Experiential, Expressive, and Physiological Effects of Positive and Negative Emotion Regulation Goals While Reappraising Amusing Stimuli

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Abstract

We examined whether positive and negative emotion regulation (ER) goals while cognitively reappraising amusing stimuli differentially engage positive (PA) and negative affect (NA) systems. Forty-eight women watched 20–30s amusing film clips. They were instructed to either respond naturally (no ER goal) or emphasize the film clips' positive (positive ER goal) or negative (negative ER goal) aspects in their interpretation. We measured PA and NA system activity on experiential, expressive, and physiological response channels through self-reported amusement and disgust, electromyography of zygomaticus major and corrugator supercilii, and autonomic nervous system reactivity from respiratory sinus arrhythmia (RSA) and pre-ejection period (PEP). Natural viewing (no ER goal) of amusing clips increased self-reported amusement (and to a lesser degree disgust), zygomaticus reactivity, and RSA. Compared to no and negative ER goals, reappraising the amusing clips with a positive ER goal decreased corrugator reactivity, decreasing negative emotional expression. Compared to no and positive ER goals, reappraising the amusing clips with a negative ER goal decreased self-reported amusement and zygomaticus reactivity and increased self-reported disgust and corrugator reactivity, decreasing positive and increasing negative emotional experience and expression. We conclude that positive and negative ER goals while reappraising amusing stimuli differentially engaged PA and NA systems: The positive ER goal engaged withdrawal of the expressive NA system, whereas the negative ER goal engaged reciprocal NA–PA system activation on experiential and expressive response channels.

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1. Introduction

Amusement arises from a combination of appraisals that evaluate a stimulus event as unexpected and incongruent but highly pleasant, unimportant to one's goals, and comprehensible through alternative meaning making (i.e., high coping potential; Ellsworth and Smith, 1988; Kreibig, 2014; Suls, 1972; Wyer and Collins, 1992). This generates a "natural" or "unregulated" amusement response. However, for the same stimulus event, we may emphasize in our appraisal attributes of the event that could be construed positively, such as care and concern for another person (Knight et al., 2019; Niven et al., 2019), humor (Braniecka et al., 2019; Samson et al., 2014), or personal learning and growth (Garnefski and Kraaij, 2006). Or we may emphasize aspects that could be construed negatively, such as ill motives (Simons et al., 2013), ridicule (Janes and Olson, 2000; Platt, 2008), or negative outcomes (Hafer and Correy, 1999; Joel et al., 2014; Feather et al., 2011). Both generate a "regulated" or "reappraised" amusement response. We here ask how engagement of positive and negative emotion regulation (ER) goals (Kreibig et al., 2022a) in reappraising amusement affects the regulated emotional response.

1.1. Emotion Regulation Goals

Emotion is a multi-system process, including loosely coupled changes in experience, expression, and physiology (Scherer, 2001). ER modifies the emotional response. It involves activating an ER goal, selecting an ER strategy, and implementing it through a particular ER tactic (Ford et al., 2019; Gross, 2015). The ER goal cognitively represents the desired or targeted emotion state, i.e., the emotion that people want to generate (Braunstein et al., 2017; Gross, 2015; Mauss and Tamir, 2014; Tamir, 2009; Tamir et al., 2019). The ER strategy of cognitive reappraisal (hereafter referred to as reappraisal) involves changing the meaning of an emotional stimulus event to change its affective impact (Giuliani and Gross, 2009). An ER tactic puts this ER strategy into practice (McRae et al., 2012a), for example, by emphasizing different aspects of a given situation, as illustrated in the introduction.

Within one ER strategy and one ER tactic, different ER goals may be pursued by increasing or decreasing emotional aspects of a situation or increasing or decreasing one's positive or negative feelings. We here focus on increasing or emphasizing certain emotional aspects of a situation. Specifically, we may pursue a positive ER goal when we emphasize a situation's positive aspects in its interpretation, such as in capitalizing (Langston, 1994; Peters et al., 2018), savoring (Quoidbach et al., 2015; Seligman et al., 2006), positivity bias (Norris et al., 2011; Unkelbach et al., 2020), optimism (Alarcon et al., 2013; Scheier and Carver, 1993), or positive refocusing (Garnefski and Kraaij, 2006). We may pursue a negative ER goal when we emphasize a situation's negative aspects, such as in negative thinking (Beck, 1967, 1987; Lyubomirsky and Nolen-Hoeksema, 1995), fault finding (Schwartz et al., 2002; Polman, 2010), negativity bias (Huang and Luo, 2006; Ito et al., 1998; Rozin and Royzman, 2001), pessimism (Showers, 1992), or rumination (Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008). Negative ER goals also are at play in the experience of empathy or vicarious guilt or shame (Tangney et al., 2007) with a focus on another person's or group's pain or harm (cf. catastrophizing and observer catastrophizing; Cano et al., 2005; Edwards et al., 2006; Sullivan et al., 2000).

Although the present report focuses on ER goals in the sense of emphasizing different affective aspects in a stimulus event's interpretation or appraisal, to simplify the following discussion, we assume that there is an interaction of bottom-up stimulus-driven emotion generation processes, e.g., generating amusement, with top-down cognition-driven ER processes, e.g., modifying the budding amusement response (McRae et al., 2012c; Ochsner et al., 2009; Otto et al., 2014). We use the terms amusement regulation or amusement reappraisal to capture the idea of the interactive nature of these two processes.

1.2. Positive and Negative Affect Systems

Two affect systems are assumed to subserve emotion, each orchestrating experiential, cognitive, behavioral, and physiological responses with partially distinct processes and operating characteristics (Cacioppo and Berntson, 1999; cf. Taylor et al., 2017): A positive affect (PA) system guides people toward situations with reward potential and generates positive emotion upon engagement; a negative affect (NA) system creates responses to cues that signal potential danger or loss and generates negative emotion upon engagement (Cacioppo and Berntson, 1994; Carver, 2006; Kreibig and Gross, 2017; Lang, 1995; Lang and Bradley, 2013).

PA and NA systems may show various activation states, including increased, decreased, or no change in activation. PA–NA systems may activate reciprocally, independently or uncoupled (Cacioppo and

Berntson, 1994, 1999; Cacioppo et al., 2004; Larsen, 2017; Norris et al., 2010), or jointly (e.g., coactivation; Kreibig et al., 2015; Kreibig and Gross, 2017; Larsen and McGraw, 2011, 2014; Norris and Wu, 2021), suggesting a two-dimensional operating space. By systematically combining these three activation states for the PA–NA systems, we derive Table 1 (cf. Berntson et al., 1991). The center cell shows no change in PA–NA activation and reflects the integrated system at baseline. We discuss Table 1 as it relates to unregulated and regulated emotional responding in the following.

1.2.1. Positive and negative affect systems in unregulated emotion

We may think of the space illustrated in Table 1 as representing possible change in activation states in unregulated emotional responding, starting from an emotionally neutral state as baseline at the center cell. With amusement being a prototypical positive approach-oriented emotion in response to humorous stimuli, it has been described as a state of pleasurable, relaxed excitation and playful, nonserious interaction with the environment (Kreibig, 2014; Ruch, 1993). Accordingly, the unregulated amusement response in the PA–NA space may be expected to consist of predominant PA activation (Gable and Harmon-Jones, 2008, 2010; Gilbert et al., 2008; Kreibig et al., 2013, 2015). This would be the case in uncoupled PA activation, i.e., greater PA activation and unchanged NA activation, or reciprocal activation–deactivation of PA and NA systems, i.e., greater PA activation and lower NA activation (hereafter referred to as reciprocal PA–NA activation; cf. Table 1).

Similar predictions apply to negative emotional states, such as disgust. With prior research situating amusement in the affective landscape as contrasted to disgust (negative emotion) and mixed emotional states (positive—negative emotion; Demaree et al., 2004, 2006; Kreibig et al., 2013, 2015; Klorman et al., 1975; McGraw and Warren, 2010; Oppliger and Zillmann, 1997), we here use disgust as the negative contrast emotion to amusement. Disgust is a prototypical negative avoidance-oriented emotion (Binyamin-Suissa et al., 2019; Kunz et al., 2013; Oaten et al., 2009; Shook et al., 2019; Tybur et al., 2013; Woody et al., 2005), that has been previously related to NA activation (Olatunji et al., 2011; Vrana, 1993, 1994, 2009). The unregulated disgust response in the PA–NA space may be expected to consist of predominant NA activation (Olatunji et al., 2011; Vrana, 1993, 1994, 2009), which would include uncoupled NA activation or reciprocal NA–PA activation, i.e., greater PA activation and lower NA activation (cf. Table 1).

1.2.2. Positive and negative affect systems in regulated emotion

We may similarly think of the space illustrated in Table 1 as representing possible change in activation states in regulated emotional responding, starting from an unregulated emotion as baseline at the center cell. With amusement as the starting point, reappraisal with a positive ER goal would be expected to generate greater PA activation because of the greater cognitive processing of positive cues. As Table 1 shows, this could be paired with either no change or lower NA activation (greater NA activation being unlikely) as in uncoupled PA activation and reciprocal PA–NA activation. Table 1 further points to the possibility of a positive ER goal being implemented through lower NA activation (and unchanged PA activation), as is the case in uncoupled NA withdrawal.

In a similar vein, with amusement as the starting point for reappraisal with a negative ER goal, we would expect generation of greater NA activation because of the greater cognitive processing of negative cues. Table 1 shows that this could occur with either no change or lower PA activation (greater PA activation being unlikely), resulting in uncoupled NA activation or reciprocal NA–PA activation. Table 1 additionally acknowledges the possibility of a negative ER goal being realized through lower PA activation (and unchanged NA activation), as in uncoupled PA withdrawal. To address how predictions of the PA–NA systems framework for unregulated and regulated amusement responses unfold empirically, we now turn to reviewing the literature that speaks to the response patterns outlined above.

1.3. Prior Research on Unregulated and Regulated Amusement

We summarize prior research on unregulated and regulated amusement in the following sections. For regulation, we particularly focus on findings relating to reappraisal of amusement. With emotion being a loosely coupled multi-system response (Scherer, 2001), we review experimental studies reporting results on experiential, expressive, and physiological channels (i.e., cardiovascular autonomic responding; Kreibig, 2012).

Table 2 summarizes results of prior empirical studies of the unregulated amusement response (Table 2, 1.) and the regulated amusement response with respect to positive (Table 2, 2.) and negative (Table 2, 3.) ER goals. Results are tabulated according to indicators of PA–NA systems for emotional experience, expression, and autonomic physiology. We list comparison conditions, to which study conditions were contrasted, and condition duration to explicate the potential influence of these parameters on observed responses. Because only four studies so far have investigated reappraisal of amusement (Table 2, 2.A and 3.A), we supplement this sparse empirical basis with findings from the literature on ER goals in the reappraisal of picture-induced positive affect (Table 2, 2.B and 3.B). We acknowledge the different nature of instructions used in the context of amusement reappraisal versus positive affect reappraisal, as will become evident below. We provide an integrative summary of the individual studies' results for each of the Table's subsections (Table 2, 1., 2., 3.), denoted "summary." We discuss each of the Table's main entries in the following.

1.3.1. Unregulated amusement response (no ER goal)

Empirical results of experiential, expressive, and physiological changes in unregulated amusement (no ER goal) are summarized in Table 2, 1. Experientially, amusement manifests through reports of strongly greater amusement and positive affect and mildly greater negative affect. If interpreting at face value, these results suggest PA–NA coactivation; if discounting for the significant albeit mild increase in negative affect, these results suggest uncoupled PA activation (see also Supplemental Online Material [SOM] Table A.1 for details of increases of non-target emotions in response to amusement stimuli in prior literature). Expressively, amusement exhibits greater expression of positive facial affect through laughter and electromyography (EMG) of zygomaticus major muscle reactivity and unchanged or lower negative facial affect through corrugator supercilii muscle reactivity, pointing to uncoupled PA activation or reciprocal PA–NA activation. Physiologically, amusement shows changes in cardiac autonomic activation as reflected in respiratory sinus arrhythmia (RSA), a measure of parasympathetic activation and PA system activation (Duarte et al., 2015; Gilbert, 2009; Kirschner et al., 2019; Porges, 2007; Rockliff et al., 2008; Thayer et al., 2009), and pre-ejection period (PEP), an inverse measure of cardiac sympathetic activation and NA system activation (Gilbert, 2010, 2019; Gray, 1991; Gray and McNaughton, 2000; Richardson et al., 2016). Observed changes include greater, unchanged, or lower parasympathetic activation and unchanged or lower sympathetic activation, with no apparent influence of comparison condition or duration. These indicate uncoupled PA activation, uncoupled PA withdrawal, uncoupled NA withdrawal, or no PA–NA change.

