Composure at Any Cost? The Cognitive Consequences of Emotion Suppression

Jane M. Richards
James J. Gross
Stanford University

We frequently try to appear less emotional than we really are, such as when we are angry with our spouse at a dinner party, disgusted by a boss's sexist comments during a meeting, or amused by a friend's embarrassing faux pas in public. Attempts at emotion suppression doubtless have social benefits. However, suppression may do more than change how we look: It also may change how we think. Two studies tested the hypothesis that emotion suppression has cognitive consequences. Study 1 showed that suppression impaired incidental memory for information presented during the suppression period. Study 2 replicated this finding and further showed that suppression increased cardiovascular activation. Mediational analyses indicated that physiological and cognitive effects were independent. Overall, findings suggest that emotion suppression is a cognitively demanding form of self-regulation.

It goes without saying that life has its ups and downs. Ups come when we get long-sought job promotions, when we are told jokes that are funny, when people who we adore reciprocate our tender feelings, and when sunny weather puts a spring in our step. But sometimes we do not get those promotions or the people of our dreams. And with respect to the jokes and weather? Sometimes they are just plain awful.

These and countless other emotion-eliciting events—both momentous and mundane—impinge on us and give rise to the emotions of everyday life. However, the events that unfold around us by no means dictate our emotional lives. We actively shape both our environments and our emotions (Gross, 1998). Recent questionnaire, interview, and experience sampling studies attest to the frequency with which people attempt to influence which emotions they have, when they have them, and how they experience and express these emotions (Gross, Feldman, Barrett, & Richards, 1999; Morris & Reilly, 1987; Thayer, Newman, & McClain, 1994). In particular, people seem to inhibit emotion-expressive behavior. When interviewed about a recent time when they tried to regulate their emotions, half our respondents described situations in which they attempted to inhibit outward signs of emotion. Moreover, among undergraduates who kept diaries of their emotion regulatory experiences during a 14-day period, inhibiting emotion-expressive behavior was reported almost one quarter of the time (Gross et al., 1999).

We refer to inhibiting overt emotion-expressive behavior as *emotion suppression* (Gross & Levenson, 1993). To examine the affective consequences of this form of emotion regulation, we have elicited emotion using films and have induced emotion suppression using specific instructions (Gross, 1998; Gross & Levenson, 1993, 1997). Results of these studies indicate that adults are generally quite successful at inhibiting overt signs of emotion-expressive behavior, even when they feel high levels of emotion. Although emotion suppression decreases outward signs of emotion, it has little effect on emotion experience, and it actually increases sympathetic activation, as evidenced by greater peripheral vasoconstriction and greater electrodermal responding (Gross, 1998). Thus, emotion suppression allows us to appear calm, cool, and collected on the outside. But on the inside, we experience just as much emotion and even more physiological activation than we do when we freely express our emotions.

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This research shows that emotion suppression influences our expressive and physiological reactions to emotion-eliciting events. But are the effects of emotion suppression really limited to the affective realm? Or might suppression affect cognitive functioning as well? This is the question that motivated the present research. Specifically, we tested whether emotion suppression has consequences for how well people can remember the events that transpire as they suppress their emotions.

In the following sections, we derive two general hypotheses by juxtaposing research showing that emotion suppression leads to sympathetic activation (Gross, 1998; Gross & Levenson, 1993, 1997) with the immense literature linking physiological arousal with various indices of performance (e.g., Christianson, 1992; Easterbrook, 1959; Neiss, 1988; Wine, 1971). Interestingly, these hypotheses regarding the cognitive consequences of emotion suppression are diametrically opposed to one another.

