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Affective Flexibility: Relations to Expressive Flexibility, Feedback, and Depression

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Abstract

Theory and research on emotion regulation have shifted from emphasizing the adaptiveness of specific strategies to flexible regulation. Studies on the modulation of emotional expression, or expressive flexibility (EF), have demonstrated a close link between flexibility and psychological adjustment. The present study extended this line of research to the modulation of subjective emotional experience. We developed the affective flexibility (AF) task, which measures individual differences in the ability to up-regulate and down-regulate subjective feeling. We examined relations between AF and EF tasks, and how each task related to feedback and depression. Performance on the two tasks was moderately correlated. Feedback did not modulate task performance, but there was an overall improvement in AF over time. Improvement in AF abilities were incrementally associated with lower depression. Specifically, after controlling for change in expressive abilities, improvements in up-regulation and down-regulation of affect were each significantly inversely associated with depression.

Keywords

affective flexibility, depression, feedback

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In the past several decades, a great deal of research has documented the important role emotion regulation plays in psychological adjustment (Gross, 2014). Much of the initial research and theory on emotion regulation has suggested that certain strategies, such as cognitive reappraisal, were inherently adaptive, whereas other strategies, such as expressive suppression, were generally maladaptive (for reviews, see Aldao, Nolen-Hoeksema, & Schweizer, 2010; John & Gross, 2007). More recently, however, a growing body of data has illuminated the important moderating role of contextual factors (Aldao, 2013; Tamir, 2009; Troy, Shallcross, & Mauss, 2013) and has suggested that the efficacy of particular strategies varies across situations and individuals (Bonanno & Burton, 2013). Based on such findings, researchers and theorists have increasingly emphasized the importance of flexibility in coping and emotion regulation (Bonanno, Papa, Lalande, Westphal, & Coifman, 2004; Cheng, 2001; Kashdan & Rottenberg, 2010; Levy-Gigi et al., 2015).

An essential feature of flexible emotion regulation is the availability of a diverse repertoire of regulatory strategies that can be deployed in various emotional situations (Aldao, 2013; Bonanno & Burton, 2013). Focusing in particular on emotional expression, Bonanno and colleagues (2004) developed an experimental paradigm, the expressive flexibility (EF) task, to measure individual differences in the ability to enhance (or up-regulate) and suppress (or down-regulate) emotional expression. In the task, participants were shown emotionally provocative images and instructed to report their emotional reactions to the stimuli. Next, they were informed that another participant in the adjacent room would view them on a video monitor and try to guess their emotions. On some trials, participants were

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instructed to be as expressive as possible so that the observer could more easily guess their emotions (enhancement condition). On other trials, they were instructed to conceal their emotions (suppression condition). Finally, on some trials, participants were told the monitor was turned off, that the observer could not see them, and that they should behave as they normally would (view condition). Participants' facial expressions were recorded while they performed the task and then rated for emotion by independent observers watching video recordings. Results from the EF task showed that participants modulated their expressions in accordance with the regulatory instructions while maintaining relatively consistent levels of subjective emotion across the instruction conditions. More important, both the ability to enhance and the ability to suppress emotional expression independently predicted better adjustment among New York college students 2 years after the 9/11 terrorist attacks (Bonanno et al., 2004). Findings from the EF paradigm were subsequently replicated in a series of studies that extended the link between EF and psychological adjustment to other stressor contexts, including cumulative life stress (Westphal, Seivert, & Bonanno, 2010), the death of a spouse (Gupta & Bonanno, 2011), and combat experiences among veterans (Rodin et al., 2017).

However, despite the effectiveness of the EF task in measuring regulatory flexibility and predicting psychological adjustment, it does not provide useful information on the regulation of subjective feeling, a form of emotion regulation that is conceptually related to, but also distinct from the modulation of facial expression. Studies investigating the convergence of emotional responses have typically found only small to moderate correlations among experiential, expressive, and physiological measures (e.g., Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005; Mauss & Robinson, 2009; Reisenzein, 2000), suggesting that different emotional response systems are only "loosely coupled" (e.g., Bonanno & Keltner, 2004). Furthermore, diverse conceptualizations of emotion regulation all highlight the broad spectrum of possible regulatory behaviors, and posit that modulation can occur at any stage and with any aspect of emotional responding (e.g., Buck, 1984; Gross, 1998b; Thompson, 1994). Subsequent empirical research has shown that regulatory strategies aimed at specific emotional components lead to divergent consequences (Gross, 1998a, 2001). More specifically, voluntary control processes that target emotional expression versus subjective experience (through cognitive reconstruction of the emotional stimulus) have been found to recruit distinct brain regions (e.g., Kim & Hamann, 2007; Ochsner et al., 2004) and to involve different neurophysiological patterns with regard to the timing and amplitude of activation (e.g., Goldin, McRae, Ramel, & Gross, 2008; see Cutuli, 2014, for a review).

Dissociation between the regulation of emotional experience and expression is also evident across various forms of psychopathology, in that different mental disorders are characterized by regulatory deficits in different emotional response channels (see Kring & Sloan, 2009, for a review). For example, people with schizophrenia typically show little facial expression in response to emotional events, but report a similar and sometimes greater level of subjective affect, compared with normal controls (Kring & Werner, 2004). By contrast, mood and anxiety disorders, as well as several personality disorders (e.g., borderline personality disorder), are defined by predominant difficulties in regulating subjective emotional experiences (e.g., Campbell-Sills & Barlow, 2007; Campbell-Sills, Barlow, Brown, & Hofmann, 2006).