As outlined above, the PA–NA systems framework predicts predominant PA activation, i.e., uncoupled PA activation or reciprocal PA–NA activation, for the unregulated amusement response. Empirical observations partially support this prediction, i.e., uncoupled PA activation on the experiential response channel, uncoupled PA activation or reciprocal PA–NA activation on the expressive response channel, and uncoupled PA activation on the physiological response channel. Empirical observations also point to additional configurations not hypothesized, i.e., PA–NA co-activation on the experiential response channel and uncoupled PA withdrawal, uncoupled NA withdrawal, and no PA–NA change on the physiological response channel.

These findings suggest that, first, affect systems may not uniformly influence emotional response channels, and, second, non-obvious states of affect-system activation may contribute to generating a given emotion (e.g., uncoupled PA withdrawal or uncoupled NA withdrawal for amusement). With this in mind, we now turn to reviewing the empirical literature on reappraising amusement with positive and negative ER goals.

1.3.2. Regulated amusement response

In what follows, we first summarize the current state of the literature with respect to ER goals in reappraisal of film-induced amusement, as most relevant to the present study and its methods (see Sections 2.2 and 2.4). We then add findings from the literature on ER goals in the reappraisal of picture-induced positive affect. For the present summary of empirical results, we distinguish between ER goals in reappraising amusement that aim at generating positive emotion (e.g., amusement or other positive emotions, i.e., positive ER goals) versus those that aim at generating negative emotion (e.g., disgust or other negative emotions, i.e., negative ER goals).

Positive ER goals in amusement reappraisal. Table 2, 2.A summarizes empirical results for positive ER goals in amusement reappraisal. Reappraisal of film-induced amusement with the goal to “maximize amusement” (e.g., “to imagine that the man tripping was not actually a game-show contestant, but instead a personally relevant figure who takes himself very seriously;” Giuliani et al., 2008, p. 715) led to greater amusement ratings, greater number of smiles, and greater sympathetic cardiovascular reactivity than simply watching the film clips under no ER goal. Positive reappraisal of film-induced amusement with the instruction to “think about positive aspects of what you are seeing...and think about what you are seeing in such a way that you feel more positive emotion” (Brady et al., 2021, p. 649) led to lower amusement ratings, greater positive facial emotional expression (zygomaticus major EMG reactivity), and greater sympathetic (electrodermal) reactivity than simply watching the film clips under no ER goal. Given the small number of studies, we cannot say to what extent different ER goal instructions or measurement duration may have contributed to the diverging experiential and physiological findings.

To add to these findings for positive ER goals in reappraising amusement, we now turn to empirical findings for positive ER goals for reappraising picture-induced positive affect (see Table 2, 2.B). Instructions to "think about the pictures in such a way that [participants] more intensely felt the emotion elicited by the picture presented, ...such as re-interpreting the emotions, actions, and outcomes of individuals depicted in a situational context" (Li et al., 2018, p. 59), led to more positive self-reported valence (Li et al., 2018, study 1) and greater zygomaticus major EMG response amplitude (Li et al., 2018, study 2) than simply viewing the picture under no ER goal. Similarly, reappraisal instructions to "think about [the pictures] in a way that would make their content more positive" (Blair et al., 2012, p. 477–478) generated greater positive valence ratings compared to simply viewing the positive pictures under no ER goal. In a similar vein, positive appraisal frames (i.e., a narrative that describes the content of an upcoming picture in emotionally positive terms) preceding pleasant pictures led to greater self-reported pleasantness, greater zygomaticus reactivity, and unchanged corrugator reactivity than viewing the pictures with neutral appraisal frames (Wu et al., 2012). Notably, the various reappraisal instructions, comparison conditions, and—fairly uniform—measurement durations led to homogeneous responses.

As detailed above, different types of instructions have been given to participants for amusement versus positive affect reappraisal. Even though amusement is included in the category of PA, "increasing amusement" may be different than "increasing positive affect." Still, given the generally convergent nature of findings, we summarize these in the following.

In relation to the PA–NA systems framework, which predicts uncoupled PA activation or reciprocal PA–NA activation or uncoupled NA withdrawal for positive ER goals in reappraising amusement, empirical observations indicate generally greater PA activation on experiential and expressive response channels and greater or unchanged NA activation on the physiological response channel. However, there is paucity of prior research regarding NA activation for experience and expression and PA activation for autonomic reactivity. That is, no concurrent measurements of PA–NA activation have been taken in the prior studies. Because we stipulate three possible states of each of the two affect systems (cf. Table 1), if only one affect system was measured, three different outcomes of PA–NA activation are possible: Experiential and expressive changes allow uncoupled PA activation, reciprocal

PA–NA activation, or PA–NA coactivation. Physiological changes permit uncoupled NA activation, reciprocal NA–PA activation, or coactivation for positive ER goals in amusement reappraisal. However, inferences remain speculative if PA–NA systems are not concurrently measured. Given this lack of data, we cannot draw conclusions regarding PA–NA activation based on the available literature. Still, we can observe that while greater PA activation supports predictions, greater NA activation suggests additional configurations not hypothesized above (however, we note above that "greater NA activation being unlikely" for a positive ER goal in reappraising amusement; cf. Section 1.2.2).

Negative ER goals in amusement reappraisal. Table 2, 3.A summarizes empirical results for negative ER goals in amusement reappraisal. Reappraisal of film-induced amusement with the goal to "minimize the amusement response to the clip" (e.g., "to imagine how painful it was for the contestant to fall off of the rope swing into the mud;" Giuliani et al., 2008, p. 715) resulted in lower amusement ratings, lower number of smiles and laughs, and lower sympathetic cardiovascular reactivity than simply watching the film clips under no ER goal.

To add to the findings for negative ER goals in reappraising amusement, we review empirical findings for negative ER goals for reappraising picture-induced positive affect (see Table 2, 3.B). Instructions to "reappraise [the pictures] in a way that would make their content more negative" generated less positive valence ratings than simply viewing the positive pictures under no ER goal (Blair et al., 2012, p. 478).

While negative ER goal instructions to imagine the pain of another (Giuliani et al., 2008) versus making a scene more negative in general (Blair et al., 2012) have different thematic emphases, the few results available do converge, which we summarize in the following. We recall that the PA–NA systems framework predicts uncoupled PA withdrawal, uncoupled NA activation, or reciprocal NA–PA activation for negative ER goals in reappraising amusement. Empirical observations indicate lower PA system activation on the experiential and expressive response channels and lower NA system activation on the physiological response channel for negative ER goals in reappraising amusement. Again, there is paucity of prior research regarding changes in NA system activation on the experiential and expressive response levels and activation of the PA system on the physiological response level. In relation to Table 1, experiential and expressive changes make uncoupled PA withdrawal, reciprocal NA–PA activation, or PA–NA coinhibition possible. Physiological changes allow for reciprocal PA activation, uncoupled NA withdrawal, or PA–NA coinhibition. Still, we cannot truly state which activation state any of these findings indicate unless these are concurrently measured. We note that while lower PA activation supports predictions, lower NA activation suggests additional configurations not hypothesized above (however, we note above that “greater PA activation being unlikely” for a negative ER goal in reappraising amusement; cf. Section 1.2.2).

To conclude this overview, we contrast theoretical predictions and empirical findings for positive versus negative ER goals in reappraising amusement. The empirical overview shows that differences are clearly expected, not only from unregulated amusement, but also between ER goals: Positive ER goals are believed to predominantly activate the PA system or deactivate the NA system, whereas negative ER goals are believed to predominantly activate the NA system or deactivate the PA system. That is, effects of positive and negative ER goals in reappraising amusement are expected to be opposite. Empirical observations support the activation of opponent processes: Positive ER goals elicited greater PA activation on experiential and expressive response channels and greater or unchanged NA activation on the physiological response channel. In contrast, negative ER goals elicited lower PA system activation on experiential and expressive response channels and lower NA system activation on the physiological response channel than no ER goal.

Still, we currently lack a thorough understanding of how positive and negative ER goals in reappraising amusement engage PA–NA systems. We also do not understand why positive and negative ER goals elicited NA activation and NA withdrawal on the physiological response channel, respectively, with only a single study having documented this finding (Giuliani et al., 2008).

1.4. Present Study

The present study investigated whether positive and negative ER goals in reappraising amusing stimuli differentially engage PA–NA systems. We included an unregulated amusement response with no ER goal as contrast condition.

According to Section 1.2.2 and Table 1, for our preliminary goal of validating successful amusement induction, we hypothesized that unregulated (no ER goal) amusement would generate uncoupled PA activation or reciprocal PA–NA activation. This would be evidenced through greater self-reported amusement, zygomaticus major reactivity, and RSA and unchanged or lower self-reported disgust, corrugator supercilii reactivity, and PEP (lengthening).

To address our primary goal, we hypothesized that a positive ER goal in reappraising amusement would generate uncoupled PA activation, reciprocal PA–NA activation, or NA withdrawal as contrasted to unregulated amusement. This would be reflected in greater self-reported amusement, zygomaticus reactivity, and RSA and unchanged or lower self-reported disgust, corrugator reactivity, and PEP (lengthening). In contrast, we hypothesized that a negative ER goal would generate PA withdrawal, uncoupled NA activation, or reciprocal NA–PA activation. This would be expressed in unchanged or lower self-reported amusement, zygomaticus reactivity, and RSA and greater self-reported disgust, corrugator reactivity, and PEP (shortening).

To test our core hypothesis, we presented well-validated amusement-inducing film clips (Kreibig et al., 2013, 2015; Samson et al., 2014); manipulated ER through a within-subject, mixed block, repeated measures, "offline" ER paradigm (Gross, 1998) where participants were first cued to regulate their emotional response and subsequently viewed the emotional stimulus; and collected reliable and well-validated indices of positive and negative emotional responding representative for PA–NA system activation on experiential (self-reported amusement and disgust), expressive (zygomaticus major and corrugator supercilii EMG; Bernat et al., 2006; Bush et al., 1989; Cacioppo et al., 1986; Jackson et al., 2000), and physiological (RSA and PEP; Kelsey, 2012; Cribbet et al., 2020; MacCormack et al., 2021) response channels.

2. Method

The experiment was approved by the Institutional Review Board of Stanford University (IRB protocol #7273).

Data of the unregulated amusement or no-ER goal condition used in the present study is the same as the one reported in Kreibig et al. (2015; denoted as pure amusement condition). Data of the two conditions reappraising amusement with positive and negative ER goals have not been previously reported.

The present study used a within-participants repeated-measures design.

2.1. Participants

Figure 1 presents the Consolidated Standards of Reporting Trials (CONSORT) participant flow diagram for the present study. As shown, sixty women were recruited for a 120-min experiment for course credit or pay ($25). Of these, five did not enroll in the study due to no-show (*n* = 4) or voluntary withdrawal (n = 1). Of the 55 women who enrolled in the study, five did not complete it due to experimenter error (n = 1), participant non-compliance (n = 3), or technical difficulties (n = 1).[1] Two participants were found ineligible after enrollment and excluded from analysis resulting in analyzed data of 48 women. Mean age of participants considered for analysis was 20.7 years, SD = 3.7. Three were African American, five Asian American, 13 White, four Hispanic, 10 multiracial, and eight declined to state. Demographic data from five participants were missing because of experimenter error.

