Emotion

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# The Thrill of Victory: Savoring Positive Affect, Psychophysiological Reward Processing, and Symptoms of Depression

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Depression is characterized by a pattern of maladaptive emotion regulation. Recently, researchers have begun to focus on associations between depression and two positive affect regulation strategies: savoring and dampening. Savoring, or upregulation of positive affect, is positively associated with well-being and negatively associated with depression, whereas dampening, or downregulation of positive affect, is positively associated with depression, anhedonia, and negative affect. To date, no research has examined whether savoring or dampening can affect neurophysiological reactivity to reward, which previous research has shown is associated with symptoms of depression. Here, we examined associations between psychophysiological reward processing—primarily captured by the Reward Positivity (RewP), an event-related potential (ERP) deflection elicited by feedback indicating reward (vs. nonreward)—positive affect regulation strategies, and symptoms of depression. One hundred undergraduates completed questionnaires assessing affect, emotion regulation, and depressive symptoms and completed a computerized guessing task, once before and again after being randomly assigned to emotion-regulation strategy conditions. Results indicate that (a) the relationship between RewP amplitude and depressive symptoms may, in part, depend upon positive affect regulation strategies and (b) the RewP elicited by reward appears sensitive to a savoring intervention. These findings suggest that mitigating depressive symptoms in emerging adults may depend on both top-down (i.e., savoring) and bottom-up (i.e., RewP) forms of positive affect regulation and have important implications for clinical prevention and intervention efforts for depressive symptoms and disorder.

*Keywords:* depression, emotion regulation, ERPs, reward processing

*Supplemental materials:* http://dx.doi.org/10.1037/emo0000914.supp



Depression is among the most widespread and financially burdensome mental illnesses (Donohue & Pincus, 2007; Robins & Reiger, 1991). Historically, depression has been considered an affective disorder, characterized by the experience of high levels of negative affect (NA) and low levels of positive affect (PA; Clark & Watson, 1991). Increasingly, depression is understood as a disorder not just of affective experience but also of emotion regulation (Gotlib & Joormann, 2010). Studies of emotion regulation, encompassing the "processes by which individuals influence which emotions they have, when they have them, and how they experience these emotions" (Gross, 1998, p. 271), have demonstrated significant associations between depression and individuals' self-reports of maladaptive emotion regulation (Gotlib & Joormann, 2010; Ochsner & Gross, 2007).

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In psychophysiological research, blunted sensitivity to reward feedback has been associated with depressive symptoms, disorder status, and disorder risk factors (Admon & Pizzagalli, 2015; Forbes & Goodman, 2014; Foti & Hajcak, 2009; Pizzagalli, Iosifescu, Hallett, Ratner, & Fava, 2008; Proudfit, 2015). Conceptual overlap between psychophysiological responses to reward and self-reported reaction to affective experiences suggest that examining both constructs together may advance understanding of depression as a disorder of emotion regulation. Here, we examined the relationship between emotion regulation and reward processing and their respective associations with symptoms of depression and anhedonia, as well as the effects of a brief emotion regulation intervention on reward processing. Demonstrating the malleability of reward processing, as well as the ways in which emotion regulation and reward processing relate to each other and to depressive symptoms, may elucidate processes underlying depression and could suggest potential targets for intervention to reduce depressive symptoms and normalize risk factors (see Burkhouse et al., 2016).

## Depression as a Disorder of Affective Experience and Regulation

Individuals with emotional disorders may have difficulty with the process of regulating emotional experiences. Based in Gross's extended process model (Gross, 2015), emotion regulation is the-

orized as a second-level valuation system modifying a first-level valuation system. That is, the regulatory process takes emotion itself as input, evaluates it, and modifies it. This process consists of five steps that influence emotional experience: (a) *situation selection* (i.e., approaching or avoiding situations that may elicit emotions), (b) *situation modification* (i.e., modifying the emotional characteristics of a situation), (c) *attentional deployment* (i.e., directing attention toward or away from emotion-eliciting stimuli), (d) *cognitive change* (i.e., altering the appraisal of emotional information) and (e) *response modulation* (i.e., modifying the character or intensity of an emotion through response *to* that emotion). Gaining a deeper understanding of emotion regulatory processes, and how dysregulation may occur in these processes, may help researchers and clinicians to better understand the mechanisms through which emotion regulation interventions can impact symptoms of emotional disorders.

Regulating an affective experience generally serves to either increase or decrease that experience (Gross & John, 2003). Most research on regulation of depression-related affect has focused on strategies that upregulate or downregulate NA (e.g., rumination, cognitive reappraisal). Given that depression is also characterized by low PA, strategies used to regulate PA have been of increasing interest. *Savoring* involves cognitive or behavioral responses to positive events that enhance or upregulate the experience of PA (Feldman, Joormann, & Johnson, 2008), whereas *dampening* involves cognitive or behavioral responses to positive events that diminish or downregulate the experience of PA. Savoring has been positively associated with well-being and negatively associated with depressive and anhedonic symptoms in youth and adults (Bryant, 2003; Quoidbach, Berry, Hansenne, & Mikolajczak, 2010), and one study found preliminary evidence that savoring is associated with both higher cognitive reappraisal and lower expressive suppression (Irvin & Bell, 2017). Additionally, savoring has been negatively associated with other internalizing disorders (i.e., generalized anxiety disorder, specific phobia, panic disorder, and obsessive–compulsive disorder) after controlling for depressive symptoms (Eisner, Johnson, & Carver, 2009). Dampening also has been associated in predictable ways with affect (higher NA, lower PA), with both higher expressive suppression and lower cognitive reappraisal, and with higher symptoms of depression and anhedonia (Early & Bell, 2011; Irvin & Bell, 2017; Verstraeten, Vasey, Raes, & Bijttebier, 2012; Werner-Seidler, Banks, Dunn, & Moulds, 2013). Although savoring and dampening are typically considered adaptive and maladaptive strategies, respectively, emotion regulation is a complex process and strategies may not always be straightforwardly "good" or "bad." Situational variability can impact the utility of these strategies. For example, adverse life events can increase the impact of savoring (Croft, Dunn, & Quoidbach, 2014). Cultural factors may also play a role and specific strategies that are maladaptive in one culture may be adaptive in another when they fit the cultural script (Miyamoto & Ryff, 2011).

Research and theory stress that emotion regulation comprises both deliberate, top-down regulatory components (i.e., employing strategies to alter the experience of emotion) and spontaneous, bottom-up regulatory processes (i.e., unconscious, automatic engagement of mechanisms that affect the experience and modification of emotion; see Ochsner & Gross, 2005; Porges, Doussard-Roosevelt, & Maitia, 1994; Rodrigues, LeDoux, & Sapolsky, 2009). Research supports that both components might engage similar underlying neurophysiological responses (e.g., Ochsner & Gross, 2007; Ochsner et al., 2009; Otto, Misra, Prasad, & McRae, 2014) and that their joint and potentially interactive contributions are critical to understanding mental health and disease (e.g., Thayer & Brosschot, 2005). In the context of depression, savoring and dampening represent a top-down, deliberate form of emotion regulation, whereas neurophysiological responses to reward can be considered a bottom-up, spontaneous form of emotion regulation.