Taken together, theory and research converge to suggest that the modulation of emotional experience and the modulation of emotional expression are related but separate regulatory processes, with differential impact on psychological health or pathology. Therefore, from the repertoire flexibility perspective (Bonanno & Burton, 2013), it is plausible that affective flexibility (AF)—the ability to modulate subjective feeling—may substantively differ from EF. Furthermore, the two forms of flexibility may be independently associated with adjustment. The current study addresses this issue by introducing a novel experimental paradigm, the AF task, which explicitly focuses on the regulation of the subjective experience of emotion. The AF task is similar to the EF task with the crucial difference that participants are instructed to up-regulate (enhance) and down-regulate (suppress) their subjective feeling of emotion rather than their outward expression of emotion.

The AF task also addresses several methodological limitations in the EF task. First, the ecological validity of the EF task is to some extent compromised in that it instructs participants to modulate facial expression of emotion, an inherently social behavior, in the nonsocial context of sitting alone in a room in front of a computer monitor. The AF task is arguably a more naturalistic task because it specifically targets the subjective experience of affect and does not entail a social component. Second, the EF task typically relies on deception by telling participants that they are communicating facial expression to an observer in another location when in fact there is no observer, which may introduce response biases and invoke potential ethical considerations (Ortmann & Hertwig, 1997). The AF task removes these concerns, as it does not require deception.

Emotion regulation researchers typically use self-report data as a measure of subjective affect. In the context of instructed affect regulation, however, self-report is highly susceptible to demand characteristics. For this reason, we chose to use facial electromyography (EMG) to assess affective experience in the AF task (Bonanno & Burton, 2013). This approach has proved effective (Jackson, Malmstadt, Larsen, & Davidson, 2000) and replicable (e.g., Birk & Bonanno, 2016; Deveney & Pizzagalli, 2008) and has been shown to function independently of shifts in visual attention (Urry, 2010). Furthermore, facial EMG has proved sensitive to variations in affective experience in the absence of and, to some extent, independent of visible facial displays of emotion (e.g., Cacioppo, Martzke, Petty, & Tassinary, 1988; Tassinary & Cacioppo, 1992) and has produced similar results regardless of whether participants knew the experimental hypotheses or reported believing a cover story (Davis et al., 1995). Finally, a recent functional MRI study has shown that EMG corrugator responses to unpleasant pictures were positively correlated with patterns of neurophysiological activation typically associated with negative affect (Heller, Lapate, Mayer, & Davidson, 2014), thus providing direct support for using EMG-based measurements as an indicator of affective experience.

In the current study, we asked participants to engage in both the AF and EF tasks. Apart from EMG response, we also collected measures of self-reported emotion and observer ratings of emotional expression in the AF task to examine variation in different response systems across regulatory conditions. We expected EMG responses to be moderately correlated with both self-report and observer ratings of expression as reported in previous studies (e.g., Mauss et al., 2005). Because modulation of experience and expression of emotion may represent distinct regulatory processes, we expected EMG responses in the AF task and observer ratings of expression in the EF task to show only small to moderate correlations with each other.

In addition to the importance of strategy repertoire, flexible emotion regulation also requires the ability to monitor regulatory efficacy and to adjust regulatory efforts when needed (Birk & Bonanno, 2016; Bonanno & Burton, 2013; Kalisch, 2009). The capacity to monitor and adjust behavior is a fundamental component of learning and control theory and has long been viewed as a key process in psychological theories of self-regulation (Bandura, 1991; Carver & Scheier, 1998). The adaptive significance of sustaining or readjusting coping efforts following an unfavorable outcome has also been highlighted in the revised model of coping (Folkman, 1997, 2008). Similarly, feedback control has been emphasized in theories of emotion regulation from the developmental (Thompson, Lewis, & Calkins, 2008), social cognitive (Pennebaker & Roberts, 1992), and more general perspectives (Gross, 1998b; Gross & Thompson, 2007). In Gross's influential process model, emotion regulation is defined as a series of emotion-generative cycles that unfold cyclically over time, beginning each cycle anew in response to feedback arising from the effects of the previous cycle (Gross, 1998b; Gross & Thompson, 2007). In other words, regulatory efforts do not end with the generation of a regulatory response; rather, specific regulation efforts may produce changes in the eliciting event, leading to the generation of additional cycles of regulatory processes, whereas unsuccessful regulation may result in strategy adjustment—continuous and reciprocal processes that are linked by feedback (Gross & Thompson, 2007; Kalisch, 2009).

A growing body of research has highlighted the link between the ability to utilize regulatory feedback and mental health. For example, a questionnaire study showed that self-reported ability to monitor coping strategy efficacy and to implement alternative strategies when necessary was associated with reduced anxiety and depression (Kato, 2012). Similarly, an experimental paradigm designed to assess the use of internal affective and physiological feedback showed that frequent emotion-regulation strategy change was associated with greater life satisfaction, but only among participants who also showed high sensitivity to internal feedback (Birk & Bonanno, 2016). The association between psychological functioning and adjustment to feedback in emotion regulation is also consistent with cognitive and neuropsychological findings of abnormal neural response to negative feedback (e.g., Elliott, Sahakian, Michael, Paykel, & Dolan, 1998; Santesso et al., 2011; Taylor Tavares et al., 2008) and the absence of or impairment in subsequent behavioral adjustment among individuals with elevated depressive symptoms (e.g., Elliott, Sahakian, Herrod, Robbins, & Paykel, 1997; Holmes & Pizzagalli, 2007; Murphy, Michael, Robbins, & Sahakian, 2003; Steele, Kumar, & Ebmeier, 2007). For example, Holmes and Pizzagalli (2007) examined behavioral adjustments following positive and negative feedback on performance in different experimental tasks (e.g., Stroop and Simon tasks). The results showed that highly depressed individuals made significantly less adjustment in accuracy and reaction time after error or conflict trials following negative performance feedback, suggesting an impaired ability to utilize feedback to adjust behavior and learn over time.