Participants were recruited from a US West Coast university, a community college, and the surrounding community via various participant pools managed through Sona Systems (Tallinn, Estonia). Of included participants, 12.5% (6) were Stanford University undergraduates and 62.5% (30) were community college undergraduate students who participated for course credit, 20.8% (10) were community research pool participants who participated for monetary reimbursement, and 4.2% (2) were from undocumented recruitment sources.

Sample size was determined by power analyses (G*Power; Faul et al., 2007) based on effect size estimates of prior studies on reappraisal of amusement (Giuliani et al., 2008; Kim and Hamann, 2007; Ohira et al., 2006). At the time of study design, no prior studies had reported on comparisons for positive and negative ER goals. We therefore based our sample size calculations on the available effect sizes for pairwise ER goal comparisons with a no-ER goal condition. Calculations suggested that a minimum sample size of N = 45 participants in this within-participant design would ensure power of at least 80% for two-tailed pairwise comparisons at $\alpha \leq .05$ to detect typical effect sizes in research studies investigating reappraisal of amusement (d's ≥ 0.431; Giuliani et al., 2008; Kim and Hamann, 2007; Ohira et al., 2006). Our achieved sample size was 55 participants at enrollment. We oversampled by 10 participants to account for the potential need of excluding participants with unusable physiology data. Final analyzable sample size was 48 participants.

2.2. Materials

Stimuli were 18 amateur video clips, each 20–30 s long, which presented situations of humorous lapses to induce amusement. For example, one film clip features a baby dancing to music with

[1] Reasons for exclusion listed in the present report slightly diverge from the ones listed in Kreibig et al. (2015) because reporting guidelines have been updated and multiple reasons for exclusion applied to these participants.

everyone laughing. Amusement film clips were shown intermixed with film clips presenting painful accidents to induce disgust and film clips presenting ambiguous situations to induce a mixed amused–disgusted emotional state (18 film clips for each emotion category; results to be reported in Kreibig et al. 2022b and Kreibig et al. 2022c). Stimuli had previously been validated (Kreibig et al., 2013, 2015; Samson et al., 2015) and are available on our website (https://spl.stanford.edu/resources).

2.3. Apparatus

Stimuli were presented with a personal computer using Presentation software (Neurobehavioral Systems Inc., Albany, CA). They were displayed on a 19-inch computer monitor at a viewing distance of 55 cm under low ambient light. Responses were entered via keyboard. Participant compliance was monitored through a hidden camera. Physiological data were recorded and amplified with a multichannel BioNex 8-slot chassis (Mindware Technologies, Grahanna, OH) equipped with an impedance cardiograph and skin conductance amplifier (Model 50-371100-00), a 4-channel biopotential amplifier (Model 50-371102-00), a 4-channel transducer amplifier (Model 50-371106-00), and a 4-channel high-level interface module (Model 50-37110300). Data were sampled at 1,000 Hz, 16-bit digitized, and transmitted to a computer for viewing and storage using BioLab 2.4 (Mindware Technologies, Grahanna, OH).

2.4. Procedure

To not draw attention to the study of emotional processes, this study was advertised as investigating psychophysiological effects of media processing. Data collection took place individually. After obtaining informed consent, participants were seated in front of a computer screen and physiological sensors attached. Participants performed a verbal fluency task (not reported here). They then read definitions of the rating scales and instructions for the reappraisal task that was to be performed during the film viewing. Participants were instructed to “change the way [they] feel in response to these film clips by consciously changing the way [they] think about each film.” Verbatim instructions for the no, positive, and negative ER goal conditions can be found in SOM Section Appendix A.1.

Participants practiced the task with two example film clips for each film type × ER goal instruction prior to performing the reappraisal task (not used in analyses). Participants said out loud the cognitive elaboration of the film clip and the experimenter provided feedback regarding the appropriateness of reappraisal and additional reappraisal suggestions. Next, participants completed a respiratory volume calibration using fixed volume bags (Morel et al., 1983). The experimenter then left the room, and participants started the reappraisal task. For each subject, film clips of each emotion category were randomly partitioned into three thirds and paired with no, positive, or negative ER goal instructions. Film clip–ER goal pairs were presented in random sequences under the condition that there be no more than two repetitions of the same emotion × ER goal condition. Thus, film clips were presented in a unique pairing with ER goal instructions and sequence for each subject. Before each film, a 4-s slide instructed participants to “attend naturally” to it (no ER goal), “focus on the funny, amusing, or positive elements of the clip” (positive ER goal), or “focus on the repulsive, painful, or negative elements of the clip” (negative ER goal). Participants then started the film clip with a button press and performed the reappraisal task without saying out loud their reappraisal. Each film clip–ER goal pair was preceded by a 20–30 s rest period (varying independently of subsequent film clip length), during which participants were instructed to sit quietly, clear their mind, and avoid moving or speaking. Participants rated their current emotional feelings immediately after each film clip. Upon completing the reappraisal task, participants performed a second respiratory volume calibration and a paced breathing task for vagal assessment at 8, 10.5, 13, and 18 cycles per minute (Ritz et al., 2001). Participants then were unhooked from physiological recording equipment, completed demographic and personality questionnaires (not reported here), and were debriefed.

2.5. Measures

2.5.1. Experience

After each film clip, participants rated their current positive (amusement) and negative (disgust) emotional feelings on a 6-point Likert scale. Scale definitions were identical to our previous studies (Kreibig et al., 2013, 2015).

2.5.2. Expressive Behavior

Surface EMG (in μV) over muscles relating to positive (zygomaticus major) and negative (corrugator supercilii) facial emotional expressions were recorded on the left side of the face with 4-mm miniature Beckman Ag/AgCl electrode pairs filled with Teca electrode gel (Oxford Instruments, Hawthorne, NY). Skin sites were cleaned and abraded to achieve interelectrode impedance of less than 10 kΩ. Signal conditioning included 500 Hz antialiasing hardware, 60 Hz notch, and 20–500 Hz digital band-pass filters, rectification, and smoothing using a 10-ms running average.

2.5.3. Physiology

We derived the following physiological measures to quantify positive (cardiac parasympathetic) and negative (cardiac sympathetic) emotional physiological reactivity.

The electrocardiogram (ECG) was recorded using Ag/AgCl spot electrodes (TraceRite LT430S, Forth-Rite Technologies, Austin, TX) positioned in a three-lead unipolar modified chest configuration. The signal was amplified and band-pass filtered at 10–40 Hz. Interbeat interval (IBI, in ms) was calculated between automatically detected R spikes (Kreibig et al., 2013). Respiratory sinus arrhythmia (uncorrected RSA, RSA_{uc}, in ms) was scored using the peak–valley method (Eckberg, 1983). RSA was corrected for within-individual effects of respiration rate and tidal volume (corrected RSA, RSA_c, in ms/l) based on measurements from the paced-breathing task (Schulz et al., 2009). We report RSA_c in primary analyses; for continuity with prior literature, we also report results for RSA_{uc}.

Impedance cardiography (ICG) was recorded using a four-spot electrode configuration over neck and thorax with Ag/AgCl electrodes (TraceRite LT430S, Forth-Rite Technologies, Austin, TX). The ICG was ensemble-averaged over 20–30 s task intervals in synchrony with the ECG R wave. Characteristic points were identified to calculate pre-ejection period (PEP, in ms), defined as the interval from the ECG R peak onset to the ICG B point (Lozano et al., 2007).

Respiration was measured using piezoelectric respiration transducers (model 1310, Ambu Sleepmate, Glen Burnie, MD) attached around the upper chest for thoracic respiration and at the height of the umbilicus for abdominal respiration. Raw signals were converted to calibrated lung volume change using data from the fixed volume bag calibration (Morel et al., 1983). Respiratory rate (RR, in cycles per minute) and tidal volume (Vi, in ml) were calculated breath by breath for the purpose of RSA correction but are not part of this report.

2.6. Data Reduction

Physiological data were processed in biosignal analysis software (Kreibig et al., 2013, 2015) written in R (R Core Team, 2020) to derive period averages for each rest and film period. For each period, 500-ms averages were derived, outliers (defined as $2.5 \times SD \pm M$) set to N/A, and subsequently averaged by epoch. Reactivity was calculated between the average of each film period and the immediately preceding rest period (percent change for facial expressions; delta scores for physiological measures).

2.7. Data Analysis

Analyses were conducted in R 4.0.5 for macOS 10.15.7, Intel 64-bit build (R Core Team, 2020), using packages car (3.0-10; Fox and Weisberg, 2019), distributions3 (0.1.1; Hayes et al., 2022), effsize (0.8.1; Torchiano, 2020), heplots (1.3-8; Friendly, 2010; Fox et al., 2021), Hmisc (4.6-0; Frank E Harrell and Dupont, 2022), lsr (0.5.2; Navarro, 2015), psych (2.1.6; Revelle, 2021), stringr (1.4.0; Wickham and RStudio, 2022), tibble (3.1.2 Müller et al., 2022), and their respective dependencies. Data were analyzed by experimental conditions across all participants.

2.7.1. Preliminary data analysis

In preliminary analyses, we tested (a) that expressive and physiological activation among prefilm baselines preceding the amusement film clips with no, positive, and negative ER goal instructions did not differ, (b) that we successfully induced amusement with our film clip stimuli, and (c) that correlation structure among experiential, expressive, and physiological measures was adequate for submission to multivariate analysis of variance (MANOVA).

Absence of prefilm baseline differences. To test whether prefilm baseline activation of expressive and physiological measures differed among ER goal conditions, MANOVAs were calculated.

Successful induction of amusement. To test for successful induction of amusement, experiential, expressive, and physiological measures under the no-ER goal condition of amusement film clips were tested for significant deviation from baseline (μ = 1 for experiential, μ = 100 for expressive, and μ = 0 for physiological measures) using one-sample t-tests (one-sided for experiential measures and two-sided for expressive and physiological measures) and Cohen's d effect sizes.

Adequate correlation structure for MANOVA. Because MANOVA works optimally for dependent variables either highly negatively correlated or moderately correlated in either direction ($r \leq |.6|$; Tabachnick and Fidell, 2013, p. 270), we computed Pearson correlations and significance level for all variable combinations. We also calculated the pooled within-group correlations among measures to evaluate relative independence of single variables contributing to multivariate effects (Tabachnick and Fidell, 2013, p. 272). Overall α-level of .05 for correlation tests was adjusted using the Bonferroni method for multiple tests for 15 possible combinations arriving at an α_{adj} of .003.

2.7.2. Primary data analysis

Primary analyses focused on testing the effect of no, positive, and negative ER goals on positive and negative affect systems by experiential, expressive, and physiological response channels. We devised analyses to test the core hypothesis (Section 1.4) by subjecting *z*-standardized emotional experience, expression, and physiology scores[2] to (a) a three-factorial (ER Goal: no, positive, negative × Affect System: negative, positive × Response Channel: experience, expression, physiology) MANOVA to test for the predicted two-way interaction of ER Goal and Affect System across Response Channels; (b) two-factorial (ER Goal: no, positive, negative × Affect System: negative, positive) MANOVAs for each Response Channel to test the two-way interaction on each response channel; (c) one-factorial (ER Goal: no, positive, negative) MANOVAs within each Affect System to decompose the two-way interaction; and (d) two-sided dependent-samples *t*-tests among ER Goals to perform pairwise comparisons (Tabachnick and Fidell, 2013, cf. p. 276).

Overall α-level was set to .05 for the three-way MANOVA, given that the use of MANOVA protects against inflated Type I error due to multiple tests of dependent variables (Tabachnick and Fidell, 2013, p. 245f). For follow-up analyses, α-level was adjusted for multiple tests according to a Bonferroni-type adjustment for inflated Type I error (Tabachnick and Fidell, 2013, p. 272): Overall α-level of .05 was equally divided (a) for two-way MANOVAs among three groups of Response Channels (experiential, expressive, and physiological), i.e., $\alpha_{adj} = .0167$; (b) for one-way MANOVAs between two groups of Affect Systems (PA–NA systems), i.e., $\alpha_{adj} = .0083$; and (c) for three pairwise *t*-tests among ER Goals (no, positive, negative), i.e., $\alpha_{adj} = .0028$. We report 95% confidence intervals (CI) on η_p^2 as effect size estimate for effects of MANOVA and on Cohen's *d* as effect size estimates of *t*-tests.

