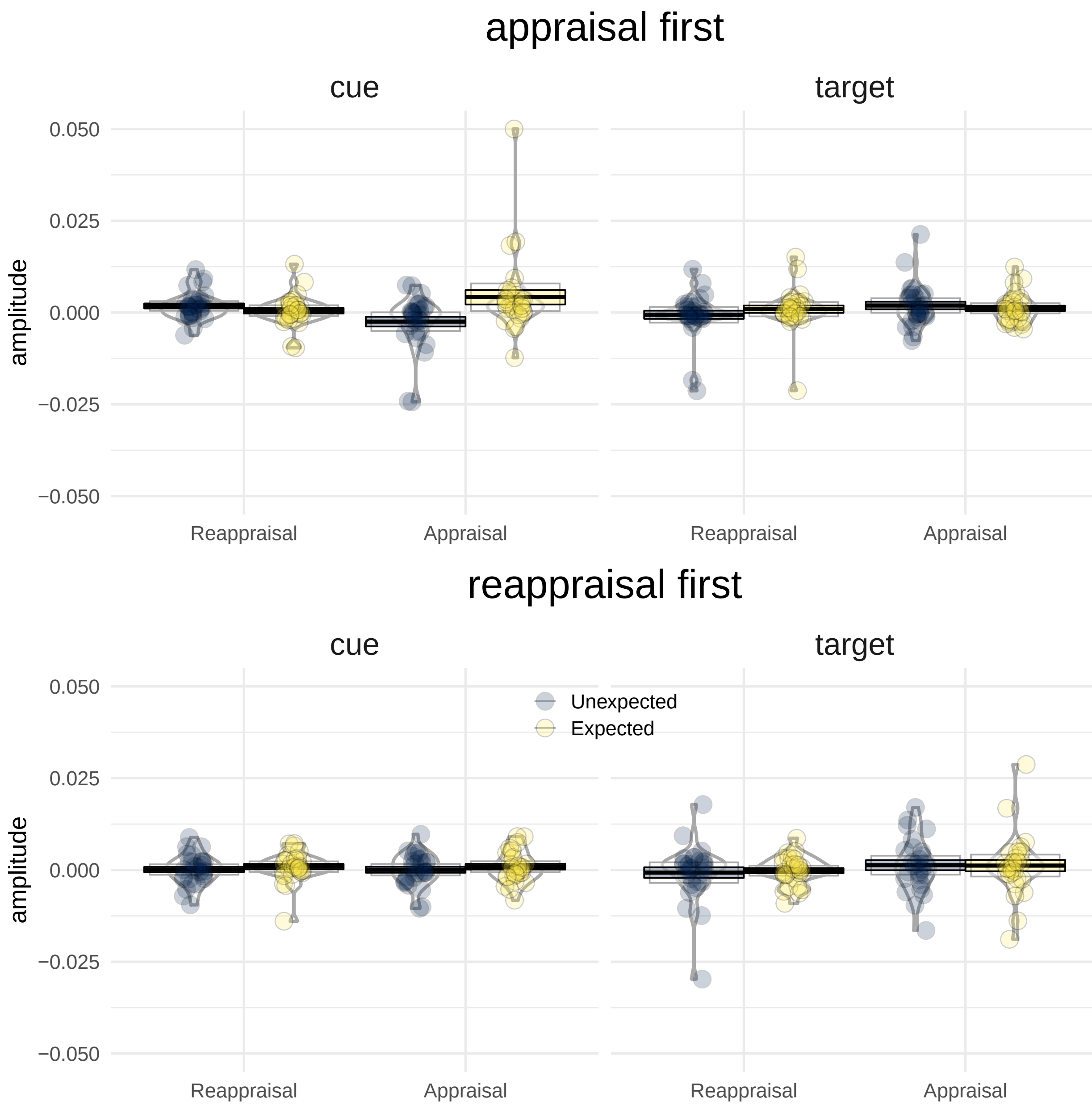

Figure 4: EMG amplitude in response to cue and target, separately for participants who started with Appraisal vs. Reappraisal blocks. *Note*: 9 values are outside the plot.