Both top-down and bottom-up factors may influence multiple steps in Gross's extended process model of emotion regulation. Carl, Soskin, Kerns, and Barlow (2013) note that attentional deployment, cognitive change, and response modulation may all comprise of both bottom-up tendencies and top-down processes. In fact, the authors note that at these three steps of the extended process model of emotion regulation (Gross, 2015), the *interaction* of these processes function to up- or downregulate PA. Savoring and dampening most often have been conceptualized as a part of cognitive change and response modulation, and even as attentional deployment (Carl et al., 2013). Thus, at multiple steps in the emotion regulation process, the top-down processes of savoring and dampening may interact with bottom-up responses in producing PA.

These two components may need to work in concert to ensure adaptive PA regulation. In other words, the effectiveness of a top-down PA regulation strategy, such as savoring, for mitigating symptoms of depression might depend on engagement of neural circuits underlying bottom-up PA regulation, and vice versa. Recent interventions aimed at increasing savoring have demonstrated initial effectiveness in improving resilience, depressive symptoms, and happiness over time (Smith & Hanni, 2019), so understanding these complexities in emotion regulatory processes may help elucidate the mechanism through which savoring impacts depressive symptoms. To date, no research has attempted to link individual differences in savoring and dampening with neurophysiological responses to reward. This was an important aim of the current study.

## Psychophysiological Responses to Reward and Emotion Regulation

Rewarding stimuli typically elicit a specific psychophysiological response associated with PA, whereas loss-related stimuli elicit a different psychophysiological response associated with NA (Schultz, 2004). The experience of both PA and NA elicited by reward may be dysregulated in some clinical samples, particularly individuals with depression (Forbes & Goodman, 2014; Luking, Pagliaccio, Luby, & Barch, 2016). Psychophysiological research examining reward sensitivity has focused on the Reward Positivity (RewP), a positive-going deflection in the event-related brain potential (ERP) peaking approximately 250 ms after feedback indicating gain, and the Feedback Negativity (FN), a negative-going deflection following feedback indicating loss (Foti & Hajcak, 2009; Proudfit, 2015). The RewP is thought to index a response to the receipt of reward versus loss, and has been conceptualized in some cases as a prediction error indicating integration of information about actions and outcomes (i.e., reward based upon a choice; Proudfit, 2015; Weinberg, Luhmann, Bress, & Hajcak, 2012). A blunted RewP has been associated with higher self-reported depressive symptoms (Foti, Carlson, Sauder, & Proudfit,

2014; Foti, Kotov, Klein, & Hajcak, 2011) and may be a marker of liability for depression that develops early in life and sustains into adulthood (Admon & Pizzagalli, 2015; Bress, Meyer, & Hajcak, 2015; Bress, Meyer, & Proudfit, 2015; Forbes & Goodman, 2014; Foti & Hajcak, 2009; Foti, Weinberg, Dien, & Hajcak, 2011; Pizzagalli et al., 2008). In short, a blunted neurophysiological response to reward may represent a bottom-up form of reward downregulation that, over time, contributes to downregulation of PA and, ultimately, to the experience of depression.

## The Current Study

A growing body of research supports the association of both self-reported PA regulation and the RewP to depression and its affective correlates. However, questions remain about how these two constructs may fit into the larger nomological network of depression as a disorder of affective experience and regulation. The current study extends existing work by testing associations between emotion regulation strategies and psychophysiological reward processing and exploring their relationships, individually and in combination, with depressive symptoms. We predicted that RewP amplitude elicited by gain versus loss feedback during a guessing task would be associated positively with trait savoring and negatively with trait dampening.

To the extent that self-reported savoring and dampening represent a self-directed or top-down form of PA regulation and the RewP reflects bottom-up PA regulation in response to reward, these two reflections of the positive valence system (Morris & Cuthbert, 2012) likely interact to determine the experience of depressive symptoms. The current study examines whether the combination of bottom-up/spontaneous and top-down/deliberate forms of PA regulation accounts for additional variance in depression-related outcomes beyond what either accounts for alone. Specifically, we predicted that use of PA regulation strategies would moderate the relationship between the RewP and depressive symptoms, such that the association between the RewP amplitude (elicited by gain vs. loss feedback) and depressive symptoms would be stronger among those whose top-down PA regulation style tends to rely on savoring or cognitive reappraisal. Examining the combination of top-down and bottom-up PA regulation may help explain the process through which associations between PA regulation and depression unfold.

In addition, the current study experimentally tested whether the functioning of the circuit that produces bottom-up/spontaneous regulation of responses to reward can be affected by implementing a brief, top-down PA regulation strategy. Individuals with emotional disorders often struggle with regulation of affect, and as compared with affect itself, emotion regulation strategies may be particularly amenable targets for change (Gross & Jazaieri, 2014). Identifying changeable correlates of depression is important for understanding how the disorder manifests and perpetuates, and for identifying potential targets for intervention (see Burkhouse et al., 2016). Modifying maladaptive emotion regulation (e.g., with cognitive reappraisal) has become a staple of evidence-based psychotherapy for a variety of psychopathologies (Aldao & Nolen-Hoeksema, 2010). To the extent that a PA regulation strategy like savoring can increase the magnitude of the RewP elicited by gain feedback in the lab, this could suggest that spontaneous sensitivity to reward delivery is amenable to clinical intervention; this, in turn, could suggest ways to reduce depressive symptoms through upregulation of PA in daily life.

We predicted that implementing a savoring strategy to upregulate responses to gain would increase the RewP, whereas implementing a dampening strategy to downregulate responses to gain would decrease the RewP. Additionally, we assumed that individuals would vary in their ability to successfully implement any PA regulation strategy and that this could influence the effectiveness of the intervention (i.e., size of the effect on the RewP). Thus, we predicted that self-reported success at implementing savoring or dampening would modulate these associations, such that those who reported more success at savoring would have a larger RewP than those who reported less success at savoring, and those who reported more success at dampening would have a smaller RewP than those who reported less success at dampening. In addition to the RewP, we also measured other ERP components related to emotion regulation (late positive potential; LPP) and attentional processes (P3). Analyses of these components are presented in the online supplemental materials because they are not central to the study's aims.