Research materials, data, and study analysis code for quantitative analytic methods will be publicly available at osf.io/ez952/.

[2] PEP was reverse scored to ensure that all variables are scaled in the same direction.

3. Results

3.1. Preliminary Analyses

3.1.1. Absence of prefilm baseline differences

SOM Table A.2 summarizes descriptive and inferential results of testing for absence of differences between 20–30-sec baselines preceding amusing film clips under no, positive, and negative ER goals. Results did not identify any significant differences. Hence, no statistical covariates were included in primary analyses.

3.1.2. Successful induction of amusement

SOM Table A.3 reports descriptive and inferential results of testing for successful induction of amusement using film clips under the no ER goal condition. Consistent with and extending prior reports of this data set (Kreibig et al., 2015), on the experiential response channel, amusement film clips generated a strong increase in self-reported amusement and a subtle increase in self-reported disgust. On the expressive response channel, amusement film clips significantly increased zygomaticus major reactivity but not corrugator supercilii reactivity from prefilm baseline activation. On the physiological response channel, amusement film clips resulted in increased RSA but unchanged PEP from prefilm baseline activation. Results support the assumption of successful induction of amusement on all three response channels using our film stimuli (see Section 4.1.1) and lay the foundation for investigating ER goals in reappraising amusing stimuli.

3.1.3. Adequate correlation structure for MANOVA

SOM Table A.4 presents correlations among experiential, expressive, and physiological response measures included in the MANOVA (Section 3.2). Correlations ranged from −0.33 (for self-reported amusement and disgust) to 0.39 (for self-reported amusement and zygomaticus major reactivity). Greater self-reported amusement was correlated with greater zygomaticus major reactivity and with lower disgust and corrugator supercilii reactivity. Greater self-reported disgust was associated with lower zygomaticus major reactivity and with greater corrugator supercilii reactivity. Greater zygomaticus major or corrugator supercilii reactivity were concomitant with lower RSA. Average intercorrelation was $r_m = -0.04$. SOM Table A.5 gives the pooled within-group correlations among measures. Correlation structure was found adequate for subjecting measures to MANOVA.

3.2. Primary Analyses

The MANOVA indicated no significant effect of Response Channel, Wilk's λ = 0.978, $F(2,36) = 0.40$, $p = .67$, $\eta_p^2 = 0.022$, 95% CI = [0.011, 0.035] but significant effects of Affect System, Wilk's λ = 0.229, $F(1,37) = 124.55$, $p = 2.1^{-13},\ \eta_p^2 = 0.771$, 95% CI = [0.753, 0.787], and ER Goal, Wilk's λ = 0.605, $F(2,36) = 11.74$, $p = 1.1^{-4}$, $\eta_p^2 = 0.395$, 95% CI = [0.363, 0.427]. There were also significant two-way interactions of Response Channel× Affect System, Wilk's λ = 0.321, $F(2,36) = 38.13$, $p = 1.3^{-9}$, $\eta_p^2 = 0.679$, 95% CI = [0.656, 0.701], Response Channel × ER Goal, Wilk's λ = 0.517, $F(4,34) = 7.94$, $p = 1.2^{-4},\ \eta_p^2 = 0.483$, 95% CI = [0.452, 0.513], and Affect System × ER Goal, Wilk's $\lambda = 0.294,\ F(2,36) = 43.15,\ p = 2.8^{-10},\ \eta_p^2 = 0.706$, 95% CI = [0.684, 0.726]. The MANOVA furthermore indicated a significant three-way interaction of ER Goal × Affect System × Response Channel, Wilk's λ = 0.297, $F(4,34) = 20.09$, $p = 1.4^{-8}$, $\eta_p^2 = 0.703$, 95% CI = [0.681, 0.723]. To decompose this effect, we next ran separate analyses for experiential, expressive, and physiological response channels.

3.2.1. Experience

For the experiential response channel, there was a significant Affect System main effect and ER Goal × Affect System interaction (Table 3). One-way MANOVAs identified significant main effects of ER Goals for each of the PA–NA systems, suggesting that ER goals modified emotional experience (see Figure 2 and Table 3). Pairwise comparisons indicated (a) unchanged amusement and disgust experience for positive versus no ER goals, consistent with unchanged PA–NA activation; (b) lower amusement and greater disgust experience for negative versus no ER goals, consistent with reciprocal NA activation; and (c) greater amusement and lower disgust experience for positive versus negative ER goals while reappraising amusement (as shown in Figure 2 and Table 3).

3.2.2. Expression

For the expressive response channel, analyses showed significant main and interaction effects of ER Goal and Affect System (Table 4). One-way MANOVAs identified significant main effects of ER Goals for each of the PA–NA systems, suggesting that ER goals modified facial expression (see Figure 2 and Table 4). Pairwise comparisons indicated (a) no difference in zygomaticus major and lower corrugator supercilii reactivity for positive versus no ER goals, consistent with uncoupled NA withdrawal; (b) lower zygomaticus major and greater corrugator supercilii reactivity for negative versus no ER goals, consistent with reciprocal NA activation; and (c) greater zygomaticus major and lower corrugator supercilii reactivity for positive versus negative ER goals while reappraising amusement (as indicated in Figure 2 and Table 4).

3.2.3. Autonomic Physiology

For the physiological response channel, there was a significant ER Goal × Affect System interaction effect, which did not remain significant after α-adjustment (Table 5). One-way MANOVAs indicated no significant main effects for ER Goals for each of the PA[3] and NA systems, suggesting that ER goals did not modify physiological reactivity (see Figure 2 and Table 5). Pairwise comparisons showed no difference in RSA and PEP for (a) positive versus no ER goals, (b) negative versus no ER goals, and (c) positive versus negative ER goals, suggesting no change in PA–NA activation while reappraising amusement (as shown in Figure 2 and Table 5).

4. Discussion

The present study examined whether positive versus negative ER goals while reappraising amusing stimuli differentially engage PA–NA systems. We presented humorous film clips that have been previously validated to induce amusement (Kreibig et al., 2013, 2015; Samson et al., 2015). We manipulated ER goals through instructions to respond naturally (no ER goal) or to emphasize the film clips' positive (positive ER goal) or negative (negative ER goal) aspects in their interpretation. We indexed PA–NA system activity on experiential, expressive, and physiological response channels through self-reported amusement and disgust, EMG of zygomaticus major and corrugator supercilii reactivity, and autonomic physiology in terms of RSA and PEP. Results indicated that positive and negative ER goals differentially modified the unregulated amusement response. We discuss these results in the context of prior empirical findings, our hypotheses derived from the PA–NA systems framework, and in relation to their broader implications.

[3] Similar results were obtained with the uncorrected RSA measure (RSA_{uc}): Wilk's $\lambda = 0.960$, $F(2,43) = 0.89$, $p = 0.42$, $\eta_p^2 = 0.040$, [0.025, 0.058].

4.1. Integration of the Present Study's Results with Prior Studies

Our findings are generally consistent with findings of prior studies of unregulated and regulated amusement and positive affect.

4.1.1. Unregulated amusement response (no ER goal)

For the unregulated amusement response under no ER goal as compared to the prefilm baseline, we found that amusement film clips strongly increased self-reported amusement with a (very) large effect size and subtly increased self-reported disgust with a small effect size on the experiential response channel; increased zygomaticus major EMG reactivity with medium effect size but left corrugator supercilii reactivity unchanged on the expressive response channel; and increased RSA reactivity with small effect size but left PEP unchanged on the physiological response channel. Taken together, the unregulated amusement response generated pronounced effects on all three response channels of emotion.

Our observation of strongly increased self-reported amusement is consistent with prior reports of greater experience of amusement, other positive emotions, positive affect, and positive valence in response to amusement film clips (cf. Table 2). The observed subtle increase in experienced disgust agrees with prior studies reporting mildly greater disgust, other negative emotions, and negative affect in response to amusement induction (cf. Table 2 and SOM Table A.1; see also film validation studies, e.g., Gross and Levenson, 1995; Hewig et al., 2005; Schaefer et al., 2010). The increased zygomaticus and unchanged corrugator EMG reactivity is alike previously reports (cf. Table 2; see also Bush et al., 1989; Larsen et al., 2003). Our result of increased RSA and unchanged PEP is akin to prior reports describing parasympathetic activation and unchanged sympathetic activation in amusement (cf. Table 2; see also Carruthers and Taggart, 1973; Wu et al., 2019).

Taken together, results of the unregulated (no ER goal) amusement condition replicated prior research and supported that humorous film clips successfully elicited an amusement response on all three response channels of emotion. This lays the foundation for exploring the reappraisal of amusement with positive and negative ER goals. Specifically, in the following, the no ER goal condition functions as the comparison condition of stimulus-generated bottom-up amusement, against which we compare effects of positive and negative ER goals that modify the unregulated amusement response through cognition-driven top-down processes.

4.1.2. Positive ER goals in amusement reappraisal

For reappraising amusing stimuli with a positive as compared to no ER goal, we found no difference in amusement and disgust on the experiential response channel; no difference in zygomaticus major but lower corrugator supercilii EMG reactivity of small effect size on the expressive response channel; and no difference in cardiac parasympathetic and sympathetic reactivity on the physiological response channel. Taken together, amusement reappraisal with a positive ER goal showed effects on only one response channel, i.e., the expressive one, with lower corrugator reactivity. Similarly, Urry (2009) found limited effects of a positive ER goal in reappraising unpleasant pictures (i.e., imagining that the situation was getting better), with lower experience of unpleasantness but no change in expressive behavior or autonomic physiology.

Decreased corrugator reactivity for a positive ER goal in reappraising amusement, which is lower than that in response to the unregulated positive emotion, has not been previously documented in the ER literature. Rather, as summarized in Table 2, prior studies involving positive ER goals in reappraising positive emotion stimuli (Blair et al., 2012; Brady et al., 2021; Giuliani et al., 2008; Li et al., 2018; Wu et al., 2012) demonstrated greater or lower self-reported amusement, greater pleasantness, and greater positive valence, greater number of smiles and laughs, greater zygomaticus and unchanged corrugator reactivity, and greater cardiovascular sympathetic or unchanged electrodermal reactivity.

Corrugator reactivity is frequently found to index the NA rather than the PA system (Cui et al., 2018; Hu and Wan, 2003; Martinie et al., 2013). We speculate that this may be the reason why corrugator reactivity has so far not been recognized as a sensitive measure to index the regulation of positive emotion. Only one prior study measured it in the context of reappraisal of positive affect (Wu et al., 2012) and reported no change in reactivity.

Still, decreased corrugator EMG reactivity below baseline activation is a common finding in emotion research. It occurs in response to both stimulus-driven bottom-up and cognition-driven top-down emotional processes. On the one hand, corrugator reactivity decreases for unregulated responding to amusement film clips (Golland et al., 2018), other types of positive emotion film clips (Kimura et al., 2019), or positive affective stimuli in general (Cacioppo et al., 1986; Dimberg et al., 2000; Lang et al., 1993; Larsen et al., 2003; Magnée et al., 2007; Ravaja et al., 2006; Ravaja, 2009). On the other hand, corrugator reactivity decreases in a variety of contexts that relate to regulating negative emotion as compared to unregulated negative emotional responding. For example, decreased corrugator reactivity occurs under reappraisal with a positive ER goal, such as “think about [the] positive aspects of what you are seeing” (Lohani and Isaacowitz, 2014, p. 685), forgiveness and empathy reappraisal (Witvliet et al., 2001), compassion or benefit-focused reappraisal (Witvliet et al., 2010, 2015), reappraisal with a neutral (decrease; Tamir et al., 2019; Wolgast et al., 2011) or unspecified ER goal (Tamir et al., 2019), expressive and physiological suppression (Dan Glauser and Gross, 2011; Witvliet et al., 2011), and unspecified ER goal and strategy (Reynaud et al., 2012). These observations suggest interpretation of corrugator reactivity as a bivariate index of valence: decreasing with positive valence and increasing with negative valence. Our observation of decreased corrugator reactivity may hence indicate either an increase in positive valence or a decrease in negative valence under a positive ER goal while reappraising amusing stimuli.