In the present study, we examined the role of feedback on regulatory flexibility and its relation to depression. Participants were randomly assigned to one of two groups. In the feedback group, participants received predetermined negative feedback on their performance upon completion of the AF and EF tasks, respectively, and were then instructed to repeat each task. Participants assigned to a no-feedback control group were simply asked to repeat each task after a brief interval. By comparing regulatory performance across the initial and later phases of the tasks, we were able to examine the specific effects of feedback on regulatory flexibility. We predicted that individuals with higher depression levels would show less improvement following feedback compared to those with lower depression levels. Because we believe that AF and EF differ in important ways, we predicted that each type of flexibility would be independently associated with depression level.

In addition, because the AF and EF tasks were novel to the participants, we expected that they would show improvement in regulatory ability over time even without feedback, due to practice effects. We predicted that the practice effects would be smaller than the feedback effects. Because learning by practice requires action monitoring and involves sensitivity to internal or self-generated feedback (Birk & Bonanno, 2016; Nicol & Macfarlane-Dick, 2006), and because this capacity is compromised for individuals with suboptimal functioning (e.g., Elliott et al., 1997; Holmes & Pizzagalli, 2007), we predicted that there would also be an inverse relationship between improvement in regulation and depression level in the control group.

Method

Participants

Participants were recruited through Craigslist advertisements and flyers posted on public notice boards. The advertisements and flyers contained a brief message describing a study on how people regulate their emotions, and invited those interested to e-mail or call the research team to receive more information. There were no exclusion criteria in the recruitment phase for the purpose of obtaining a diverse sample, which could potentially increase variability in the variables of interest and improve generalizability of the findings. Out of the 100 subjects who participated in the study, data from three participants were excluded (two provided invalid EMG data and one did not believe the feedback manipulation), leading to a total sample of 97. Participants (48 females, 48 males, and 1 participant who did not provide information on gender) ranged from 19 to 62 years in age (M = 34.39, SD = 11.52). The racial/ethnic composition of the sample was diverse, including 36 African Americans (37.1%), 18 Asians or Asian Americans (18.5%), 25 Caucasians (27.8%), and 18 who identified as mixed race (18.6%). Socioeconomic status was not assessed. The feedback (n = 57) and control (n = 40) groups did not differ in age, gender, or race/ethnicity (ps > .10).

Procedure

Participants completed a packet of questionnaires comprising demographic questions and a measure of depression, and subsequently undertook the EF and AF tasks in a counterbalanced order. Upon completion of both tasks, participants in the feedback group answered questions about the perceived accuracy and believability of the feedback manipulation. Finally, all participants were fully debriefed and received $20 as compensation.

Questionnaires

Depression level. The 11-item abbreviated version of the Center for Epidemiological Studies Depression Scale (Kohout, Berkman, Evans, & Cornoni-Huntley, 1993) was used to assess depression level (i.e., total score; Cronbach's α = .86). The feedback and control groups did not differ on this measure (p > .10).

Feedback debriefing questions. Two questions assessed participants' perception of the accuracy of the feedback: (a) "How accurate do you think the feedback about your physiological response presented during the experiment was?" (b) "How accurate do you think the feedback about your emotional expression presented during the experiment was?" The third question asked about the believability of the feedback manipulation: "How likely do you think it is that the two pieces of feedback provided during the experiment were truly based on your performance?" Each question was rated on a 5-point Likert-type scale (1 = *not at all*, 5 = *extremely*).

AF task

Prior to the task, physiological sensors were applied to the participants by a trained experimenter. Following guidelines for EMG placements, facial muscular activity was recorded from two electrodes placed on the corrugator supercilii muscle as an indicator of negative affect (Fridlund & Cacioppo, 1986). Participants were presented with blocks of negatively valenced pictures selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008) and instructed on different blocks of trials to either enhance or suppress their subjective feelings, or simply view the pictures. In the enhancement condition, participants were instructed to increase the intensity of the emotions they felt in response to the pictures. In the suppression condition, participants were instructed to decrease the intensity of the emotions they felt in response to the pictures. In the view condition, participants were instructed to respond to the pictures naturally and to not attempt to modify their emotions in any way.

Following practice trials, participants completed three negative picture blocks, each randomly paired with one of the affective regulation instructions (enhancement, suppression, or view), along with one neutral picture block with view instructions as the baseline. Each block consisted of 10 consecutively presented pictures with each picture presented for 7 s. The valence and arousal levels of the pictures were equalized across the three experimental blocks. A full description of the instructions was presented prior to each block, and a one-word prompt ("Increase," "Decrease," or "View") was presented for 1 s prior to each picture as a reminder of the instructions. Upon completion of each block, participants rated the degree of negative emotions they felt in response to the pictures on a 7-point Likert-type scale (1 = *no emotion*, 7 = *extreme emotion*).