Analysis EMG (no outliers)

Antonio Schettino

2020-03-23

Eleven participants did not believe the experimental manipulation, and the responses of 3 participants are missing. Here we confirm that the results are qualitatively similar with and without these 14 outliers.

Code can be inspected here: https://github.com/aschetti/reappraisal-expectation-nasso-2020.

Table 1: Descriptive statistics of EMG amplitude, separately for each condition.

Stimulus	ER_Strategy	Expectation	median	mad
cue	Reappraisal	Unexpected	0.00099	0.0032
cue	Reappraisal	Expected	0.00056	0.0025
cue	Appraisal	Unexpected	-0.00065	0.0043
cue	Appraisal	Expected	0.00112	0.0042
target	Reappraisal	Unexpected	-0.00022	0.0029
target	Reappraisal	Expected	0.00037	0.0024
target	Appraisal	Unexpected	0.00153	0.0051
target	Appraisal	Expected	0.00122	0.0036

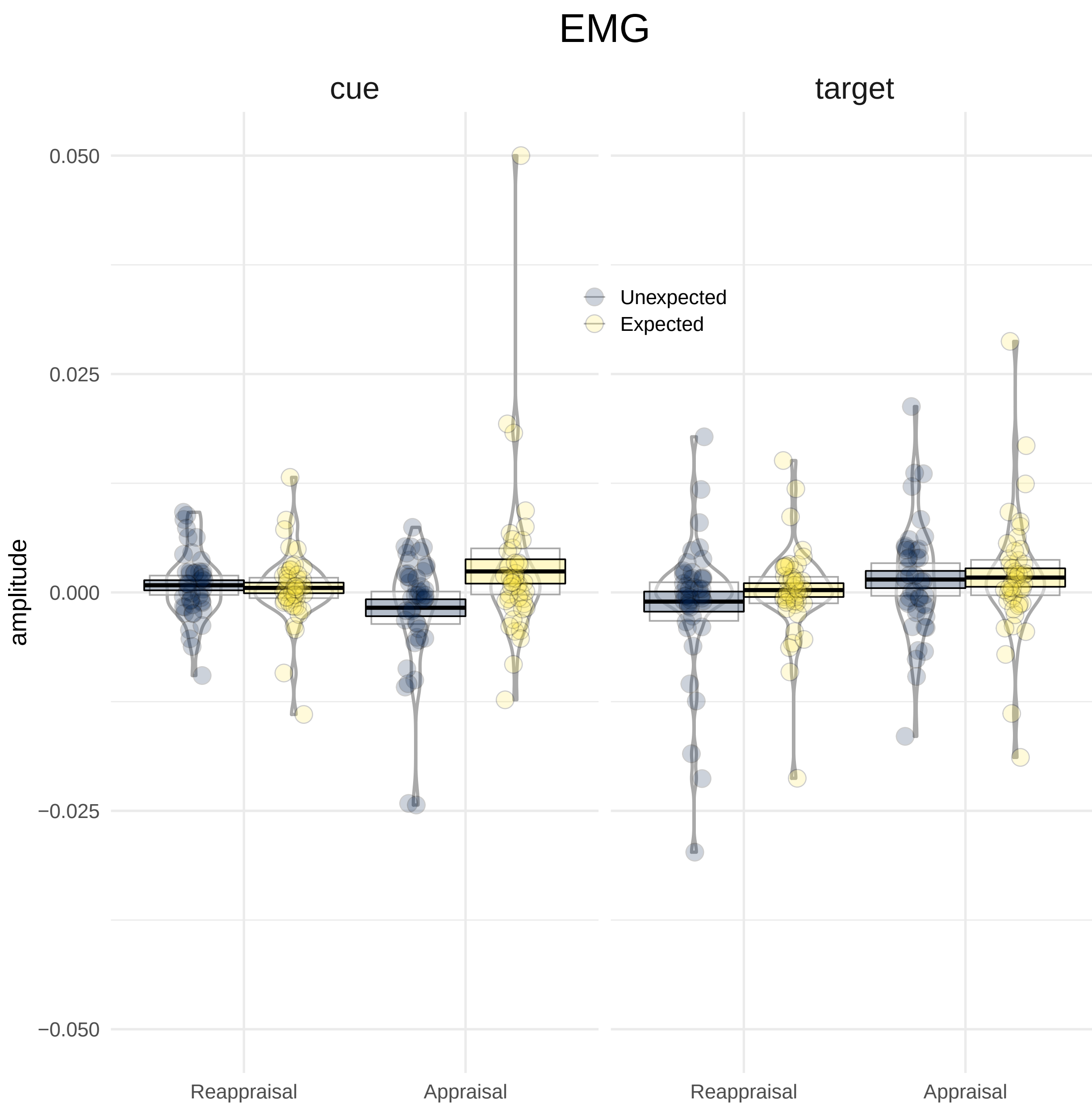

Figure 1: EMG amplitude in response to cue and target. *Note*: 18 values are outside the plot.

Table 2: Repeated measures nonparametric ANOVA (Aligned Rank Transform).

Term	Df	Df.res	F	p.value	eta.sq.part
Stimulus	1	322	2.29	0.131	0.007
ER_Strategy	1	322	1.58	0.210	0.005
Expectation	1	322	3.56	0.060	0.011
Stimulus:ER_Strategy	1	322	3.46	0.064	0.011
Stimulus:Expectation	1	322	0.43	0.513	0.001
ER_Strategy:Expectation	1	322	0.01	0.909	0.000
Stimulus:ER_Strategy:Expectation	1	322	7.72	0.006	0.023