Decreased corrugator reactivity may, in fact, be evidence of increased positivity bias (Neta et al., 2009). Thus, there would be an interaction of cognition-generated top-down positivity with stimulus-generated bottom-up amusement (McRae et al., 2012c; Ochsner et al., 2009; Otto et al., 2014). The top-down cognitive generation of a positive evaluative response appears to enhance the bottom-up stimulus-driven generation of the amusement response, as observed under unregulated (no ER goal) responding.

The finding of decreased corrugator reactivity under a positive ER goal while reappraising amusing stimuli points to the possibility that a positive ER goal may be achieved not only by activation of the same-valence affect system (i.e., PA) but also by withdrawal of the opposite-valence affect system (i.e., NA). It also illustrates the importance of concurrently assessing indicators of both PA–NA systems to differentiate engagement of either system in regulatory efforts.

4.1.3. Negative ER goals in amusement reappraisal

For reappraising amusing stimuli with a negative as compared to no ER goal, we found lower amusement and greater disgust of large effects size on the experiential response channel; lower zygomaticus major and greater corrugator supercilii EMG reactivity of large and medium effect sizes, respectively, on the expressive response channel; and unchanged cardiac parasympathetic (RSA) reactivity (small effect size increase[4] albeit nonsignificant) and sympathetic (PEP) reactivity on the physiological response channel. We conclude that amusement reappraisal with a negative ER goal showed effects on experiential and expressive response channels. Future research will have to follow up on potential effects of the negative ER goal on RSA on the physiological response channel.

Prior studies of reappraising positive emotion with a negative ER goal demonstrated lower self-reported amusement and positive valence, smaller number of smiles and laughs, and lower cardiovascular sympathetic reactivity (Blair et al., 2012; Giuliani et al., 2008; as summarized in Table 2). The present study's finding of decreased amusement experience for a negative ER goal in reappraising amusement replicates these prior self-report results (Blair et al., 2012; Giuliani et al., 2008).

The present study's finding of decreased zygomaticus reactivity mirrored the decrease in amusement of the experiential response channel on the expressive response channel. It extends prior reports of decreased positive emotion expression in reappraising amusement with a negative ER goal from observer coding to EMG recording (Giuliani et al., 2008). It also extends findings from reappraising positive emotions with the goal to decrease positive emotion or generate a neutral or detached emotional state (Kalokerinos et al., 2015; Wu et al., 2012; Schönfelder et al., 2014; Lalot et al., 2014; Gruber et al., 2014; Wu et al., 2015) to the present study's amusement reappraisal with a negative ER goal, i.e., emphasizing ill motives, ridicule, or negative outcomes. This convergence of results of different ER goals suggests that reappraisal of positive emotion with negative, neutral, or detached ER goals may have similar, possibly uniform, decreasing effects on positive emotional experience and expression. Future research will have to test this supposition and extend it to response channels of negative emotional experience and expression, see below.

The present study's findings of increased disgust experience and corrugator reactivity go beyond what has been documented in prior ER literature. Still, increased disgust experience is usually reported in response to disgust stimuli, such as film clips (de Jong et al., 2011; Samson et al., 2015; Shenhav and

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[4] We caution interpretation of the nonsignificant increase in RSA, $t(44) = -1.91$, $p = .063$, $d = -0.30$, 95% CI = [0.61, 0.02], given that this effect was found after a non-significant MANOVA over ER goals, Wilk's $\lambda = 0.924$, $F(2,43) = 1.77$, $p = .18$, $\eta_p^2 = 0.079$, 95% CI [0.056,0.099]. While not meeting our cutoff for statistical significance, we note the potential clinical relevance and health implications of the medium effect size of the non-significant omnibus test, η_p^2=0.079, that likely was driven by the small effect, $d = -0.30$, of the negative versus no ER goal comparison for RSA (Cohen, 1992). Our sample may have been underpowered to detect this effect given that power calculations were aimed at effects with a $d \geq 0.431$ (see Section 2.1).

Mendes, 2014) or pictures (Caseras et al., 2007; Fink-Lamotte et al., 2021; Schienle et al., 2005; Wolf et al., 2005). Increased disgust experience has also been reported in response to disgust imagery (Vrana, 1993), the contact with outgroup religious beliefs, as these beliefs pose a threat to spiritual purity (Ritter and Preston, 2011), or moral transgressions (Chapman and Anderson, 2013). Moderate, as contrasted to strong, disgust experience—in coactivation with amusement or other positive emotions—has been reported under mixed emotional experiences (Hemenover and Schimmack, 2007; Kreibig et al., 2013, 2015; Samson et al., 2015). These various avenues to increased disgust experience suggest that disgust may be generated both from a stimulus-driven bottom-up approach as well as from a thought-driven top-down approach (McRae et al., 2012c; Ochsner et al., 2009; Otto et al., 2014). As we observed increased disgust experience in response to amusing stimuli in the present study, we reason that the increased disgust experience reflects the top-down cognitive ER mechanism of reappraising the amusing stimulus with a negative ER goal. Its moderate emotional intensity may point to the fact of generating a mixed, rather than a "pure" negative, emotion. Future research should strive to shed more light on the generation of negative versus mixed emotions in the context of reappraising amusing stimuli with a negative ER goal.

As for decreased amusement experience and decreased zygomaticus reactivity, increased corrugator reactivity mirrored the increase in disgust of the experiential response channel on the expressive response channel. Specifically, as for increased disgust experience, increased corrugator reactivity occurs in response to both stimulus-driven bottom-up and cognition-driven top-down emotional processes: On the one side, corrugator reactivity increases in response to disgusting film clips (Aguado et al., 2016; Borg et al., 2016; Kreibig et al., 2013, 2015; Reynaud et al., 2012; Sloan, 2004; Wolgast et al., 2011) or pictures (Fink-Lamotte et al., 2021; Vrana, 1993). It also responds to film clips or pictures of scenes relating to other negative emotions, such as anger, fear, and sadness (Bradley et al., 2001; Brown and Schwartz, 1980; Kreibig et al., 2007; Lang et al., 1993; Lee and Lang, 2009; Schwartz et al., 1980; Vrana, 1993; Yartz and Hawk, Jr., 2002) or negative facial expressions (i.e., anger, disgust, fear, and sadness; Balconi and Canavesio, 2013; Dimberg et al., 2011; Lundqvist, 1995; Murata et al., 2016; Rymarczyk et al., 2016, 2019). On the other side, corrugator reactivity also increases when thinking about moral violations, specifically another person's behavior that harms others (Cannon et al., 2011), or under negative affective imagery and aversive conditioning (Dimberg, 1990; Fridlund and Izard, 1983; Vrana, 1993). Accordingly, corrugator reactivity has been discussed as an indicator of global negative affect or negative emotional judgement (Bradley et al., 2001; Jackson et al., 2000; Larsen et al., 2003). Because there is not only greater corrugator reactivity under judgement of unpleasant events compared to neutral ones but also lower than baseline activation under pleasant events (see Section 4.1.2; Dan Glauser and Gross, 2011; Lang et al., 1993; Larsen et al., 2003; Vrana, 1993), corrugator reactivity has also been suggested as a bipolar indicator of affective valence.

Increased corrugator reactivity moreover occurs in response to emotionally ambiguous (a.k.a. mixed emotional; Kreibig et al., 2013, 2015) or surprising stimuli (Lundqvist, 1995; Topolinski and Strack, 2015). Neta et al. (2009) suggested that corrugator reactivity reflects a participants' tendency to rate a given stimulus as more negative and less positive (cf. negativity bias). Increased corrugator reactivity may furthermore reflect an increased empathic response to negative emotion (Balconi and Canavesio, 2013; Rymarczyk et al., 2016; Westbury and Neumann, 2008) as the observer generates a shared emotional response to understand the other's emotion by simulating it.

Lastly, increased corrugator reactivity also arises in the context of ER in response to unpleasant pictures with a negative ER goal (ER strategy unspecified, i.e., "increase the intensity of [negative emotion] you feel;" Jackson et al., 2000, p. 522) or reappraisal with a negative ER goal (i.e., "imagine the depicted situation getting worse;" Urry, 2009, p. 786). It also increases in response to reappraising pleasant pictures with a neutral/negative ER goal (i.e., "feel neutral by imagining that the depicted positive scenario would become more negative over time;" Wu et al., 2015, p. 3).

Jackson et al. (2000, p. 516) reasoned that "if the presence of negative affect is indexed by increased corrugator activity, successful enhancement of negative affect should produce increases in the activity of this psychophysiological variable." We suggest that this is what we see in the present study: Based on the above reviewed lines of research, we interpret the increased corrugator reactivity while reappraising amusing stimuli with a negative ER goal as indicating greater negative affective judgment and greater top-down cognitive generation of negative emotion (either resulting in "pure" negative emotion, such as disgust, or "mixed emotion") from successful implementation of ER efforts with a negative ER goal as well as, possibly, greater empathy than under unregulated responding to the amusement film clips. The top-down cognitive generation of an alternative emotional response appears to overwrite or attenuate the bottom-up stimulus-driven generation of the amusement response, as observed under unregulated (no ER goal) responding. Disentangling the specificity of responses with respect to affective judgement, emotion generation and regulation, and empathizing while reappraising amusing stimuli with a negative ER goal represents a promising avenue for future research.

Taken together, we summarize that reappraising amusing stimuli with a negative ER goal is accompanied by convergence of results between experiential and expressive response channels, with decreased amusement experience and zygomaticus reactivity and increased disgust and corrugator reactivity than under unregulated responding to the amusement film clips. We interpret these findings as evidence for both reduction in positive emotion as well as generation of negative, mixed, or prosocial emotion from successful implementation of ER efforts.

4.1.4. Positive versus negative ER goals in amusement reappraisal

Reappraising amusing stimuli with a negative versus positive ER goal had a similar pattern of results as the negative versus no ER goal comparison. Positive and no ER goals differed significantly only regarding corrugator supercilii reactivity. Accordingly, negative as contrasted to positive ER goals generated lower amusement and greater disgust experience of large effect size; lower zygomaticus major and greater corrugator supercilii expression of large effect size; and no change in cardiac parasympathetic (RSA) and sympathetic (PEP) autonomic physiology.

The negative versus positive ER goal comparison amplified the contrast involving corrugator reactivity: Differential response direction of corrugator reactivity resulted from decreased reactivity under the positive ER goal and increased reactivity under the negative ER goal in reappraising amusing stimuli. This response pattern attests to this measure's discriminative sensitivity to willfully, by means of altered interpretation, both increasing positive/decreasing negative emotion and decreasing positive/increasing negative emotion, as discussed in Sections 4.1.2 and 4.1.3. Future research should make use of this valuable feature of corrugator reactivity.

4.2. Integration of the Present Study's Results with Hypotheses

We tested hypotheses derived from the PA–NA systems framework for no, positive, and negative ER goals for reappraising amusing stimuli. Results largely support our hypotheses, but we also identify notable deviations.

4.2.1. Unregulated amusement response (no ER goal)

As outlined in Sections 1.2.1 and 1.4 and Table 1, we hypothesized that unregulated amusement (no ER goal) would generate uncoupled PA activation or reciprocal PA–NA activation on experiential, expressive, and physiological response channels. With the present study, we found that unregulated amusement strongly increased positive and subtly increased negative emotional experience; increased positive and left unchanged negative expression; and increased RSA and left unchanged PEP, see Table 6. Specific predictions for the unregulated amusement response were supported across all response channels. The observed response pattern supports uncoupled PA activation on experiential, expressive, and physiological response channels, see Table 7. Convergence of results—both among response channels in the present study as well as between the present and prior studies (see Section 4.1.1)—makes this a robust finding. We invite researchers to use uncoupled PA activation as an *a priori* hypothesis in future investigations involving unregulated amusement to test its generalization to other contexts and measures.