Participants were filmed by an unobtrusive camera placed on top of the computer monitor. Corrugator activity was recorded continuously during the task using the wireless BioNomadix system (Biopac, Goleta, CA). EMG data were acquired using the MP150 WSW system with the AcqKnowledge 4 software (Biopac, Goleta, CA). Signals were sampled at 1000 Hz.

EF task

The EF task was adapted from the paradigm developed by Bonanno and colleagues (2004). For practice, participants viewed a block of five negative pictures selected from the IAPS (Lang et al., 2008) and, following the block, rated the degree of negative emotions they felt in response to the pictures on the same 7-point scale used in the AF task. Participants were then informed that another participant in the study would view them on a monitor in another location and attempt to determine their emotions in response to each picture based on their facial expressions. Participants were further asked to follow the instructions presented on different blocks of trials to (a) enhance their facial expressions so that the observing person could more easily determine their emotions, (b) suppress their facial expressions so that the observing person would not be able to determine their emotions, or (c) simply behave naturally because the monitor would be turned off during these trials. Following practice trials, participants completed three randomly presented five-picture blocks (enhancement, suppression, view), with each picture presented for 7 s. As in the AF task, participants rated their emotional responses to the pictures upon completion of each block. Participants were filmed continuously throughout the experimental task.

Feedback manipulation

Participants in the feedback group received predetermined feedback on their performance upon completion of the AF and EF tasks, respectively. The feedback presentation included a 30-s wait time to increase believability, followed by a written statement of the feedback, also lasting for 30 s. The feedback instructions stated that the participant performed below the average level found in previous research and that he or she should try harder to improve performance when the task was repeated. The control participants received a statement simply instructing them to take a break (60 s) and then proceed to the second half of the task. All participants subsequently repeated the AF and EF tasks. The order of the blocks was kept identical for each participant in the two task phases to control for block order effects.

Data reduction and analysis

AF task. EMG data were processed using MATLAB software (MathWorks, Natick, MA) with the ANSLAB algorithms (Wilhelm & Peyk, 2005). Raw corrugator EMG was first notch-filtered at 60 Hz to eliminate ambient noise and highpass-filtered at 10 Hz. The data were then resampled at 400 Hz, rectified and smoothed with a 16-Hz lowpass filter, and finally decimated to 4 Hz. Artifacts were corrected during data processing. Values larger or smaller than four standard deviations from the within-subjects mean were eliminated on a second-by-second basis. Mahalanobis distances across regulatory conditions and task phases were computed to detect multivariate outliers using a significance criterion of $p < .001$. Approximately 95.1% of the data were retained following the procedures (ranging from 98.4% to 92.3% across experimental conditions). Videotapes of participants' facial expressions were rated by two observers who were blind to the experimental design and hypotheses. Raters viewed the video files on a computer monitor individually and rated the average level of negative emotion they perceived from each participant's facial expressions across each block on the same rating scale used by the participants. The average ratings of the two raters were used in the final analysis (ICC = .84).

EF task. Similar to the AF task, participants' facial expressions were rated by independent observers, and the average ratings across four raters were used in the final analysis (ICC = .84).

Results

Preliminary analyses did not reveal any main effect of gender, age, or race/ethnicity, nor did these factors moderate depression level or any of the significant affective-regulation or expressive-regulation findings reported (.10 < *p*s < .99). There was no main effect or interaction effect of the order of the two tasks (.16 < *p*s < .87). Accordingly, these variables were excluded in subsequent analyses. Follow-up tests in the analyses were corrected using the Bonferroni adjustment to reduce Type I errors.

AF task

Manipulation check. Paired *t*-tests were performed to compare mean scores of the negative picture view condition versus the baseline neutral picture view condition for the three emotion indices. All tests converged to indicate that negative pictures effectively elicited negative emotion. Participants reported more negative affect when viewing negative pictures (M = 4.81, SD = 1.33) relative to neutral pictures (M = 2.09, SD = 1.37), $t(96)$ = 18.38, $p < .001$, d = 2.34. Participants also showed more negative facial expressions when viewing negative pictures (M = 2.22, SD = 1.02), compared to neutral pictures (M = 1.93, SD = 0.36), $t(95)$ = 6.93, $p < .001$, d = 0.36. Finally, negative pictures (M = 12.83, SD = 7.69) elicited greater corrugator activity than did neutral pictures (M = 8.62, SD = 0.49), $t(96)$ = 7.49, $p < .001$, d = 2.08.

Next, separate ANOVA analyses were performed on subjective affect, observed expression, and corrugator EMG, with condition (enhancement, suppression, view) and phase (1, 2) as within-subjects variables, and feedback group (control, feedback) as a between-subjects variable. Figures 1a to 1c present mean subjective affect, observed expression and corrugator EMG across affective regulatory conditions and task phases for the control and feedback groups. There was a main effect of condition for subjective affect, $F(2, 96)$ = 46.01, $p < .001$, η^2 = .49. Follow-up analyses indicated that participants reported more subjective affect in the enhancement condition (M = 5.43, SD = 0.13) and less subjective affect in the suppression condition (M = 4.18, SD = 0.15), compared to the view condition (M = 4.81, SD = 0.14), *p*s < .001, d = 1.69 and d = 1.67, respectively. There was also a significant Condition × Phase × Group three-way interaction, $F(2, 96)$ = 5.58, $p < .05$, η^2 = .09. For the control group, subjective affect did not change from Phase 1 to Phase 2 in any of the three regulatory conditions (*p*s > .10). In contrast, participants from the feedback group reported more negative affect under the enhancement condition (p = .019, d = 0.92) and marginally less negative affect under the suppression condition following feedback (p = .075, d = 0.78). There was no change in affect under the view condition prior to and following feedback instructions (p = .103).