## Method

### Participants

The sample size for this study was determined with an a priori power analysis to ensure adequate power for primary analyses involving the full sample and supplementary hypothesis-testing involving between-groups comparisons. Previous research, primarily with clinical samples, has shown moderate associations between RewP amplitude and depressive symptoms (Foti, Kotov, et al., 2011; Foti, Weinberg, et al., 2011). Because we focused on individual differences within a nonclinical sample, we conservatively estimated power to detect a small to moderate effect. Alpha was set to 0.05. Power analyses were done for ordinary least squares (OLS) regression models using G*Power (Faul, Erdfelder, Buchner, & Lang, 2009); for multilevel models (MLMs) we used the *simr* package in R (Green & MacLeod, 2016), which simulates effects for various sample sizes for a multilevel model. Power analyses for OLS models indicated that $N = 90$ should be sufficient to detect a small to moderate ($f^2 = 0.10$) main effect within the full sample at 80% power. Power analyses for MLMs suggested that $N = 90$ participants should be sufficient to detect a small moderation effect if one exists within the full sample and to detect small main effects within subgroup samples ($N = 33$) at 80% power. To account for likely data exclusion due to issues arising during data collection, a sample of 100 undergraduates enrolled in introductory psychology courses was recruited (60% female; mean age = 18.5 years; 81% White/Caucasian, 7% Multiracial, 4% Native American or American Indian, 4% Hispanic or Latino, 3% Asian or Pacific Islander, and <1% Black or African American).

### Measures and Materials

**Self-reported depression and anhedonia.** Depressive symptoms were measured with the Mood and Anxiety Symptom Questionnaire (MASQ), a 90-item self-report measure developed by Watson et al. (1995) to assess the dimensions of Clark and Watson's tripartite model (Clark & Watson, 1991). This questionnaire consists of three subscales: Anhedonic Depression (AD; e.g., "During the past week, how much have you looked forward to things with enjoyment?"), Anxious Arousal (AA; e.g., "During the past week, how much have you felt like your heart was racing or pounding?"), and

General Distress (GD; e.g., "During the past week, how much have you felt hopeless?"). For each item, participants responded using a scale ranging from 1 (*not at all*) to 5 (*extremely*). This measure has high internal consistency and satisfactory convergent and discriminant validity among college students and adults (Watson et al., 1995). For the purposes of this study, we focused on the GD and AD subscales, which both showed excellent internal consistency in the current sample ($\alpha$s = 0.96).

**Positive affect regulation.** The use of specific strategies for regulation of PA was measured with the Emotion Regulation Profile-Revised (ERP-R; Nelis, Quoidbach, Hansenne, & Mikolajczak, 2011). The measure utilizes a vignette-based structure to examine types of savoring and dampening strategies people tend to use. The measure includes six vignettes, each constructed to evoke a particular type of PA: joy, excitation, pride, gratitude, contentment, and awe. For each vignette, participants choose the response options that reflect how they might respond to this type of situation. There are eight response options for each vignette, one for each type of dampening strategy (distraction, fault finding, suppression, and negative mental time travel) and savoring strategy (capitalizing, behavioral display, being present, and positive mental time travel). Dampening and Savoring scores are based upon the number of times respondents endorsed any dampening or savoring strategy. The ERP-R was originally constructed in French and was translated to English for a prior study (Irvin & Bell, 2017) and has demonstrated good internal reliability and convergent, divergent, incremental, and predictive validity (Nelis et al., 2011). In this sample, the dampening ($\alpha$ = .78) and savoring ($\alpha$ = .90) scores showed acceptable and excellent internal consistency, respectively.

**Domain-general emotion regulation.** In addition to the PA regulation strategies of primary interest here, participants also completed a measure of domain-general emotion regulation. Specifically, the 10-item Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) was used to measure the extent to which participants typically engage in Cognitive Reappraisal and Expressive Suppression. Given that the ERQ has been used much more frequently in research on emotion regulation than has the ERP-R, we thought it important to test (a) how reports of Savoring and Dampening correlated with responses to these ERQ subscales and (b) whether PA regulation strategies (Savoring and Dampening) relate to the RewP differently than do indices of domain-general emotion regulation. Participants used a 7-point scale anchored at 1 (*strongly disagree*) and 7 (*strongly agree*) to indicate their agreement with statements reflecting use of Cognitive Reappraisal (e.g., "When I want to feel more positive emotion [such as joy or amusement], I change what I'm thinking about") and Expressive Suppression (e.g., "I control my emotions by not expressing them"). Each ERQ subscale has high test–retest reliability and adequate convergent and discriminant validity among college students (Gross & John, 2003). In this sample, the Cognitive Reappraisal ($\alpha$ = .83) and Expressive Suppression ($\alpha$ = .77) scales demonstrated acceptable to good internal consistency.

**Doors Task.** Neurophysiological responses to gains and losses were measured during a Doors Task (see Proudfit, 2015). As depicted in Figure 1, on each trial, participants choose one of two identical schematic "doors" by clicking the left or right mouse button. Following the choice, a central fixation cross appears for 1 s, after which a visual feedback stimulus indicates whether their choice resulted in a "win" (upward-pointing ar-

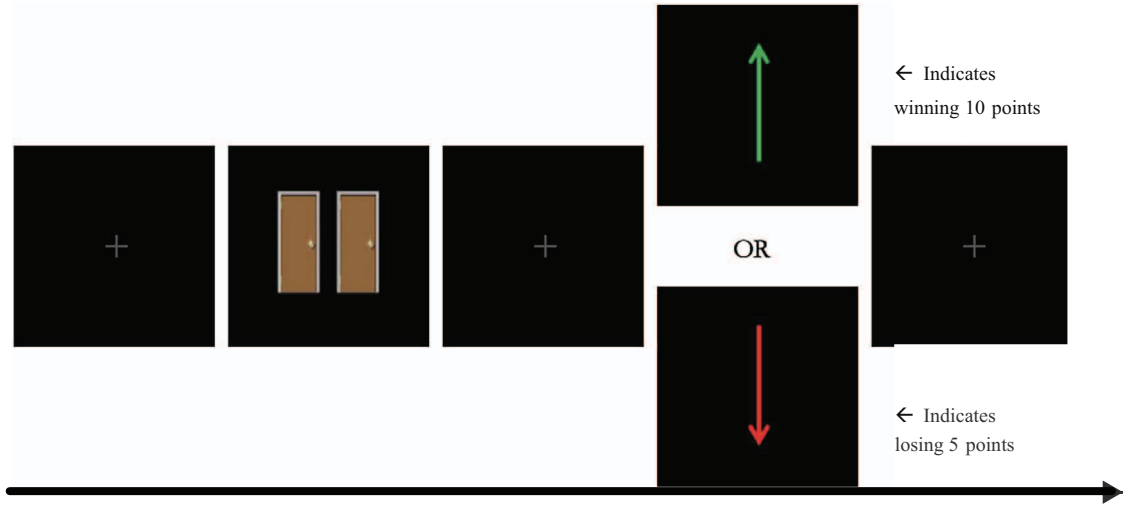


*Figure 1.* Structure of a single trial in the Doors Task. See the online article for the color version of this figure.

row) or a "loss" (downward-pointing arrow). Because losses are subjectively around twice as valuable as gains (Tversky & Kahneman, 1992)—and to ensure that participants accrue points over the course of the task—rewards are twice as large in magnitude as losses (10 points and 5 points, respectively). Participants were told they would receive a monetary incentive (entered into a raffle for either a $10, $25, or $50 gift card) based upon the number of points accumulated during the task. Presentation of gain and loss feedback was random and fixed to be equally probable within each of 10 blocks of 20 trials.