4.2.2. Positive ER goals in amusement reappraisal

As outlined in Sections 1.2.2 and 1.4 and Table 1, we hypothesized that a positive ER goal while reappraising amusing stimuli would generate uncoupled PA activation, reciprocal PA–NA activation, or NA withdrawal as contrasted to unregulated amusement. We found that the positive ER goal decreased negative emotional expression, but positive and negative experience, expression, and physiology otherwise remained unchanged, see Table 6. Specific predictions for reappraising amusement with a positive ER goal were only supported for corrugator reactivity. The observed response pattern of decreased corrugator reactivity suggests uncoupled NA withdrawal on the expressive response channel, see Table 7.

If these data are taken at face value, they indicate that effects of positive ER goals while reappraising amusing stimuli are limited to the expressive response channel. Results indicate that positive ER goals are implemented through the NA system in terms of withdrawal below levels of baseline activation. During the study's baseline, participants were instructed to sit quietly, clear their mind, and avoid moving or speaking—implementing a neutral emotional state without audiovisual stimulation. This means that participants would have entered an even less negative affective state while reappraising amusing stimuli with a positive ER goal than that during the neutral resting baseline condition.

From a methodological perspective, data may alternatively be taken to indicate either ineffectiveness of the positive ER goal manipulation or presence of a ceiling effect. With respect to the concern of an ineffective positive ER goal manipulation, effectiveness of the manipulation is supported by unpublished pilot data as well as its effects in reappraising disgusting (Kreibig et al., 2022b) and mixed emotional (Kreibig et al., 2022c) stimuli. This makes ineffectiveness of the positive ER goal manipulation in the context of reappraising amusing stimuli unlikely.

With respect to the concern of a ceiling effect, amusement film clips could have elicited an already as positive as possible response on experiential, expressive, and physiological response channels. This could have not allowed for display of an even stronger amusement response. However, amusement ratings were collected on a 6-point Likert scale and average amusement rating while reappraising amusing stimuli with a positive ER goal was 4.40 (*SD* = 1.41). This leaves considerable room for an increase in amusement ratings under this condition. Additionally, for EMG, a ceiling would only be reached if participants were smiling, laughing, or grimacing so strongly that a physiologically defined ceiling would be reached. Video recordings and behavioral observations from the laboratory sessions do not support this interpretation. Finally, for physiological responses, a ceiling effect for reappraising amusing stimuli with a positive ER goal is unlikely given the greater RSA that was observed for the negative ER goal and the lower RSA that was observed for no ER goal in the present study. This demonstrates greater and lower RSA reactivity than that observed for positive ER goals. These considerations make a ceiling effect unlikely.

Taken together, we summarize that reappraising amusing stimuli with a positive ER goal decreased corrugator reactivity, indicative of NA withdrawal (cf. Table 7). Our finding suggests that reappraising amusing stimuli with a positive ER goal may operate by minimizing engagement of the opposite-valence (negative) affect system. Future research should strive to replicate this finding and identify its boundary conditions.

4.2.3. Negative ER goals in amusement reappraisal

As outlined in Sections 1.2.2 and 1.4 and Table 1, we hypothesized that a negative ER goal while reappraising amusing stimuli would generate uncoupled NA activation, reciprocal NA–PA activation, or PA withdrawal. We found that the negative ER goal decreased positive and increased negative emotional experience; decreased positive and increased negative emotional expression; and left RSA and PEP unchanged, see Table 6. Specific predictions were supported for positive and negative experience and expression and partially for autonomic physiology (unchanged for RSA but no shortening for PEP). Our results suggest that experiential and expressive effects of negative ER goals in reappraising amusement may be more closely coupled than physiological effects. The observed response pattern indicates reciprocal NA system activation on experiential and expressive response channels and no change on the physiological response channel.

4.3. Broader Implications of the Present Study's Results

The present study's results suggest that positive and negative ER goals in reappraising amusing stimuli differentially engaged PA–NA systems: Compared to the unregulated (no ER goal) amusement response's uncoupled experiential, expressive, and physiological PA activation, reappraising amusing stimuli with a positive ER goal engaged withdrawal of the expressive NA system. Reappraising amusing stimuli with a negative ER goal engaged reciprocal NA–PA system activation on experiential and expressive response channels (cf. Table 7). Accordingly, we suggest conceptualizing effects of positive and negative ER goals while reappraising amusing stimuli, first, as taking effect in a two-dimensional fashion, as expressed in terms of the PA–NA systems framework, and, second, as potentially exhibiting non-uniform effects across experiential, expressive, and physiological response channels.

With respect to the first point, if ER goals were to take effect in a one-dimensional fashion, we would have expected to see highly negative correlations between pairs of indicators for PA–NA systems, e.g., self-reported amusement and disgust or zygomaticus major and corrugator supercilii EMG reactivity. However, we found low to moderate levels of inter-variable correlations for pairs of indicators for PA–NA systems (SOM Table A.4). These results illustrate that effects of ER goals specifically, and of ER more broadly, take effect not only in a one-dimensional fashion (i.e., presence or absence of emotional effect) but rather in a two-dimensional fashion (i.e., presence or absence of independent positive and negative emotional effects, suggestive of engagement of separate PA–NA systems). These results suggest a broadening of our view from uni-dimensional effects of ER to acknowledging separate (coupled or uncoupled) impact of ER on positive and negative response components of the regulated emotional response.

With respect to the second point, if ER goals were to uniformly affect response channels, we would have expected to see effects of positive and negative ER goals on all three response channels. However, we found that ER goals may affect only one of the response channels, as in the case of the positive ER goal in amusement reappraisal. Alternatively, ER goals may affect several emotional response channels, as in the case of the negative ER goal in amusement reappraisal. According to effect size (η_p^2 of one-way MANOVAs; cf. Tables 3–5), zygomaticus major reactivity evidenced the largest effects of ER goals, followed by corrugator supercilii reactivity and next self-reported amusement and disgust. Effects of ER goals were least pronounced on the physiological response channel. Low to moderate levels of inter-variable correlations (SOM Table A.5) reflect that emotional responses are not identical between response channels but rather reflect a loosely coupled, integrated process with partially overlapping effects on experience, expression, and physiology (Scherer, 2001).

We derive the following recommendations from the present study's results: first, to conceptualize effects of ER goals within a two-dimensional space of potential emotional change; second, to measure effects of ER goals using measures of both positive and negative emotional responses corresponding to the PA–NA systems; and third, to obtain PA–NA system measures from multiple response channels of emotion to adequately capture effects of emotional reactivity or regulation. This approach of studying ER acknowledges that emotional effects may diverge between response channels (Mauss et al., 2004, 2005) or be reflected on only one response channel.

The present work bears testimony to the basic supposition of emotion research that appraisal outcomes determine emotional response generation (Scherer, 2001, cf. Section 1). As experimental instructions changed appraisals away from stimulus-driven amusement generation (no ER goal) to cognitively emphasizing the stimulus event's positive or negative aspects, we found that emotional responses changed accordingly: With greater emphasis of positive aspects (positive ER goal) of the amusing stimulus, there was even less evidence of negative emotion in emotional expression. This finding may shed light on fundamental processes involved in capitalizing (Langston, 1994; Peters et al., 2018), savoring (Quoidbach et al., 2015; Seligman et al., 2006), positivity bias (Norris et al., 2011; Unkelbach et al., 2020), optimism (Alarcon et al., 2013; Scheier and Carver, 1993), or positive refocusing (Garnefski and Kraaij, 2006). With greater emphasis of negative aspects (negative ER goal) of the amusing stimulus, there was less evidence of positive emotion and more evidence of negative emotion in emotional experience and expression. This finding may illuminate basic mechanisms involved in negative thinking (Beck, 1967, 1987; Lyubomirsky and Nolen-Hoeksema, 1995), fault finding (Schwartz et al., 2002; Polman, 2010), negativity bias (Huang and Luo, 2006; Ito et al., 1998; Rozin and Royzman, 2001), pessimism (Showers, 1992), or rumination (Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008). Our results may be viewed as a demonstration of the powerful role of cognitive top-down processes in modifying stimulus-driven bottom-up emotional responses. These findings support to the adage: “Change your thinking to change your feelings,” distilled in the concept of cognitive reappraisal.

4.4. Limitations and Future Directions

The present study is a first attempt to directly contrast the differential effects of positive and negative ER goals while reappraising amusing stimuli on indicators of PA–NA systems in three domains of emotional responding—experience, expression, and physiology. Several limitations of this study warrant comment.

First, this study’s sample was restricted with respect to gender (women only), age (18 to 30 years), and education (predominant student sample). Future research should study ER goals in more diverse samples.

Second, we investigated positive and negative ER goals while reappraising amusing stimuli in the context of film-induced amusement. However, we did not contrast positive and negative ER goals while reappraising amusing stimuli to reappraisal of other positive emotions, such as joy, pride, or tenderness, other affective stimuli, such as still pictures or music clips, or yet other types of ER goals, such as neutral or detachment ER goals. There are many possible combinations of discrete emotions, affective stimuli, and ER goals, which future research should investigate by systematically exploring this space.

Third, with respect to our operationalization, we chose to investigate positive and negative ER goals in terms of emphasizing positive or negative aspects in participants’ interpretations of emotional stimuli. Prior research of amusement or positive affect reappraisal used instructions to increase emphasis of emotional intensity, positive emotion, or amusement/ridicule for positive ER goals or to increase emphasis of negative emotion or pain for negative ER goals (cf. Section 1.3). The scope of the present study did not permit analysis of the effect of different thematic emphases of reappraisal instructions. Even beyond this, there exist many other scenarios of ER goals. For example, a positive ER goal may involve the generation of another same-valence emotions than amusement, such as serenity or interest; a negative ER goal may involve the generation of other opposite-valence emotions than disgust, such as anger, fear, or sadness; and a neutral ER goal may involve the emphasis of neutral aspects in one's interpretation. ER goals may also target one's interpretation of one's feelings rather than one's interpretation of the emotional stimulus.

Fourth, we investigated the construct of ER goals as applied to one generally adaptive ER strategy—reappraisal (McRae et al., 2012b). Future research should examine effects of ER goals in the context of other ER strategies, such as attention deployment and response modulation, or combinations of different ER strategies (blending).

Fifth, the present study used an offline ER paradigm. This leaves untested the impact of ER goals on ER outcome in online-regulation paradigms, i.e., when applied to an already generated emotion (Kreibig et al., 2022a; Sheppes and Meiran, 2007, 2008). Beyond this, future research will merit exploring the impact of ER goals on ER strategy choice (Sheppes et al., 2011, 2014) and effectiveness (Augustine and Hemenover, 2009; Webb et al., 2012).

Sixth, we examined the effects of positive and negative ER goals on emotional experience, facial expressive behavior, and autonomic physiology. We measured reliable and well-validated indices of positive and negative emotional experience, facial muscles (Bernat et al., 2006; Bush et al., 1989; Cacioppo et al., 1986; Jackson et al., 2000), and cardiac autonomic measures (Kelsey, 2012; Cribbet et al., 2020; MacCormack et al., 2021). Future research should strive to not only replicate here-reported effects but also to generalize these to other indicators of PA–NA system engagement. Yet other response channels of emotion may be informative to assess for better characterizing the effects of ER goals. For example, self-reported appraisals would be informative to better understand how reappraisal with various ER goals changes appraisal outcomes. Self-reported ER strategy or tactic actually used in response to each film stimulus would not only help confirm successful experimental manipulation but could elucidate how healthy adults implement positive and negative ER goals through ER tactics. Neural measures, such as electroencephalography or functional magnetic resonance imaging, would allow examination of differences in time course and neural bases between positive and negative ER goals (Murray et al., 2021).

In conclusion, the present study investigated effects of ER goals while reappraising amusing stimuli in terms of PA–NA systems engagement on experiential, expressive, and physiological response channels. We found that positive and negative ER goals while reappraising amusing stimuli differently engaged affect systems: Positive ER goals engaged withdrawal of the expressive NA system. Negative

ER goals engaged reciprocal NA system activation and PA system withdrawal on experiential and expressive response channels. We are excited about the outlook of future studies replicating the present study's results and applying the PA–NA systems framework on multiple response channels to examining fundamental mechanisms of ER goals in the context of other emotions, ER strategies, and ER tactics.