For observed expression of emotion, there was also a significant main effect of condition, $F(2, 88)$ = 35.44, $p < .001$, η^2 = .45. Participants showed more expression in the enhancement condition (M = 2.92, SD = 0.13), and less expression in the suppression condition (M = 1.84, SD = 0.07), relative to the view condition (M = 2.24, SD = 0.11), *p*s < .001, d = 1.95 and d = 1.31, respectively. The Condition × Phase two-way interaction was nonsignificant, $F(2, 88)$ = 1.37, p = .261, η^2 = .03, as was the Condition × Phase × Group three-way interaction, $F(2, 88)$ = 1.58, p = .211, η^2 = .04, indicating that practice and feedback instructions did not have any effect on the observed expression in the AF task.

As predicted, the main effect of condition for corrugator EMG was highly significant, $F(2, 94)$ = 14.62, $p < .001$, η^2 = .24. Instructions to enhance subjective feelings led to greater corrugator activity (M = 16.37, SD = 1.33), whereas instructions to suppress feelings led to less corrugator activity (M = 10.37, SD = 0.57), compared to the view instructions (M = 12.96, SD = 0.80), *p*s < .001, d = 3.36 and d = 3.06, respectively. Participants also showed greater overall corrugator activity in Phase 2 (M = 13.71, SD = 0.89) than in Phase 1 (M = 12.72, SD = 0.80), $F(1, 95)$ = 4.61, p = .034, d = 1.07. This main effect was qualified by a marginal Phase × Condition interaction, $F(2, 94)$ = 2.86, p = .062, η^2 = .06. Follow-up analyses indicated that corrugator response levels under the suppression and view conditions were comparable across the two task phases (*p*s > .10), whereas there was an increase in corrugator activity when participants were enhancing their feelings in Phase 1 relative to Phase 2 (p = .011, d = 2.01), indicating improvement in regulation over time, particularly with the ability to up-regulate feelings. However, the three-way interaction of Condition × Phase × Group that represents feedback effects failed to achieve significance, $F(94, 2)$ = 1.76, p = .178, η^2 = .04. Taken together, these results suggest that although affective modulation, as indexed by corrugator activity, improved with time, performance feedback alone did not lead to enhanced modulation.

Reliability and validity of AF task. Intertrial reliability and test–retest reliability were calculated to examine internal consistency of the EMG data (Varghese, Hui-Chan, Wang, & Bhatt, 2014). Data were reorganized to obtain the mean corrugator activity for each picture (i.e., trial) across the 7 s presentation period. Intertrial reliability was measured by the range of correlations between trial means across regulatory conditions, task phases, and groups (Varghese et al., 2014). Cronbach's alpha ranged