In the current study, participants completed the Doors Task twice, once to establish a baseline RewP amplitude and again under one of three randomly assigned sets of affect-regulation instructions (described next). Prior to completing the Doors Task for the first time, participants first completed a practice block consisting of six trials (half gain, half loss). During each task, participants were given 1-min breaks between each block. The Doors Task was administered on a 19-in. CRT monitor; E-prime 2 software (Psychology Software Tools, Inc., Sharpsburg, PA) was used to control presentation and timing of all events in the task.

**PA regulation manipulation.** After completing the Doors Task for the first time, participants were assigned via block randomization to one of three experimental conditions in which they were instructed to *savor* or *dampen* their PA, or they were given no instructions (*control*), when completing the Doors Task for a second time. To balance the potential influence of self-reported PA regulation, prior to assignment participants were classified into four groups based upon a median split of their ERP-R Savoring and Dampening scores: high savoring/high dampening, high savoring/low dampening, low savoring/high dampening, and low savoring/low dampening. Block randomization was monitored to ensure that there were approximately equal numbers of participants from each of the four groups represented in the three experimental conditions.

In the *savoring* condition, participants were instructed that when they received a green upward arrow indicating that they won 10 points, they were to do their best to savor that positive experience and any PA they felt along with it. In contrast, participants assigned to the *dampening* condition were instructed that when they received a green upward arrow, they were to do their best to dampen that positive experience and any PA they felt along with it. Participants in both conditions were given written descriptions of savoring or dampening strategies according to their condition assignment and demonstrated their understanding of their assigned strategy on a brief quiz prior to completing the second Doors Task. Following the task, participants in these two groups responded to a single item self-report measure of the effectiveness of their savoring or dampening: "How well do you think you were able to use savoring [dampening] strategies when you received positive feedback?" using a scale anchored at 1 (*Not well at all*) and 7 (*Very well*). Participants assigned to the *control* condition simply completed the second Doors Task as they had the first one, with no further instructions.

## Electrophysiological Recording and Analysis

EEG was recorded from 32 standard scalp locations based on the expanded 10–20 electrode placement system using tin electrodes fixed in an electrode cap (Electro-Cap International, Eaton, OH). The EEG was sampled continuously at a rate of 500 Hz (Neuroscan Synamps, Compumedics U.S.A., Charlotte, NC) and bandpass filtered online at .05–40 Hz. All scalp electrodes were referenced online to the right mastoid; an average mastoid reference was derived offline. A ground electrode was located at FPz. Vertical and horizontal electrooculogram were recorded using bipolar electrodes placed 1 in. above and below the center of the left eye and 1 cm lateral to both external canthi, respectively. Impedance values were kept below 10 KΩ at all electrodes. Ocular artifacts (i.e., blinks) were corrected offline using a regression-based procedure (Semlitsch, Anderer, Schuster, & Presslich, 1986). Following blink correction, feedback-locked epochs of 1,200 ms, including 100 ms prestimulus baseline, were derived from the continuous EEG. Epochs were baseline corrected and inspected for artifacts; epochs containing voltage deflections of ± 75 microvolts (μV) were discarded, as were trials that contained large muscle artifacts as determined by visual inspection. Following artifact removal and rejection, EEG data were averaged according to participant, electrode, and stimulus conditions.

Feedback-locked grand average waveforms showed a positive voltage deflection, maximal at fronto-central scalp locations, which was overlaid with a negative-going deflection on loss trials (the FN), occurring between 240 and 315 ms following feedback onset (see Figure 2). This positive voltage deflection was interpreted as the RewP, consistent with previous studies using the Doors Task (Foti & Hajcak, 2009; Foti et al., 2014). Following those previous studies, the RewP and FN were quantified as the average amplitude elicited on gain and loss trials, respectively, for each participant at each of nine fronto-central electrodes (F3, Fz, F4, FC3, FCz, FC4, C3, Cz, and C4). The signal detected at the trial-level has stable (i.e., waveform morphology, amplitude, and latency) and unstable (i.e., noise) characteristics, and averaging across trials for a mean amplitude for gain and for loss trials reduces noise that may occur at the trial level, ideally capturing an individual's stable RewP/FN response at each electrode (Spencer, 2005). Using this grouping of electrodes surrounding where the ERP of interest (i.e., the RewP) is most typically maximal (i.e., FCz) allows for increased information about the underlying neural source (Slotnick, 2005) and accounts for intraindividual differ-

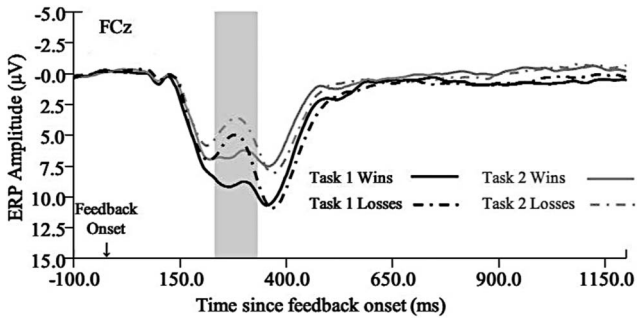


*Figure 2.* Grand average event-related potential (ERP) waveforms elicited by win and loss feedback in the first (Task 1) and second (Task 2) Doors Tasks. Waveforms depicted here were recorded at the fronto-central midline scalp site (FCz). Shading indicates the time window (240–315 ms following feedback onset) during which the ERP response to win feedback (RewP) and loss feedback (FN) was quantified.

ences in brain morphology that could cause variability in where the ERP is maximal. Use of data from multiple electrodes also ensures that data from more individuals can be included in the analyses, even if data at a given focal electrode (e.g., FCz) are unusable for some individuals. As in previous studies (Foti & Hajcak, 2009; Foti et al., 2014; Levinson, Speed, Infantolino, & Hajcak, 2017), ΔRewP was quantified for each participant as the difference between RewP and FN amplitude (RewP − FN).[1]

## Procedure

The study was reviewed and approved by the University of Missouri-Columbia Institutional Review Board. Participants completed the MASQ, the ERQ, and the ERP-R as part of an online questionnaire battery administered prior to their lab visit (intervals ranged from 1 to 87 days; $M = 23.1$ day). Upon arrival to the lab, participants read and signed an informed consent form and were given a general overview of the study procedures. Next, an experimenter led the participant to a quiet EEG recording room where recording electrodes were placed and tested.

Once the electrodes were in place, the experimenter explained the Doors Task and the monetary incentive then left the room and started the task. After completing six practice trials, participants completed 10 blocks (20 trials each) of the Doors Task. Next, the experimenter returned and announced a 5-min break, offering the participant water and a light snack. Then, following random assignment to condition (Savor: $N = 33$; Control: $N = 34$; Dampen: $N = 33$), the experimenter informed the participant either that it was time to complete the Doors Task again (for those in the control condition), or explained the relevant PA regulation instructions (for those in the savor and dampen conditions) prior to starting the second Doors Task. Participants also completed a measure of state affect, the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), once before the first Doors Task, a second time between the two administrations of the Doors Tasks, and again after the second Doors Task. See the online supplemental materials for results related to state affect.