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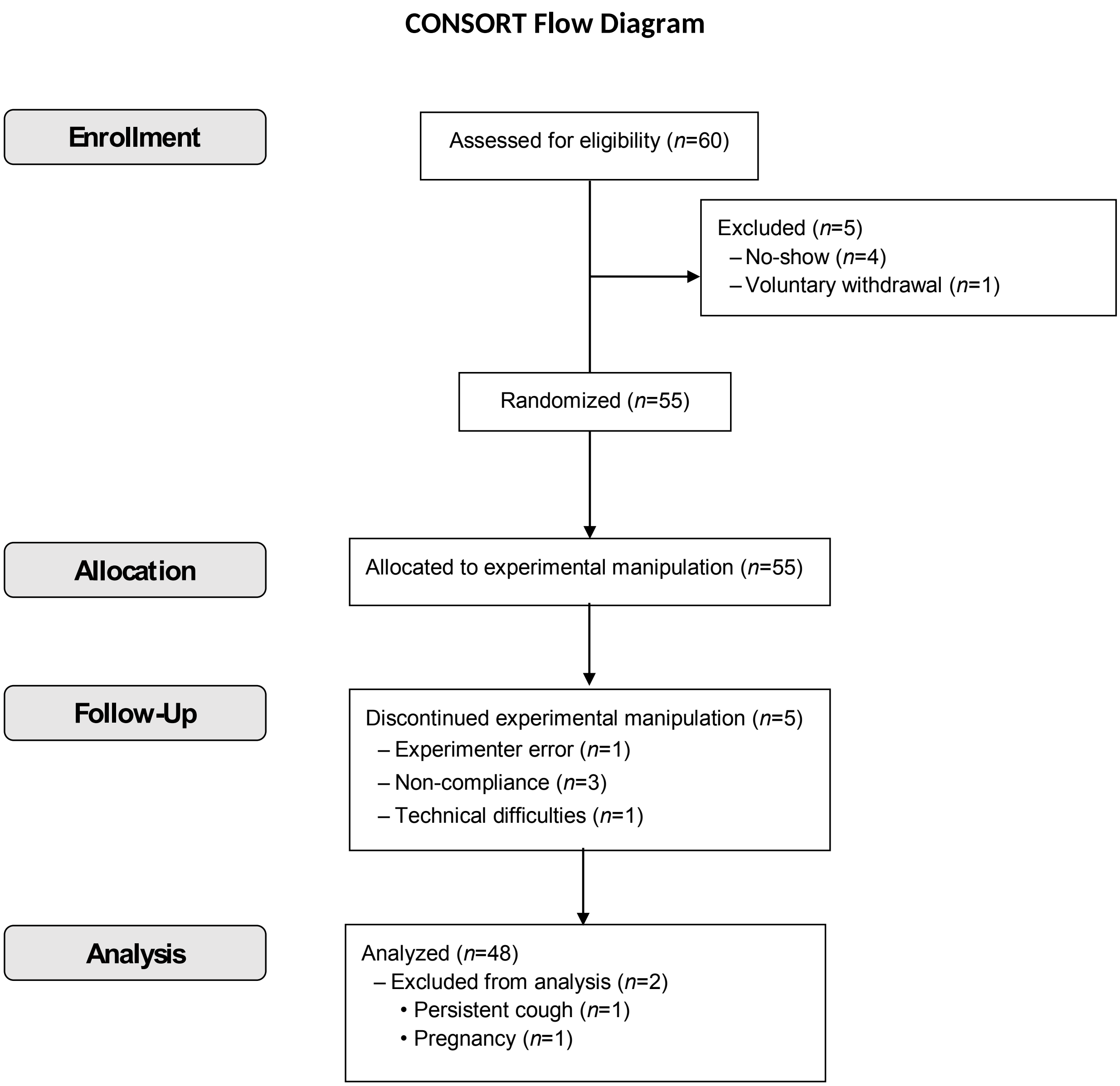

Figure 1: CONSORT Participant Flow Diagram of the Present Study.

Note. CONSORT – Consolidated Standards of Reporting Trials.

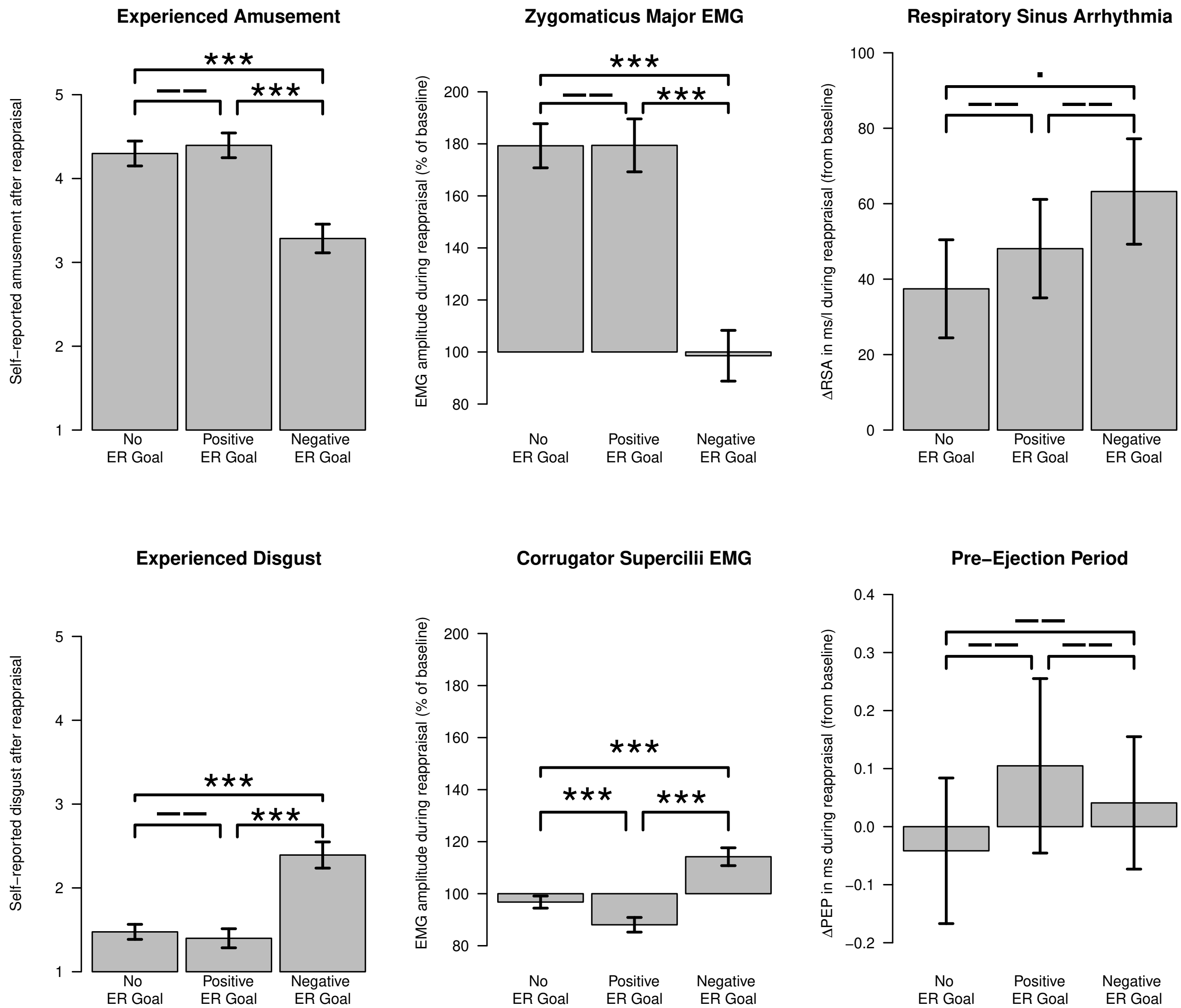

Figure 2: Illustration of Mean Effects of No, Positive, and Negative Emotion Regulation Goals While Cognitively Reappraising Amusing Stimuli on Raw Scores of Emotional Experience, Facial Expression, and Autonomic Physiological Reactivity. Error Bars Reflect 95% Confidence Intervals Plotted Around Condition Means.

Note. *** – $p \leq .001$; ** – $p \leq .01$; * – $p \leq .05$; • – $p \leq .10$; - - – $p > .05$; Δ – delta change scores; EMG – electromyography; ER – emotion regulation; PEP – pre-ejection period; RSA – respiratory sinus arrhythmia.

	Negative Affect System		
Positive Affect System	Increase	No change	Decrease
Increase	PA–NA Coactivation	Uncoupled PA activation Amusement *Positive ER goal*	Reciprocal PA–NA activation Amusement *Positive ER goal*
No change	Uncoupled NA activation Disgust *Negative ER goal*	Baseline Neutral emotional state *No ER goal (Unregulated)*	Uncoupled NA withdrawal *Positive ER goal*
Decrease	Reciprocal NA–PA activation Disgust *Negative ER goal*	Uncoupled PA withdrawal *Negative ER goal*	PA–NA Coinhibition

Table 1: Illustration of the Two-Dimensional Space of (1) Activation States of Positive Affect and Negative Affect Systems According to Increase, No Change, and Decrease of Activation (Top Row of Each Cell); (2) Generation of Emotional States, Including Neutral (Center Mid-Grey Cell), Positive (e.g., Amusement; Two Top Light-Grey Cells), or Negative (e.g., Disgust; Two Bottom Dark-Grey Cells) Emotional States; and (3) Regulation of a Given Emotion According to No (i.e., Unregulated; Center Mid-Grey Cell), Positive (Three Top Light-Grey Cells), or Negative (Three Bottom Dark-Grey Cells) Emotion Regulation Goals (Bottom Row of Each Cell).
Note. ER – emotion regulation; NA – negative affect; PA – positive affect.

			Amusement Response					
		Experimental Cond.$_{DUR}$/	Experience		Expression		Autonomic Physiology	
ER Goal	Study	Comparison Cond.$_{DUR}$	PA	NA	PA	NA	PA	NA
1. Unregulated Amusement Response (No ER Goal)								
	Herring et al. (2011)	VI-AFC$_{215}$/REST$_{120}$	↑ amu ↑ PA		↑ PA ↑ laughter		↔ HF	↔ PEP
	Kreibig et al. (2013)	VI-AFC$_{25}$/REST$_{25}$	↑ amu ↑ val	↑ dis	↑ ZM EMG	↓ CS EMG	↓ PV$_{uc}$ ↔ PVc	↔ PEP
	Kreibig et al. (2015)	VI-AFC$_{25}$/REST$_{25}$	↑ amu ↑ val	↑ dis	↑ ZM EMG	↔ CS EMG	↓ PV$_{uc}$ ↑ PV$_{c}$	↔ PEP
	Overbeek et al. (2012)	VI-AP$_{150}$,VI-AFC$_{150}$/ VI-NP$_{150}$,VI-NFC$_{120}$	↑ enj, plea	↑ ang, dis, (fea), (sad)	↑ ZM EMG	↓ CS EMG	↓^{1}/↔^{2} HF-PDS$_{uc/c}$ ↓^{1}/↔^{2} HF-SCV$_{uc/c}$ ↓^{1}/↔^{2} RMSSD$_{uc/c}$ ↓^{1}/↔ CVSD$_{uc/c}$	↔ PEP
	Shiota et al. (2011)	VI-AP$_{90}$/VI-NP$_{90}$	↑ amu ↑ ent/exc, lov/att, ten/com ↔ awe				↔ HF	↔ PEP
	Stephens et al. (2010)	VI-AFC$_{145}$,LI-AMC$_{145}$/ VI-NFC$_{145}$,LI-NMC$_{145}$	↑ amu ↑ con	↑ ang, fea, sad			↔ PV$_{uc/c}$	↑ PEP
	Summary		⇑	⇑	⇑	⇔ / ⇓	⇔ / ⇓	⇔
2.A Positive ER Goal in Amusement Reappraisal								
	Giuliani et al. (2008)	PERI-AFC$_{15}$/VI-AFC$_{15}$	↑ amu		↑ # smiles ↑ # laughs			↑ CV-SNS
	Brady et al. (2021)	PERI-AFC$_{120}$/VI-AFC$_{120}$	↓ amu		↑ ZM EMG			↔ SCL
2.B Positive ER Goal in Positive Affect Reappraisal								
	Li et al. (2018, study 1)	PERI-PP$_{4}$/MI-PP$_{4}$	↑ val					
	Li et al. (2018, study 2)	PERI-PP$_{12}$/MI-PP$_{12}$			↑ ZM EMG			
	Blair et al. (2012)	PERI-PP$_{5}$/VI-PP$_{5}$	↑ val					
	Wu et al. (2012)	PN-PP$_{4}$/NN-PP$_{4}$	↑ plea		↑ ZM EMG	↔ CS EMG		
	Summary		⇑	—	⇑	⇔	—	⇑
3.A Negative ER Goal in Amusement Reappraisal								
	Giuliani et al. (2008)	NERI-AFC$_{15}$/VI-AFC$_{15}$	↓ amu		↓ # smiles ↓ # laughs			↓ CV-SNS
3.B Negative ER Goal in Positive Affect Reappraisal								
	Blair et al. (2012)	NERI-PP$_{5}$/VI-PP$_{5}$	↓ val					
	Summary		⇓	—	⇓	—	—	⇓

Table 2: Summary of Prior Studies' Empirical Results and Across-Studies Summaries for the Unregulated Amusement Response (No Emotion Regulation [ER] Goal) and Amusement Reappraisal with Positive and Negative ER Goals on Positive and Negative Affect Systems on Experiential, Expressive, and Autonomic Physiological Channels.