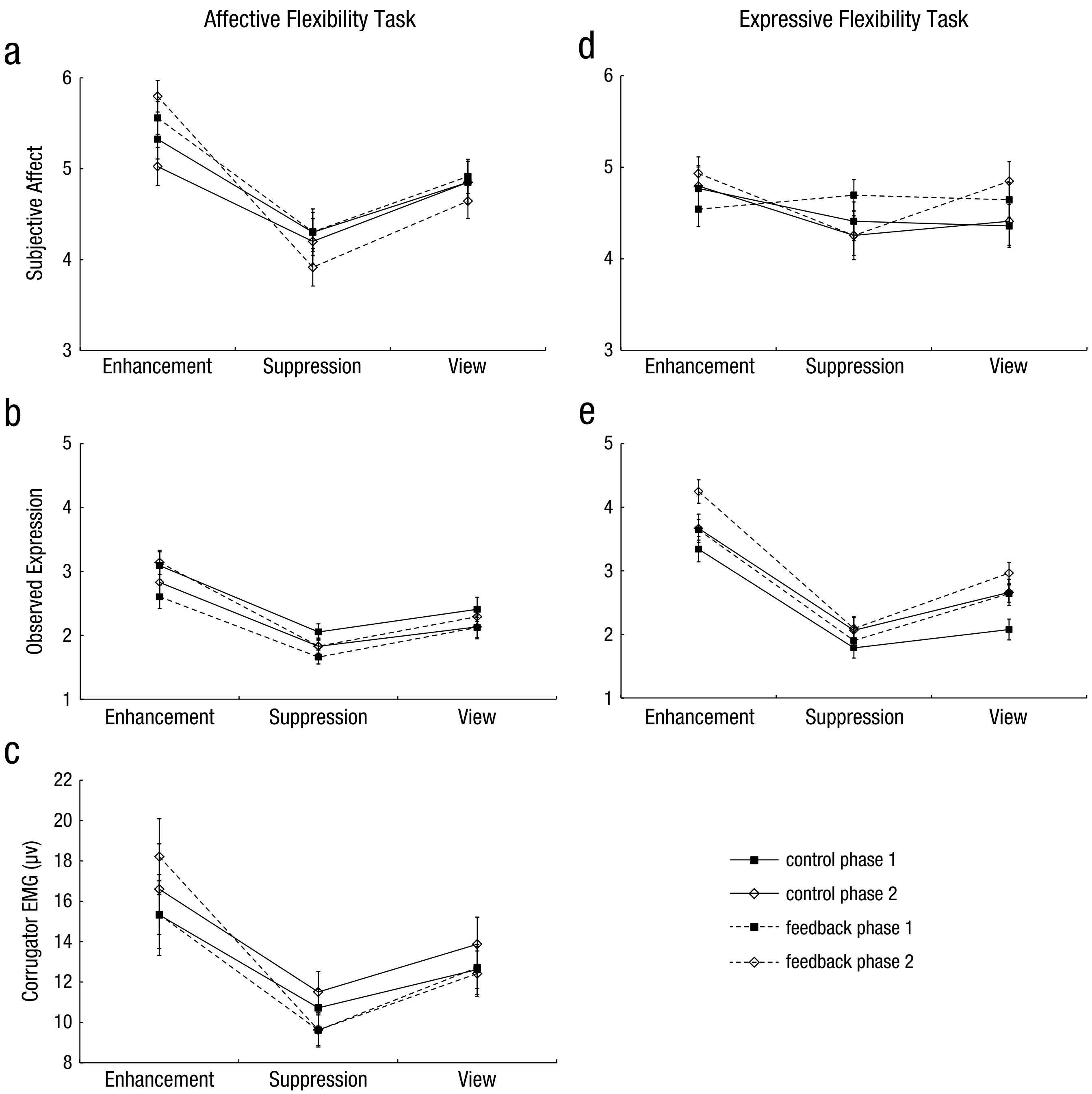

Fig. 1. Means of subjective affect, observed expression in affective flexibility and expressive flexibility tasks, and EMG corrugator response in the affective flexibility task for the three regulation conditions across two task phases for the control and feedback groups.

from .69 to .98, demonstrating moderately high intertrial reliability. Test–retest reliability was measured by comparing the means of corrugator activity in the first versus second task phases. The range of Cronbach's alpha was .69 to .84 across the three affective regulatory conditions for the control and feedback groups, indicating adequate test–retest reliability. We report the incremental validity of the AF task in the hierarchical regression analyses investigating the relationship between improvement in regulatory flexibility and depression level.

EF task

Similar to the AF task, subjective affect and observed expression from the EF task were examined in separate ANOVAs, with condition (enhancement, suppression,

Table 1. Correlations of Measures From the Affective Flexibility and Expressive Flexibility Tasks

	1	2	3	4	5	6	7	8	9	10
1. AF corrugator EMG—enhance	—									
2. AF corrugator EMG—suppress	−.04	—								
3. AF subjective affect—enhance	.02	−.19	—							
4. AF subjective affect—suppress	−.10	.22*	−.40**	—						
5. AF facial expression—enhance	.60***	−.22*	.13	−.22*	—					
6. AF facial expression—suppress	.06	.56**	−.21*	.20	−.30**	—				
7. EF facial expression—enhance	.39**	.06	.11	.03	.25*	.01	—			
8. EF facial expression—suppress	−.02	.29**	.06	−.04	−.19	.34*	−.16	—		
9. EF subjective affect—enhance	−.10	−.04	.00	.03	−.08	.00	.23*	−.06	—	
10. EF subjective affect—suppress	.11	−.11	.10	−.19	.11	−.10	−.06	.21*	.41**	—

Note: AF = affective flexibility; EF = expressive flexibility.
*$p < .05$. **$p < .01$. ***$p < .001$.

view) and phase (1, 2) as within-subjects variables, and feedback group (control, feedback) as a between-subjects variable. Figures 1d and 1e present mean subjective affect and observed expression scores in the expressive regulatory conditions across two task phases for the feedback and control groups. Previous studies with the EF task have consistently reported similar levels of subjective affect across different expressive regulatory conditions (e.g., Bonanno et al., 2004; Westphal et al., 2010). However, we observed a small main effect of condition for subjective affect, $F(2, 95) = 6.48$, $p < .01$, $\eta^2 = .12$, which was qualified by a significant Condition × Phase interaction effect, $F(2, 95) = 5.15$, $p < .01$, $\eta^2 = .10$. Follow-up tests revealed that the interaction was driven by the phase effect. Participants reported slightly less subjective affect in the suppression condition ($M = 4.26$, $SD = 0.17$) relative to the view condition ($M = 4.63$, $SD = 0.17$) in Phase 2, $p = .022$, $d = 0.91$, whereas subjective affect remained the same in the enhancement and view conditions across task phases. No significant results were observed for task phase or group status (ps >.05), indicating that there were no practice or feedback effects on subjective affect in the EF task.

The main effect of condition for observed expression was highly significant, $F(2, 94) = 81.59$, $p < .001$, $\eta^2 = .53$. Consistent with previous studies (Bonanno et al., 2004; Westphal et al., 2010), emotional expression was greater in the enhancement condition ($M = 3.52$, $SD = 0.13$) and reduced in the suppression condition ($M = 1.86$, $SD = 0.10$), compared to the view condition ($M = 2.42$, $SD = 0.11$), ps < .001, $d = 3.24$ and $d = 1.73$, respectively. The Condition × Phase interaction was nonsignificant, and feedback group status did not produce a significant main effect or interaction effects (ps >.10), suggesting that there were no practice or feedback effects on expressive regulation.

Relation of AF and EF

We examined the relationship between AF and EF using only data from the first task phase to minimize the impact of feedback and practice for this comparison. We first calculated regulatory ability scores. *Enhancement ability* was calculated by subtracting each participant's score in the view condition from his or her score in the enhancement condition; *suppression ability* was calculated by subtracting each participant's score in the suppression condition from his or her score in the view condition. Correlations of the ability scores across different emotional response systems in the two tasks are presented in Table 1. Similar to prior studies (e.g., Mauss et al., 2005), the multiple components of emotion within each task showed small to moderate correlations with one another. More important, consistent with our hypothesis, there was a moderate correlation between the ability to enhance emotional expression in the EF task and the ability to enhance subjective affect, measured by corrugator activity, in the AF task ($r = .39$, $p < .01$). Also, the ability to suppress emotional expression in the EF task was moderately correlated with the ability to suppress subjective affect, measured by corrugator activity, in the AF task ($r = .29$, $p < .01$). The results suggest that AF and EF may represent related but distinct aspects of a broader regulatory flexibility ability.