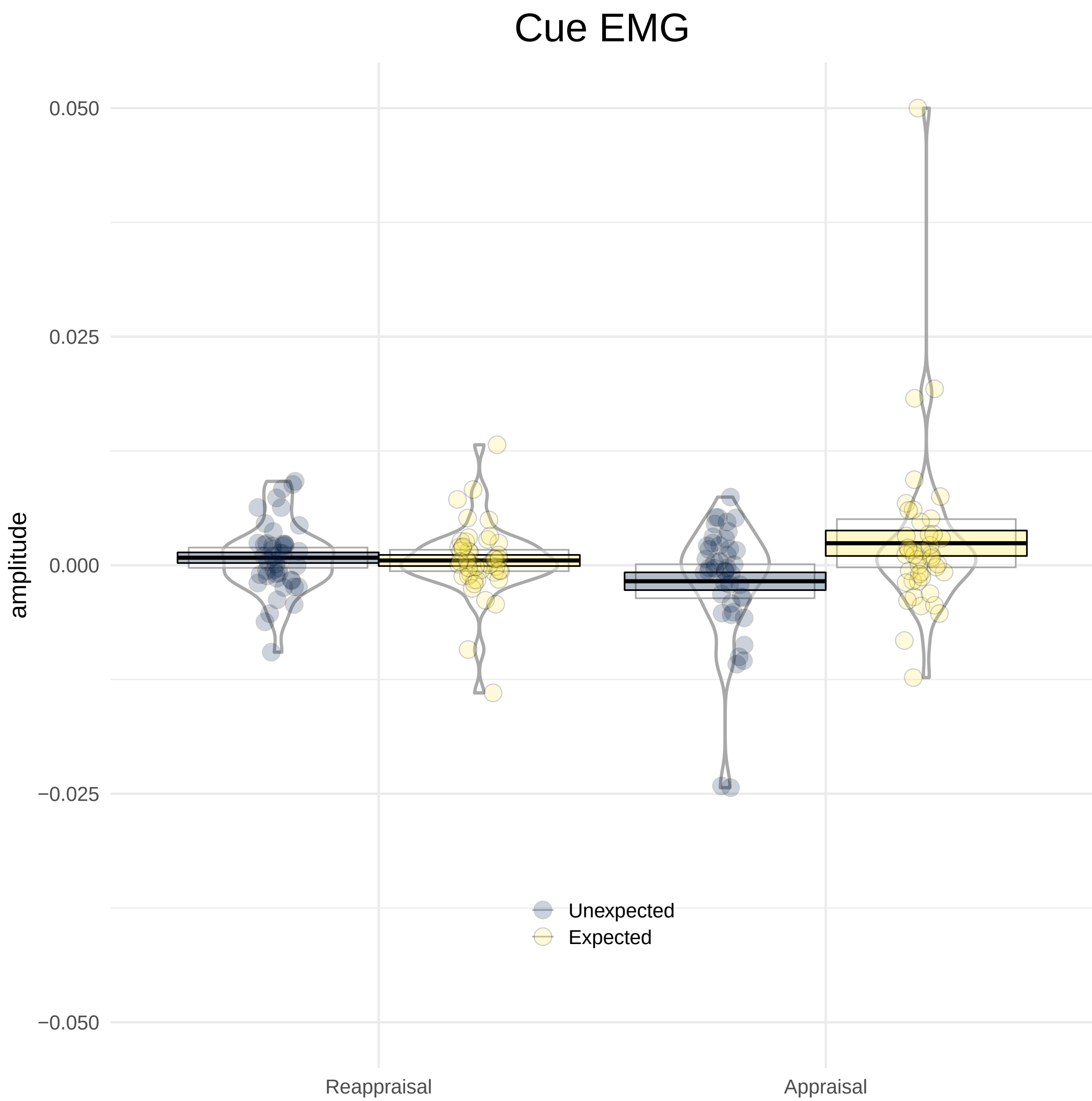

Figure 2: EMG amplitude in response to cue. *Note*: 9 values are outside the plot.

Table 3: Responses to Cue. Repeated measures nonparametric ANOVA (Aligned Rank Transform).

Term	Df	Df.res	F	p.value	eta.sq.part
ER_Strategy	1	138	0.38	0.539	0.003
Expectation	1	138	4.21	0.042	0.030
ER_Strategy:Expectation	1	138	6.53	0.012	0.045

Table 4: Responses to Cue. Post-hoc Repeated Samples Wilcoxon tests (Bonferroni-Holm p-value correction), bootstrapped effect size.

comparison	V	p	r	CI95_lower	CI95_upper
Appraisal, Expected vs. Unexpected	802	0.044	-0.37	-0.59	-0.08
Reappraisal, Expected vs. Unexpected	529	0.738	0.05	-0.24	0.34
Expected, Appraisal vs. Reappraisal	650	0.738	-0.13	-0.41	0.15
Unexpected, Appraisal vs. Reappraisal	370	0.119	0.30	0.02	0.55