Note. ↑ or ⇑ – greater, ↔ or ⇔ – unchanged, or ↓ or ⇓ – lower activation for single studies or across-studies summaries, respectively; () – marginal significance; ^{1} – When Harry Met Sally; ^{2} – Comedian. # – number; AFC – amusing film clip; AMC – amusing music clip; amu – amusement; ang – anger; AP – amusing pictures; c – respiratory sinus arrhythmia (RSA) corrected for within-individual effects of respiration rate and tidal volume; con – contentment; cond – condition; CS – corrugator supercilii; dis – disgust; DUR – duration; EMG – electromyography; enj – enjoyment; ent/exc – enthusiasm/excitement; ER – emotion regulation; fea – fear; HF – high-frequency heart rate variability; LI – listen instruction; lov/att – love/attachment; MI – maintain instruction; NA – negative affect; NERI – negative ER goal instruction NFC – neutral film clip; NN – neutral narrative; NP – neutral pictures; PA – positive affect; PERI – positive ER goal instruction; plea – pleasantness; PN – positive narrative; PP – positive pictures; PV – peak–valley; REST – resting baseline; sad – sadness; ten/com – tenderness/compassion; uc – respiratory sinus arrhythmia (RSA) uncorrected for within-individual effects of respiration rate and tidal volume; val – valence; VI – view instruction; ZM – zygomaticus major.

Emotional Experience					
MANOVAs	Wilks' λ	F	p	η_p^2	95% CI
ER Goal × Affect System MANOVA					
ER Goal	0.969	$F(2,46) = 0.731$	0.49	0.031	0.018, 0.047
Affect System	0.162	$F(1,47) = 243.86$	$<\mathbf{2.2^{-16}}$***	0.838	0.825, 0.850
ER Goal × Affect System	0.431	$F(2,46) = 30.40$	$\mathbf{3.9^{-9}}$***	0.569	0.541, 0.596
ER Goal MANOVA for Positive Affect System					
ER Goal	0.472	$F(2,46) = 25.74$	$\mathbf{3.16^{-8}}$***	0.528	0.499, 0.557
ER Goal MANOVA for Negative Affect System					
ER Goal	0.479	$F(2,46) = 24.98$	$\mathbf{4.5^{-8}}$***	0.521	0.491, 0.549

t-tests	t	p	d	95% CI
Pairwise t-Tests for Positive Affect System: Self-Reported Amusement				
positive vs. no ER Goal	$t(47) = -0.70$	0.49	-0.09	-0.36, 0.17
negative vs. no ER Goal	$t(47) = 6.21$	$\mathbf{1.3^{-7}}$***	1.03	0.62, 1.44
positive vs. negative ER Goal	$t(47) = 6.84$	$\mathbf{1.4^{-8}}$***	1.13	0.71, 1.55
Pairwise t-Tests for Negative Affect System: Self-Reported Disgust				
positive vs. no ER Goal	$t(47) = 1.00$	0.32	0.12	-0.12, 0.36
negative vs. no ER Goal	$t(47) = -7.02$	$\mathbf{7.7^{-9}}$***	-1.04	-1.41, -0.68
positive vs. negative ER Goal	$t(47) = -6.71$	$\mathbf{2.3^{-8}}$***	-1.15	-1.58, -0.71

Table 3: Results of Multivariate Analyses of Variance and t-Tests for Effects of No, Positive, and Negative Emotion Regulation Goals While Reappraising Amusing Stimuli on Positive and Negative Affect Systems as Indexed by Self-Reported Amusement (Positive Experience) and Disgust (Negative Experience) on the Experiential Response Channel.

Note. Values typeset in boldface remain significant after correcting α for multiple tests using the Bonferroni method (see Section 2.7). . – $p \leq .10$; * – $p \leq .05$; ** – $p \leq .01$; *** – $p \leq .001$; CI – confidence interval; ER – emotion regulation; MANOVA – multivariate analysis of variance.

Emotional Expression					
MANOVAs	Wilks' λ	F	p	η_p^2	95% CI
ER Goal × Affect System MANOVA					
ER Goal	0.531	$F(2,46) = 20.35$	**4.7^{-7}*****	0.469	0.438, 0.500
Affect System	0.375	$F(1,47) = 78.46$	**1.4^{-11}*****	0.625	0.600, 0.650
ER Goal × Affect System	0.263	$F(2,46) = 64.59$	**4.4^{-14}*****	0.737	0.718, 0.756
ER Goal MANOVA for Positive Affect System					
ER Goal	0.328	$F(2,46) = 47.18$	**7.2^{-12}*****	0.672	0.649, 0.694
ER Goal MANOVA for Negative Affect System					
ER Goal	0.435	$F(2,46) = 29.93$	**4.7^{-9}*****	0.565	0.537, 0.592

t-tests	t	p	d	95% CI
Pairwise t-Tests for Positive Affect System: Zygomaticus Major EMG				
positive vs. no ER Goal	$t(47) = -0.02$	0.99	0.00	-0.25, 0.25
negative vs. no ER Goal	$t(47) = 9.26$	**3.6^{-12}*****	1.30	0.92, 1.67
positive vs. negative ER Goal	$t(47) = 7.81$	**4.9^{-10}*****	1.19	0.79, 1.58
Pairwise t-Tests for Positive Affect System: Corrugator Supercilii EMG				
positive vs. no ER Goal	$t(47) = 3.93$	**2.8^{-4}*****	0.40	0.19, 0.61
negative vs. no ER Goal	$t(47) = -5.90$	**3.8^{-7}*****	-0.67	-0.92, -0.42
positive vs. negative ER Goal	$t(47) = -7.82$	**4.7^{-10}*****	-1.05	-1.38, -0.72

Table 4: Results of Multivariate Analyses of Variance and t-Tests for Effects of No, Positive, and Negative Emotion Regulation Goals While Reappraising Amusing Stimuli on Positive and Negative Affect Systems as Indexed by Zygomaticus Major (Positive Expression) and Corrugator Supercilii (Negative Expression) Electromyography Reactivity on the Expressive Response Channel.

Note. See Table 3 notes; EMG – electromyography.

Physiological Reactivity					
MANOVAs	Wilks' λ	F	p	η_p^2	95% CI
ER Goal × Affect System MANOVA					
ER Goal	0.935	$F(2,36) = 1.26$	0.30	0.065	0.047, 0.087
Affect System	0.998	$F(1,37) = 007$	0.80	0.002	0.000, 0.007
ER Goal × Affect System	0.842	$F(2,36) = 3.37$	0.045*	0.158	0.130, 0.187
ER Goal MANOVA for Positive Affect System					
ER Goal	0.924	$F(2,43) = 1.77$	0.18	0.076	0.056, 0.099
ER Goal MANOVA for Negative Affect System					
ER Goal	0.970	$F(2,37) = 0.56$	0.57	0.030	0.017, 0.045

t-tests	t	p	d	95% CI
Pairwise t-Tests for Positive Affect System: Respiratory Sinus Arrhythmia (RSA)				
positive vs. no ER Goal	$t(44) = -0.85$	0.40	-0.12	-0.39, 0.16
negative vs. no ER Goal	$t(44) = -1.91$	0.063.	-0.30	-0.61, 0.02
positive vs. negative ER Goal	$t(44) = -1.11$	0.27	-0.17	-0.47, 0.13
Pairwise t-Tests for Positive Affect System: Pre-Ejection Period (PEP)				
positive vs. no ER Goal	$t(38) = 1.02$	0.32	0.22	-0.21, 0.65
negative vs. no ER Goal	$t(38) = 0.77$	0.44	0.14	-0.22, 0.49
positive vs. negative ER Goal	$t(38) = -0.48$	0.64	-0.10	-0.52, 0.32

Table 5: Results of Multivariate Analyses of Variance and t-Tests for Effects of No, Positive, and Negative Emotion Regulation Goals While Reappraising Amusing Stimuli on Positive and Negative Affect Systems as Indexed by Respiratory Sinus Arrhythmia (Parasympathetic Nervous System Reactivity) and Pre-Ejection Period (Sympathetic Nervous System Reactivity) on the Physiological Response Channel.

Note. See Table 3 notes.

ER Goal Condition	Amusement Response: Experience PA	Experience NA	Expression PA	Expression NA	Autonomic Physiology PA	Autonomic Physiology NA
1. Unregulated Amusement Response (No ER Goal) (vs. emotionally neutral baseline)						
Observed response	strong ↑ amu	mild ↑ dis	↑ ZM EMG	↔ CS EMG	↑ RSA	↔ PEP
Response pattern	**uncoupled PA activation**		**uncoupled PA activation**		**uncoupled PA activation**	
2. Positive ER Goal in Amusement Reappraisal (vs. unregulated/no-ER goal amusement)						
Observed response	↔ amu	↔ dis	↔ ZM EMG	↓ CS EMG	↔ RSA	↔ PEP
Response pattern	**no change**		**NA withdrawal**		**no change**	
3. Negative ER Goal in Amusement Reappraisal (vs. unregulated/no-ER goal amusement)						
Observed response	↓ amu	↑ dis	↓ ZM EMG	↑ CS EMG	↔ RSA	↔ PEP
Response pattern	**reciprocal NA-PA activation**		**reciprocal NA-PA activation**		**no change**	

Table 6: Summary of the Present Study's Empirical Results and Integrated Response Patterns for the Unregulated Amusement Response (No Emotion Regulation [ER] Goal) and Cognitively Reappraised Amusement Response with Positive or Negative ER Goals on Positive and Negative Affect Systems on Experiential, Expressive, and Autonomic Physiological Response Channels.

Note. ↑ – greater activation; ↔ – unchanged activation; ↓ – lower activation; amu – self-reported amusement; CS – corrugator supercilii; dis – self-reported disgust; EMG – electromyography; ER – emotion regulation; NA – negative affect; PA – positive affect; PEP – pre-ejection period; RSA – respiratory sinus arrhythmia; ZM – zygomaticus major.

ER Goal Condition	**Integrative PA–NA System Response Summary**
Unregulated Amusement / No ER Goal	Uncoupled experiential, expressive, and physiological PA activation
Positive ER Goal in Amusement Reappraisal	Uncoupled expressive NA withdrawal
Negative ER Goal in Amusement Reappraisal	Reciprocal experiential and expressive NA activation

Table 7: Summary of Positive Affect and Negative Affect System Responses Across Experiential, Expressive, and Physiological Response Channels for No, Positive, and Negative Emotion Regulation Goals, as Observed in the Present Study.

Note. ER – emotion regulation; NA – negative affect; PA – positive affect.