Is improvement in AF and EF over time associated with lower depression level?

Improvement in the ability to enhance emotion over time (i.e., change score) was calculated by subtracting each participant's enhancement ability score in Phase 1 from the corresponding score in Phase 2. Similarly,

Table 2. Hierarchical Regression Predicting Depression Level by the Change in the Ability to Enhance and Suppress Expression (Observed Expression) and Subjective Feelings (Corrugator Electromyography) Over Time

	β	F_{change}	R^2_{change}	PCor
Step 1		1.893	0.040	
EF enhance (change)	–0.49			–.15
EF suppress (change)	0.29			.09
Step 2		2.236†	0.091	
EF enhance (change)	–0.66*			–.20
EF suppress (change)	0.29			.09
AF enhance (change)	–0.14*			–.20
AF suppress (change)	–0.21*			–.21
Step 3		0.150	0.002	
EF enhance (change)	–0.69*			–.21
EF suppress (change)	0.28			.09
AF enhance (change)	–0.14*			–.21
AF suppress (change)	–0.21*			–.22
Feedback group	0.38			.04
Step 4		1.315	0.053	
EF enhance (change)	0.69			.07
EF suppress (change)	0.97			.10
AF enhance (change)	–0.23			–.19
AF suppress (change)	–0.42			–.27
Group	0.01			.01
EF enhance (change) × Group	–1.02			–.08
EF suppress (change) × Group	–0.58			–.13
AF enhance (change) × Group	0.14			.20
AF suppress (change) × Group	0.40			.10

Note: AF = affective flexibility; EF = expressive flexibility; Group = feedback group status (feedback vs. control); PCor = partial correlation.
†$p < .10$. *$p \leq .05$.

improvement in the ability to suppress emotion over time was calculated by subtracting each participant's suppression ability score in Phase 1 from the corresponding score in Phase 2.

To examine whether overall improvement in AF and EF from Phase 1 to Phase 2 was associated with reduced depression, and whether change in AF would incrementally predict depression over and above the variance accounted for by change in EF, we conducted a two-step hierarchical regression analysis for depression level. In this analysis, changes in expressive enhancement and suppression were entered on the first step, and changes in affective enhancement and suppression were entered on the second step (Table 2). On the first step, neither EF change variable was meaningfully related to depression level. On the second step, both change in affective enhancement ($\beta = -0.14$, $p = .05$, Cohen's $f^2 = .04$) and change in affective suppression ($\beta = -0.21$, $p < .05$, Cohen's $f^2 = .05$) were found to be associated with less depression. In this step, improvement in enhancing emotional expression also showed a significant negative correlation with depression level ($\beta = -0.67$, $p = .05$, Cohen's $f^2 = .04$).

Subsequently, we entered feedback group status (Step 3) and interactions of group status and change scores (Step 4) into the model to examine whether performance feedback modulated the relation between improvement in regulatory flexibility and depression level (Table 2). Results indicated that adding these variables did not improve model fit, nor did the variables yield significant associations with depression level.

Finally, we examined the possible moderating role of perceived accuracy of feedback in the association between change in regulation over time and depression level. No significant correlation was observed between the degree of perceived accuracy of feedback and change in regulatory abilities (ps > .10), suggesting that the observed relationship between regulatory flexibility and depression was unaffected by perception of the feedback.

Discussion

Previous research has examined individual differences in EF—the ability to enhance (up-regulate) and suppress (down-regulate) facial expression of emotion—and has provided solid evidence for the link between this type of flexibility and healthy adjustment (e.g., Bonanno et al., 2004; Gupta & Bonanno, 2011; Rodin et al., 2017; Westphal et al., 2010). One of the goals of the present study was to extend this line of investigation to individual differences in the flexible modulation of subjective affect. We developed a novel experimental paradigm, the AF task, focusing explicitly on the ability to enhance and suppress subjective experience of emotion. The AF task showed adequate internal consistency, as measured by intertrial reliability and test–retest reliability (Varghese et al., 2014). The AF task also addresses several methodological limitations of the EF task, removing the need for deception and utilizing a more ecologically valid experimental design.

The second goal of this study was to examine whether negative performance feedback might improve regulatory ability, and whether the improvement would be associated with lower levels of depression. The artificial feedback manipulation produced inconsistent effects on expressive and affective regulation across different response systems. Expressive regulation was unaffected by the feedback instructions and did not show practice effects over time. For affective regulation, self-reported affect showed improvements with feedback, whereas corrugator EMG responses showed overall improvement due to practice. These inconsistent results could be a consequence of the small sample size. They might also suggest that the current feedback manipulation was insufficient to produce reliable effects on regulatory behaviors. Although bogus performance feedback has been shown to induce meaningful individual differences in cognitive tasks (e.g., Elliott et al., 1998; Holmes & Pizzagalli, 2007), the effect of this type of feedback tends to diminish quickly over time (Holmes & Pizzagalli, 2007). The one-time feedback presented in the current study thus might not have been sufficiently proximal to self-monitoring and behavioral adjustment processes on later trials to influence performance (Bandura, 1991). Future research could utilize trial-by-trial feedback manipulation to examine this possibility. Furthermore, although the postexperimental questionnaire suggested that participants believed the feedback was genuine and that there was no relation between perceived accuracy of feedback and improvement in regulation, it is still plausible that the experimental feedback in some way interfered with participants' natural learning processes. One way to examine this issue would be to ask participants to evaluate their own performance before providing external feedback; the association of change in regulation and evaluation-feedback discrepancy would render more conclusive evidence on the effects of experimentally manipulated feedback.