Following the second Doors Task, electrodes were removed and participants were escorted to a nearby, private restroom where they could rinse the electrode gel from their face and hair. Upon returning to the experiment room, participants were debriefed about the full purpose of the study, given their course credit, thanked, and dismissed.

## Data Analysis

For all hypothesized statistical tests, a $p$ value of .05 was used to indicate statistical significance. OLS regression was used to test hypotheses involving ERP components as an independent variable. For all such models, the average ERP component amplitude across electrodes was derived to form a single ERP component measure. To account for the hierarchical structure of the ERP data (i.e., electrodes nested within subjects), all analyses in which ERP components were the dependent variable were carried out using MLMs with random intercepts for subject and electrode channel. To account for differences across participants in neural sources contributing to the ERPs of interest, and in numbers of electrodes contributing usable data to the analyses across trials and individuals, electrodes were nested within subjects. MLM is robust to occasional missing data (e.g., bad electrode channels for given participants; differing numbers of usable trials across participants), and specification of random intercepts for participants and electrode channels allows partitioning of unique sources of variance and accounts for individual differences in both baseline response and changes over time (Brush, Ehmann, Hajcak, Selby, & Alderman, 2018). These features make MLM ideal for analysis of multichannel ERP data (Goldstein, 2011; Page-Gould, 2017; Volpert-Esmond, Merkle, Levsen, Ito, & Bartholow, 2018).

Data from all self-report measures were examined for missing data and for normality, outliers, and heteroscedasticity of error. Self-report data from two participants were excluded for missing more than 50% of check questions. However, because these check questions only applied to the self-report portion of the study, these participants' ERP data were retained. In addition, ERP data from three participants were excluded due to excessive EEG artifact resulting in fewer than 75% usable trials (Luck, 2014). One participant had an outlying value (>3 *SD*s) for ΔRewP, and that value was winsorized (Blaine, 2018) prior to analyses.

To examine the extent to which the pattern of results from this study depends upon various data processing choices (Steegen, Tuerlinckx, Gelman, & Vanpaemel, 2016), we conducted a multiverse analysis, which is presented in the online supplemental materials. Results of this analysis indicate that, overall, the data processing choices made (i.e., artifact rejection criteria, check question cutoff point, data exclusion criteria, and treatment of outliers) did not significantly impact the pattern or statistical significance of the study's findings.

Table 1
*Average Amplitudes (μV) of the RewP, FN, and ΔRewP as a Function of Task Administration and Task 2 Experimental Group*

| Task | RewP | FN | ΔRewP |
|---|---|---|---|
| Doors Task 1 | 7.96 (4.46) | 5.22 (3.88) | 2.72 (2.47) |
| Doors Task 2 | 5.91 (4.09) | 3.79 (3.35) | 2.13 (2.31) |
| Savor | 6.43 (4.12) | 4.07 (3.73) | 2.35 (2.31) |
| Dampen | 5.96 (3.86) | 4.02 (2.98) | 1.94 (2.46) |
| Control | 5.39 (4.21) | 3.31 (3.53) | 2.08 (3.14) |

*Note*. RewP = reward positivity; FN = feedback negativity; ΔRewP = difference in amplitude elicited by win feedback and loss feedback. Values in parentheses are standard deviations.

# Results

## Preliminary Analyses

Average amplitudes (μV) of the RewP, FN, and ΔRewP as a function of task and experimental condition are shown in Table 1.

[1] Because some previous studies have shown that a residualized difference score between the RewP and FN is slightly more reliable than the traditional subtraction-based difference scores (Brush et al., 2018; Levinson et al., 2017), a RewP Residual variable was calculated to isolate reward-related activity. However, in all analyses where the RewP Residual was used in place of ΔRewP, all patterns of association and significance remained the same. Thus, all analyses examining the difference between RewP and FN used the more easily interpretable ΔRewP.

Consistent with previous work assessing psychophysiological reward processing, a paired samples $t$ test ($M_{difference} = 2.73$), indicated that overall, participants had a larger response to gains (i.e., the RewP) than losses (i.e., the FN), resulting in a generally positive difference score (i.e., ΔRewP). Inspection of the ERP waveforms elicited during the two Doors Tasks showed what appeared to be a considerable negative polarity shift during the second administration of the task, relative to the first (see Figure 2). More importantly, a paired-samples $t$ test indicated that ΔRewP was significantly smaller during Task 2 compared with Task 1, $t(872) = 7.03$, $p < .001$, $d = 0.59$, 95% CI [0.43, 0.76] (see Table 1). Given this change across tasks, and to account for the possibility that individual differences in the magnitude of this change could affect responses to the manipulation, analyses examining effects of the experimental manipulation of PA regulation (*savor*, *dampen*, or *control*) on ΔRewP during the second Doors Task, described later, included Task 1 ΔRewP as a covariate.

## Associations Among Affect and Emotion Regulation Measures

The magnitude of associations between self-report variables was estimated with bivariate correlations (see Table 2). These correlations generally supported hypothesized associations between PA regulation and depressive symptoms. Savoring was negatively related to Anhedonic Depression, and Dampening was positively related to scores on both General Distress and Anhedonic Depression. Moreover, Savoring and Dampening were associated in predictable ways with the domain-general emotion regulation strategies of Cognitive Reappraisal and Expressive Suppression. Specifically, Savoring was negatively correlated with Suppression and positively correlated with Reappraisal, whereas Dampening showed an opposing pattern. These patterns suggest that Savoring, like Reappraisal, may contribute to adaptive emotion regulation, whereas Dampening, like Suppression, may contribute to maladaptive emotion regulation.

## Task 1: Relationships Among Emotion Regulation and Psychophysiological Reward Processing

MLM analyses were used to examine hypothesized relationships between ERP amplitudes elicited during Task 1 and trait PA regulation scores (see Table 3). Contrary to hypotheses, trait PA regulation was not significantly associated with ΔRewP amplitude (Savoring: $p = .76$, $f^2 = 0.001$; Dampening: $p = .89$, $f^2 = 0.001$). Similarly, there were no significant relationships between general trait emotion regulation scores and the ΔRewP (Expressive Suppression: $p = .19$, $f^2 = 0.01$; Cognitive Reappraisal: $p = .23$, $f^2 = 0.01$).

## Task 1: Relationships of Emotion Regulation and Psychophysiological Reward Processing to Depressive Symptoms

Contrary to the findings of some previous research (e.g., Bress et al., 2015; Foti, Kotov, et al., 2011, 2014), separate MLMs indicated that depressive symptoms were not predicted by amplitude of ΔRewP (General Distress: $\beta = -0.01$, $SE = 0.01$, $t = -0.27$, $p = .79$, $f^2 = 0.001$, 95% CI [−0.02, 0.02]; Anhedonic Depression: $\beta = 0.01$, $SE = 0.01$, $t = 0.71$, $p = .48$, $f^2 = 0.004$, 95% CI [−0.01, 0.03]).