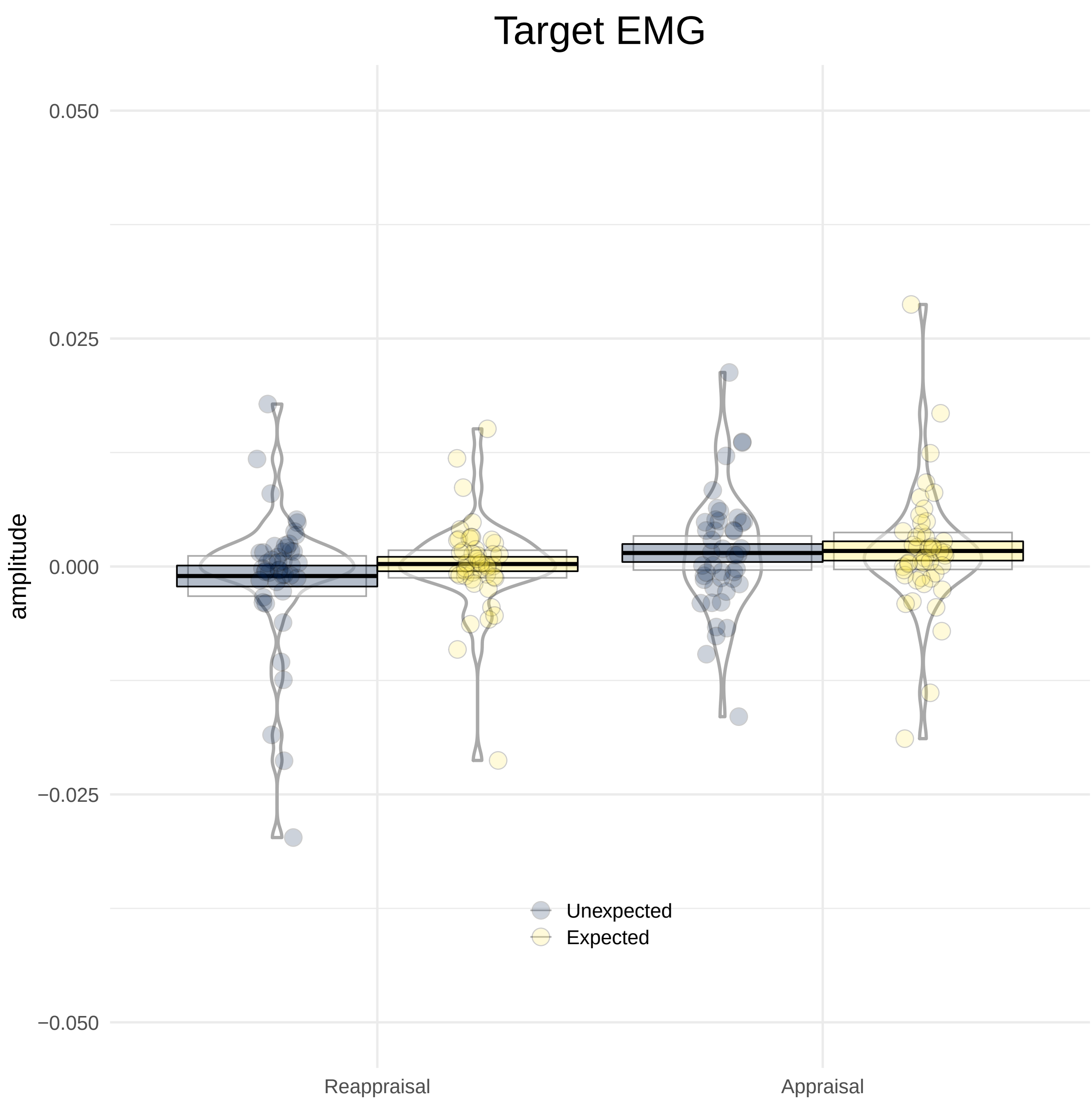

Figure 3: EMG amplitude in response to target. *Note*: 9 values are outside the plot.

Table 5: Responses to Target. Repeated measures nonparametric ANOVA (Aligned Rank Transform).

Term	Df	Df.res	F	p.value	eta.sq.part
ER_Strategy	1	138	5.58	0.020	0.039
Expectation	1	138	0.35	0.553	0.003
ER_Strategy:Expectation	1	138	4.36	0.039	0.031

Table 6: Responses to Target. Post-hoc Repeated Samples Wilcoxon tests (Bonferroni-Holm p-value correction), bootstrapped effect size.

comparison	V	p	r	CI95_lower	CI95_upper
Appraisal, Expected vs. Unexpected	514	0.604	0.08	-0.22	0.34
Reappraisal, Expected vs. Unexpected	667	0.562	-0.16	-0.43	0.13
Expected, Appraisal vs. Reappraisal	692	0.537	-0.20	-0.46	0.09
Unexpected, Appraisal vs. Reappraisal	836	0.014	-0.42	-0.62	-0.13

List of personality-trait descriptors used as social feedback

Negative personality-trait descriptors

List of negative adjectives and their affect rating (mean and standard deviation) selected from Hermans and De Houwer, 1994.