Although the feedback manipulation did not meaningfully alter performance, general improvement in AF over time due to practice was inversely related to depression level. Given that learning by practice requires action monitoring and involves sensitivity to internal or self-generated feedback (Birk & Bonanno, 2016; Nicol & Macfarlane-Dick, 2006), our findings are thus consistent with the corpus of research demonstrating that dysphoric individuals tend to be less able to adjust their behavior following feedback (Elliott et al., 1997; Holmes & Pizzagalli, 2007; Murphy et al., 2003).

Improvement in EF was less clearly related to depression. Change in expressive enhancement showed an inverse relationship to depression level, whereas change in expressive suppression was unrelated to depression level. One possible explanation is that there was a floor effect as participants showed very little expression in the suppression condition even in the first phase of the task. A second possible explanation is related to the fact that people with suboptimal functioning readily use expressive suppression to down-regulate their emotions (Gross & John, 2003); therefore, it is plausible that dysphoric individuals were actually more adept at this type of regulatory skill, leading to the null results observed in the study.

The AF and EF tasks demonstrated comparable modulation across multiple emotion response systems and performance on the two tasks was moderately correlated, suggesting that the two types of regulation may reflect a broader underlying regulatory flexibility capacity. However, AF and EF also differed in important ways. First, there was a dissociation of subjective affect and facial expression in the EF task as participants reported comparable affect and yet successfully modulated expression across regulatory conditions. By contrast, in the AF task subjective affect, expression, and corrugator EMG showed consistent variations across conditions. Furthermore, as discussed earlier, improvement in AF was more robustly associated with lower levels of depression, compared to EF, suggesting that each type of flexibility may have differential benefits.

From a conceptual perspective, the ability to flexibly adjust facial expressions of emotion according to situational demands has been proposed to be particularly protective in aversive life events (e.g., Bonanno et al., 2004; Westphal et al., 2010). In the present study, we examined one particular form of psychological adjustment, as represented by lower depression level, which showed a stronger association with changes in AF than

EF, but we did not include a measure of aversive life events. These results point to the possibility that various aspects of flexibility may differentially impact health, with EF more salutary in the context of specific stressors, and AF more beneficial with general stress. Research investigating the predictive utility of the two forms of regulatory flexibility for psychological outcome under extreme stressors, is needed to further illuminate the nature and relation of these capacities. Examination of the similarities and differences between EF and AF could also facilitate a deeper understanding of the distinct emotional regulation deficits associated with different mental disorders (Kring & Sloan, 2009).

Several limitations of the study warrant further discussion. As an effort to increase ecological validity, the AF task did not restrict the type of strategies that could be used to enhance or suppress affect. Although participants were explicitly instructed to regulate their subjective feelings and there was less variation in observed expression across regulatory conditions as compared to that in the EF task (see Figures 1b and 1e), we could not preclude the possibility that some participants relied on expressive modulation to regulate affect (see John & Gross, 2007), with changes of expression being captured as subjective affect in EMG. One way to overcome this limitation would be to instruct participants to use regulatory strategies that do not directly target expressive behaviors, such as cognitive reconstruction of the situation, or distraction from the emotional event (see Webb, Miles, & Sheeran, 2012, for a review of emotion regulation strategies). Comparison and contrast across multiple studies adopting different types of regulatory strategies could further verify the utility of EMG as a measure of affective states in the context of instructed regulation. Finally, although the current study included a diverse range of participants with regard to race/ethnicity, gender and age, our small sample size prohibited exploration of the impact of these factors on regulatory abilities (e.g., Blanchard-Fields, Stein, & Watson, 2004; Butler, Lee, & Gross, 2007; McRae, Ochsner, Mauss, Gabrieli, & Gross, 2008). Particularly relevant to feedback control is research evidence suggesting that Westerners and non-Westerners tend to differ in attentional allocation to internal signals versus external feedback in making behavioral adjustments (e.g., Kanagawa, Cross, & Marcus, 2001; Ma-Kellams, Blascovich, & McCall, 2012; Morris & Peng, 1994). An important agenda for future research would be to investigate possible cultural variation in the source of feedback that guides emotion regulation processes.

In sum, the present study contributes to the growing body of research on emotion regulation by extending the investigation of regulatory flexibility from the modulation of emotional expression (e.g., Bonanno et al., 2004) to the modulation of subjective affect. Although more research is needed to further illuminate the different properties of the two forms of flexibility, the current results suggest that AF is related to EF but also represents a distinct capacity. The study also extends research on depression and performance adjustment by showing that individuals with elevated depression levels were less able to improve in regulatory flexibility, in particular in affective experience, over time.

Author Contributions

G. A. Bonanno developed the study concept, and both authors contributed to the study design. Z. Zhu conducted data analysis under the guidance of G. A. Bonanno. Z. Zhu drafted the early versions of the article. G. A. Bonanno provided critical revisions. Both authors approved the final version of the article for submission.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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