Given the lack of a significant association between ΔRewP and depressive symptoms, we were interested in whether individual differences in emotion regulation strategy use might play a role in the circumstances under which an association might emerge. Post hoc power analyses for OLS models indicated 75% power to detect a small to moderate ($f^2 = 0.10$) interaction effect but only 20% power to detect a small ($f^2 = 0.02$) interaction in the current sample. Although power to detect an interaction in the current study was limited to moderate to large effects, we were interested in exploring the possibility that the relationship between ΔRewP and depressive symptoms might be moderated by each of four emotion regulation strategies. Conceptually, if variation in emotion regulation moderates the association between ΔRewP and depressive symptoms, this would have implications for the potentially protective or detrimental effects of various emotion regulation strategies in the context of depression. However, because there was not adequate power to formally test these interactions, we consider these analyses to be exploratory. Thus, these findings should be interpreted with caution. Interactions involving each of these emotion regulation measures and Task 1 ΔRewP amplitude were tested in the context of separate multiple regression models (see Table 4).

Table 2
*Sample Means (and SDs) and Bivariate Correlations for Primary Self-Report Variables*

| Variable | PA | NA | ES | CR | GD | AD | Savoring | Savor success | Dampening |
|---|---|---|---|---|---|---|---|---|---|
| *M* | 31.03 | 18.08 | 15.59 | 29.72 | 40.83 | 51.60 | 15.52 | 4.45 | 4.26 |
| *SD* | 8.46 | 5.98 | 5.12 | 6.52 | 24.16 | 23.76 | 5.16 | 1.06 | 3.59 |
| NA | −.36*** | | | | | | | | |
| ES | −.44*** | .11 | | | | | | | |
| CR | .20 | −.19 | .06 | | | | | | |
| GD | −.49*** | .78*** | .10 | −.20 | | | | | |
| AD | −.85*** | .48*** | .41*** | −.25** | .63*** | | | | |
| Savoring | .51*** | −.13 | −.46*** | .29** | −.10 | −.45*** | | | |
| Savor success | .35 | −.01 | −.42* | .07 | .05 | −.28 | .26 | | |
| Dampening | −.30** | .52*** | .22* | −.12 | .48*** | .33*** | −.12 | .01 | |
| Dampen success | .13 | .11 | −.23 | .10 | .11 | .03 | .25 | NA | .20 |

*Note*. PA = positive affect; NA = negative affect; ES = expressive suppression; CR = cognitive reappraisal; GD = general distress; AD = anhedonic depression.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3
*Results From Models Regressing ΔRewP Amplitude on Trait PA Regulation*

| | ΔRewP | | | | |
|---|---|---|---|---|---|
| Measure | β | *SE* | *t* | *p* | 95% CI |
| Savoring | −0.01 | 0.05 | −0.31 | .76 | [−0.10, 0.07] |
| Dampening | 0.01 | 0.06 | 0.14 | .89 | [−0.12, 0.14] |
| Expressive suppression | 0.06 | 0.05 | 1.31 | .19 | [−0.03, 0.15] |
| Cognitive reappraisal | −0.04 | 0.04 | −1.21 | .23 | [−0.11, 0.03] |

*Note*. ΔRewP = difference in amplitude elicited by win feedback and loss feedback; PA = positive affect.

Separate models indicated that the relationship between general distress symptoms and ΔRewP amplitude was moderated by Savoring, $F = 9.16$, $p < .01$, Cognitive Reappraisal, $F = 7.23$, $p < .01$, and Expressive Suppression, $F = 10.38$, $p < .01$. Additional models showed that the relationship between anhedonic depression symptoms and ΔRewP amplitude was moderated by Cognitive Reappraisal, $F = 28.84$, $p < .001$ and, to a lesser extent, by Expressive Suppression, $F = 4.26$, $p = .04$. These interactions all had a similar form. Specifically, individuals with higher trait levels of Savoring and Cognitive Reappraisal and lower trait levels of Expressive Suppression showed the expected (negative) relationship between ΔRewP amplitude and depressive symptoms. However, individuals with lower trait levels of Savoring or Cognitive Reappraisal and higher trait levels of Expressive Suppression showed the opposite relationship, with greater ΔRewP amplitude relating to greater depressive symptoms. Notably, Dampening did not emerge as a moderator for either general distress or anhedonic depression.

## Task 2: Malleability of the RewP Through PA Regulation

Figure 3 shows feedback-elicited waveforms from the second Doors Task as a function of feedback type and group (also see Table 1). A MLM covarying Task 1 ΔRewP amplitude indicated that group significantly predicted ΔRewP in Task 2 ($\beta = -0.10$, $SE = 0.04$, $t = -2.76$, $p < .001$, $f^2 = 0.04$, 95% CI [−0.17, −0.03]). Specifically, participants in the savor group had a significantly larger ΔRewP in Task 2 compared with participants in the control group ($\beta = -0.25$, $SE = 0.07$, $t = -3.65$, $p < .001$, $f^2 = 0.09$, 95% CI [−0.39, −0.12]) and participants in the dampen group ($\beta = -0.36$, $SE = 0.08$, $t = -4.39$, $p < .001$, $f^2 = 0.06$, 95% CI [−0.52, −0.20]). Task 2 ΔRewP amplitude did not differ for participants in the control and dampen groups ($\beta = 0.10$, $SE = 0.08$, $t = 1.36$, $p = .17$, $f^2 = 0.01$, 95% CI [−0.05, 0.25]). In other words, relative to the control and dampening manipulations, the savoring manipulation was effective in maintaining a larger ΔRewP in Task 2.

## Task 2: PA Regulation Success

To the extent that effectively implementing top-down PA regulation varies across individuals, it should be the case that participants who felt they were more effective in savoring PA during wins would show a larger RewP during Task 2 than participants who felt their savoring attempts were less effective. Similarly, participants who were better able to dampen PA during wins theoretically should show a smaller Task 2 RewP than participants whose dampening efforts were less effective. We examined the relationship between RewP and PA regulation success within Task 2 only. Because our intervention was specific to regulation of PA to wins, for these analyses we examined effects of group on RewP