Adjective	Affect Mean	Affect SD
Afhankelijk	2.94	1.23
Agressief	1.89	1.21
Angstig	2.73	1.05
Asociaal	1.96	1.08
Bazig	2.21	1.01
Bedrieglijk	2.04	1.1
Bekrompen	1.88	1.12
Besluiteloos	2.86	0.82
Bevooroordeeld	2.29	0.92
Bot	1.98	0.97
Conservatief	3.19	1.06
Cynisch	2.99	1.12
Depressief	2.25	1.28
Droevig	2.51	1.16
Eenzaam	2.56	1.17
Egoïstisch	1.79	1.29
Gefrustreerd	2.01	0.98
Gesloten	3.2	1.02
Hebzuchtig	1.68	0.92
Hoogmoedig	2.28	1.12
Koel	2.81	1.2
Kwaad	2.35	1.41
Lichtgeraakt	2.46	0.81
Lui	2.47	1.23
Lusteloos	2.35	0.92
Materialistisch	2.48	1.16

Nalatig	2.58	0.96
Nonchalant	3.27	0.14
Onaangenaam	1.99	0.87
Onbetrouwbaar	1.69	1.27
Oneerlijk	1.52	0.71
Ongelukkig	1.96	1.34
Oninteressant	2.31	1.03
Onnauwkeurig	2.73	1.07
Onoplettend	2.79	0.88
Onredelijk	2.35	0.9
Onsympathiek	1.91	0.99
Onverdraagzaam	1.85	1.1
Onverschillig	2.44	1.06
Onvolwassen	2.98	1.14
Onvriendelijk	1.74	0.89
Oppervlakkig	2.51	0.95
Ouderwets	2.94	1.1
Passief	2.73	1.22
Pessimistisch	1.95	1.21
Prikkelbaar	2.4	0.96
Slordig	2.81	1.14
Streng	3.27	1.31
Tactloos	2.04	0.98
Teruggetrokken	3.3	1.02
Vals	1.48	1.09
Vergeetachtig	3.23	1.04
Verlegen	3.54	1.01
Verstrooid	3.44	0.96
Vervelend	2.09	1.07
Vijandig	1.8	1.11
Wantrouwig	2.01	0.72
Zelfvoldaan	3.22	1.39
Zenuwachtig	2.89	1.16
Zwak	2.53	1.01

Positive

List of positive adjectives and their affect rating (mean and standard deviation) selected from Hermans and De Houwer (1994).

Adjective	Affect Mean	Affect SD
Aangenaam	6.07	0.82
Begrijpend	5.86	1.1
Behulpzaam	5.98	1.02
Betrouwbaar	6.33	0.94
Breeddenkend	5.77	0.98
Creatief	5.91	1
Doorzettend	5.73	1.15
Eerlijk	6.4	0.86
Efficiënt	5.35	1.04
Enthousiast	5.91	1.1
Gelukkig	6.63	0.71
Goedgehumeurd	5.89	1.02
Grappig	6.02	1.08
Intellectueel	5.33	1.06
Interessant	5.69	1.08
Krachtig	5.16	1.03
Levendig	5.85	0.99
Onafhankelijk	5.21	1.15
Ondernemend	5.54	1.05
Ontspannen	6	1.12
Opgewekt	6.27	0.94
Oprecht	6.17	1.12
Optimistisch	6.36	0.93
Origineel	5.98	0.84
Positief	6.11	0.94
Rechtvaardig	6.28	0.91
Sympathiek	6.14	1.05
Verantwoordelijk	5.52	1.25
Vriendelijk	6.28	1

Vrijgevig	5.65	1.06

References

Hermans, D., & De Houwer, J. (1994). Affective and subjective familiarity ratings of 740 Dutch words. Psychologica Belgica, 34(2-3).