Table 4
*Results From Models Regressing Anhedonic Depression and General Distress, Respectively, on ΔRewP Amplitude, Emotion Regulation Strategies, Their Interactions, and Simple Slopes*

| | Anhedonic depression | | | | | General distress | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Measure | β | *SE* | *t* | *p* | 95% CI | β | *SE* | *t* | *p* | 95% CI |
| ΔRewP | 5.59 | 3.06 | 1.83 | .07 | [−0.49, 11.66] | 9.29 | 3.36 | 2.76 | <.01 | [2.61, 15.97] |
| Savoring | −1.13 | 0.70 | −1.61 | .11 | [−2.51, 0.27] | 1.36 | 0.77 | 1.77 | .08 | [−0.17, 2.88] |
| ΔRewP × Savoring | −0.33 | 0.19 | −1.71 | .09 | [−0.72, 0.05] | −0.64 | 0.21 | −3.02 | <.01 | [−1.07, −0.22] |
| Low savoring (−1 *SD*) | | | | | | 2.60 | 1.46 | 1.79 | .08 | |
| High savoring (+1 *SD*) | | | | | | −4.06 | 1.64 | −2.48 | .02 | |
| ΔRewP | −0.90 | 1.71 | −0.53 | .60 | [−4.30, 2.50] | −0.58 | 1.63 | −0.35 | .73 | [−3.82, 2.66] |
| Dampening | 1.40 | 0.93 | 1.51 | .14 | [−0.45, 3.24] | 3.17 | 0.88 | 3.59 | <.001 | [1.41, 4.92] |
| ΔRewP × Dampening | 0.30 | 0.25 | 1.21 | .23 | [−0.20, 0.80] | 0.03 | 0.24 | 0.14 | .89 | [−0.44, 0.51] |
| ΔRewP | −6.56 | 3.42 | −1.92 | .06 | [−13.36, 0.24] | −11.79 | 3.68 | −3.20 | <.01 | [−19.10, −4.49] |
| ES | 0.82 | 0.68 | 1.21 | .23 | [−0.53, 2.17] | −1.27 | 0.73 | −1.75 | .08 | [−2.73, 0.17] |
| ΔRewP × ES | 0.42 | 0.20 | 2.06 | .04 | [0.02, 0.82] | 0.70 | 0.22 | 3.22 | <.01 | [0.27, 1.13] |
| Low ES (−1 *SD*) | −2.18 | 1.53 | −1.43 | .16 | | −4.45 | 1.65 | −2.71 | <.01 | |
| High ES (+1 *SD*) | 2.09 | 1.37 | 1.53 | .13 | | 2.71 | 1.47 | 1.85 | .07 | |
| ΔRewP | 25.69 | 4.80 | 5.36 | <.001 | [16.16, 35.21] | 13.79 | 5.46 | 2.53 | .01 | [2.96, 24.63] |
| CR | 1.81 | 0.60 | 3.01 | <.01 | [0.61, 3.00] | 0.79 | 0.68 | 1.16 | .25 | [−0.57, 2.15] |
| ΔRewP × CR | −0.88 | 0.16 | −5.37 | <.001 | [−1.20, −0.55] | −0.50 | 0.19 | −2.69 | .01 | [−0.87, −0.13] |
| Low CR (−1 *SD*) | 5.37 | 1.32 | 4.06 | <.001 | | 2.22 | 1.50 | 1.47 | .14 | |
| High CR (+1 *SD*) | −6.05 | 1.54 | −3.92 | <.001 | | −4.29 | 1.75 | −2.45 | .02 | |

*Note*. ES = expressive suppression; CR = cognitive reappraisal; ΔRewP = difference in amplitude elicited by win feedback and loss feedback. Simple slopes are provided for significant interactions.

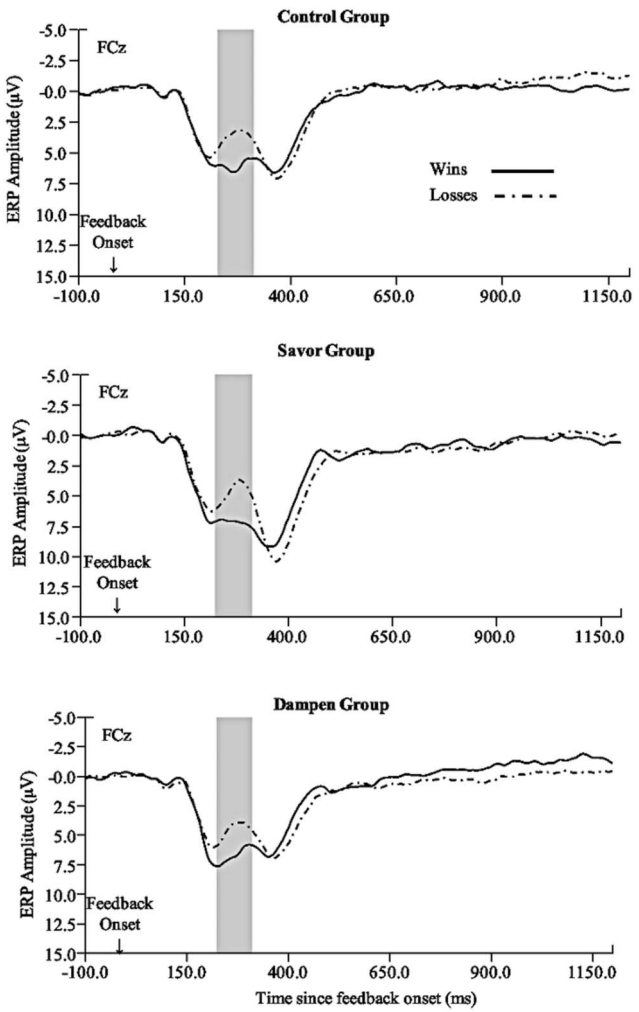


*Figure 3.* Grand average event-related potential (ERP) waveforms elicited by win and loss feedback in the second Doors Task as a function of experimental groups. Top panel: Control group. Middle panel: Savor group. Bottom panel: Dampen group. Waveforms depicted here were recorded at the fronto-central midline scalp site (FCz). Shading indicates the time window (240–315 ms following feedback onset) during which the ERP response to win feedback (RewP) and loss feedback (FN) was quantified.

amplitude rather than ΔRewP amplitude. Within the second Doors Task only, savor success predicted a larger RewP ($\beta = 1.96$, $SE = 0.52$, $t = 3.78$, $p < .001$, $f^2 = 0.30$, 95% CI [0.94, 2.98]), whereas dampen success was unrelated to RewP amplitude ($\beta = 0.76$, $SE = 0.48$, $t = 1.59$, $p = .12$, $f^2 = 0.07$, 95% CI [−0.18, 1.70]).

Finally, because we found an overall diminution of RewP between the two administrations of the task, we conducted post hoc analyses to examine whether participants reporting higher levels of savor success maintained a more robust RewP across tasks than participants reporting lower levels of savor success and whether participants reporting higher levels of dampen success showed greater diminution of RewP across tasks than participants with lower levels of dampen success. Change in RewP amplitude across tasks was calculated as Task 2 RewP − Task 1 RewP. Although dampen success did not significantly predict change in RewP amplitude across tasks ($\beta = 0.05$, $SE = 0.35$, $t = 0.14$, $p = .89$, $f^2 = 0.001$, 95% CI [−0.63, 0.72]), savor success did ($\beta = 0.58$, $SE = 0.28$, $t = 2.04$, $p < .05$, $f^2 = 0.10$, 95% CI [0.03, 1.12]). Specifically, participants who reported that they were able to effectively savor wins in the second Doors Task experienced a smaller reduction in RewP from the first to the second administration of the task.

## Discussion

The current study aimed to examine (a) the extent to which bottom-up/spontaneous (i.e., psychophysiological reward processing) and top-down/deliberate PA regulation (i.e., Savoring and Dampening) are uniquely associated with depression-related symptoms; (b) whether the combination of top-down and bottom-up PA regulation factors accounts for additional variance in depression-related outcomes beyond what either accounts for alone; and (c) whether directed PA regulation can affect the functioning of the circuit that produces the bottom-up/spontaneous regulation of reward responses. Overall, results from the current study support that PA regulation and psychophysiological reward processing are largely independent forms of regulation, but preliminary evidence suggests that they may work together to help explain the experience of depressive symptoms in a nonclinical, emerging adult sample. Importantly for clinical intervention, the results suggest that the RewP may be malleable in response to affect-regulation interventions. Taken together, these results add to a growing body of evidence supporting savoring as an important PA regulation strategy for preventing or reducing the impact of depression. This study also helps extend the evidence base to support these relationships in emerging adults and to demonstrate that PA regulation interventions may be effective in changing neurophysiological correlates of depression.

The current results were only partially consistent with previous findings showing a negative association between feedback-elicited ΔRewP amplitude in the Doors Task and symptoms of depression. In the current data this predicted association did not emerge as a main effect, but in exploratory analyses, the effect was moderated by individual differences in trait PA regulation styles. Individuals who reported higher levels of trait savoring and cognitive reappraisal and lower levels of expressive suppression showed a negative association between the ΔRewP and depressive symptoms similar to what previous reports have shown (Foti & Hajcak, 2009; Foti, Kotov, et al., 2011). However, for individuals who reported lower levels of trait savoring and cognitive reappraisal and higher levels of expressive suppression, ΔRewP was either unassociated or was associated positively with depressive symptoms. These findings suggest that understanding the experience of depressive symptoms may require consideration of bottom-up sensitivity to reward in conjunction with deliberate, top-down strategies for regulating one's reward-related experiences, especially in emerging adults.

A recent meta-analysis of studies examining neurophysiological responses to reward in depression found a stronger blunting of reward-related neurophysiological activity in samples younger than 18 years of age than in samples older than 18 (Keren et al., 2018). This finding may reflect that bottom-up mechanisms of emotion regulation play a larger role in depression during child-

hood, when top-down PA regulation strategies are less well-established than in adulthood (see Martin & Ochsner, 2016; van Duijvenvoorde, Zanolie, Rombouts, Raijmakers, & Crone, 2008). Thus, whereas in childhood the association between blunted ΔRewP and depression is more straightforward, as people mature into adulthood this association might increasingly depend on variability in top-down PA regulation strategies. Here, individuals whose neurophysiological responses to reward were relatively strong but who fail to deliberately savor PA, as well as those who report regularly attempting to savor PA but whose neurophysiological responses to reward were blunted both report relatively high levels of depressive symptoms. Thus, neither process alone appears sufficient to protect against the experience of depressive symptoms.

Of greater importance for consideration of the clinical relevance of PA regulation, the current results suggest that the bottom-up circuitry producing responsiveness to reward might be malleable to a PA savoring strategy. The results of the experimental manipulation of PA regulation provide some evidence that individuals with blunted bottom-up reward responsivity could be coached to enhance their reactivity to reward through savoring or other PA regulation strategies, and that engaging in these strategies could enhance bottom-up, spontaneous responses to reward. Specifically, individual differences in the successful implementation of the savoring strategy were associated with the magnitude of the savoring effect, such that participants who were better able to savor wins during Task 2 experienced a smaller reduction in their neural responses to reward across tasks compared with participants who were less successful at savoring. This suggests that effective top-down enhancement of reward-related affect can bolster bottom-up reward sensitivity, which otherwise declines over repeated activations.[2] Moreover, in the face of a general decline in ΔRewP across administrations of the Doors Task, savoring wins was effective in helping to maintain reward responsiveness across tasks. However, we note that this finding was a post hoc analysis and should be interpreted with caution.

Taken together, these findings provide mechanistic evidence for the process through which savoring and depressive symptoms may be related. As noted previously, identifying changeable mechanisms for depressive symptoms is critical for intervention and prevention efforts. Given the current results, it is possible that a longer-term, chronic change in reward responsiveness—and, thereby, the experience of depression symptoms—could be affected using a programmatic, sustained intervention. This, along with examination of other facets of reward processing (e.g., reward learning) that may be impacted by affect interventions, are exciting areas for future research.

It is important to consider the current results in the context of several limitations of the study. The current study focused on current depressive symptoms assessed via the MASQ subscales of General Distress and Anhedonic Depression, rather than a clinical diagnosis of Major Depressive Disorder. Such symptom-level assessment might not adequately capture the phenotype most associated with reward responsivity. Bowyer et al. (2019) found that RewP magnitude covaried with persistent depressive conditions but not with current depressive symptoms, indicating that a blunted RewP may reflect an impaired reward learning capacity that is associated with risk for depression. The difference in our methodology and that of Bowyer et al. could help to explain why we failed to observe the predicted simple, bivariate association between RewP and depressive symptoms here, and why this association was moderated by participants' reported use of top-down PA regulation strategies. Further, in our assessment of emotion regulation, we used a vignette-based measure that does not account for how situational variability might impact the adaptiveness of specific strategies in regulating particular types of positive affect.

Additionally, the relatively small incentives in the Doors Task may have reduced participants' motivation to attend to the task and their interest in the task feedback. Although we did provide some incentive (i.e., varying levels of gift card raffles to be entered into), it is possible that this probability of reward not inherent to the task itself might introduce additional noise into the data.

Another limitation of the current study was its small sample size and the subsequent exploratory nature of the analyses examining how emotion regulation may moderate the association between psychophysiological reward processing and depression. Our results indicate that emotion regulation may play a role in this relationship; however, more research with larger samples is needed to better test these relationships.

In addition, the cross-sectional nature of the study—and the fact that the sample were all emerging adults—limits our ability to understand the mechanism(s) through which emotion regulation might affect symptoms of depression. It is possible that adaptive affect-regulation influences the sensitivity of the spontaneous reward-processing system, which in turn might influence the experience of depressive symptoms. If so, it could be that individual differences in the emergence of PA regulation during adolescence play a key role in modulating the association between reward responsivity and depression. Ideally, these mechanisms can be studied in the context of a longitudinal investigation aimed at disentangling their temporal associations, which could help determine whether PA regulation is causally related to depressive symptoms. Future work also could assess the stability of savoring and dampening in daily life (e.g., using ecological momentary assessment) and whether that stability is linked to depressive symptoms.

In conclusion, findings from this study extend previous work on reward processing and depression (Foti et al., 2014; Foti, Kotov, et al., 2011) by providing preliminary evidence of an interplay between top-down, deliberate forms of PA regulation and bottom-up, stimulus-driven reward responsiveness as reflected in the RewP in understanding variability in depressive symptoms. Results also indicate that modification of top-down forms of PA regulation (i.e., savoring) may impact bottom-up forms of PA regulation, which has novel and valuable implications for prevention and intervention efforts for those at-risk for or with depression.

[2] Although some previous research indicates that the RewP is relatively stable within a 60-trial version of the Doors Task (Bress et al., 2015), to our knowledge no studies have demonstrated the RewP's stability within or across tasks using a larger number of trials, as in the paradigm used here.

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