Emotion Suppression Enhances Memory

One hypothesis is that emotion suppression—with its elevated sympathetic activation—should enhance memory. This hypothesis derives from evidence that memory storage and consolidation processes are improved by physiologically based treatments that increase physiological activation (for a review, see McGaugh, 1983). Several studies, for example, suggest that the physiological arousal associated with increases in epinephrine and catecholamine activity leads to stronger memory encoding via effects on glucose memory systems (e.g., Gold, 1987; Lee, Graham, & Gold, 1988) or the delivery of oxygen and glucose to the brain, respectively (for a review, see McEwen & Sapolsky, 1995). These conclusions are buttressed by a recent study that selectively blocked the effects of sympathetic activation, thereby producing decrements in memory performance (Cahill, Prins, Weber, & McGaugh, 1994). Taken together, these findings suggest that if emotion suppression is sufficiently arousing, memory for events that co-occur with suppressed emotion should be better than memory for events that co-occur with expressed emotion.

Emotion Suppression Degrades Memory

A second hypothesis is that emotion suppression should degrade memory. This hypothesis derives from research linking sympathetic activation with decreased performance on both cognitive and sensorimotor tasks (for reviews, see Christianson, 1992; Easterbrook, 1959; Neiss, 1988). For example, Lacey and Lacey (1974) showed that increases in heart rate and blood pressure blunt sensory reception, thereby compromising the event encoding processes that produce memory. In light of findings such as these, we might expect emotion suppression—with its elevated sympathetic activation—to decrease cognitive functioning. Therefore, we might expect that memory for events that co-occur with suppressed emotion should be worse than memory for events that co-occur with expressed emotion.

The Present Research

To examine the cognitive consequences of emotion suppression, we conducted two studies. Study 1 tested whether suppression had an impact on memory. Study 2 sought to replicate the memory findings of Study 1 and to directly assess (a) whether suppression increased sympathetic activation and (b) whether sympathetic activation mediated the observed effects of emotion suppression on memory.

STUDY 1

Five criteria must be met to examine the cognitive consequences of emotion suppression: (a) Cognitive consequences of interest must be clearly specified, (b) emotion must be elicited using a well-validated emotion induction procedure, (c) discrete units of information must be presented during emotion induction, (d) memory for this information must be tested using multiple measures, and (e) specific suppression instructions must be given to randomly selected participants.

To meet these criteria, we adapted an eyewitness memory slide-viewing paradigm (Christianson & Nilsson, 1984). Because we were interested in incidental rather than intentional memory, we told participants that we were studying impression formation. No mention was made of any memory tests. Participants were told that they would be shown a sequence of slides of individuals who had been severely injured. Individuals whose injuries had been recent would appear wounded; others would not. Slides were randomly paired with what participants believed to be biographical information about each person. Afterward, each participant's incidental memory for this information was tested with three measures of memory performance (cued recall, cued recognition, and self-estimates). To test whether the cognitive consequences of emotion suppression would vary as a function of emotional intensity, we manipulated the degree of emotion elicited during the slide sequence by showing three previously validated sets of slides, the second of which elicited particularly high levels of negative affect. Emotion suppression was experimentally manipulated by randomly assigning half of the participants to a condition in which we asked them to suppress their emotional behavior during slide viewing.

METHOD

Participants

Participants were 58 female undergraduates who participated in individual experimental sessions in partial completion of a course requirement.[1] Participants ranged in age from 17 to 22 years (M = 18.8 years), with 60% identifying themselves as Caucasian, 26% as Asian, 7% as Latino, 3% as African American, 2% as Native American, and 2% as other.

Stimulus Materials

Eighteen slides were presented in three sets of 6.[2] The first and third sets included slides of men that call forth low levels of negative affect. The second set included slides of badly wounded men that elicit high levels of negative affect. Slides in each set were accompanied by three bits of fictitious information presented orally: the individual's name, occupation, and cause of injury. Two versions of the slide sets were generated by separate random assignments of names, occupations, and accidents to each of the slides. No difference between versions emerged for either memory test, so we collapsed across version. Each slide was shown for 10 seconds; slides within each set were separated by 4 seconds.

Experience Measures

After each slide set, participants rated how they had felt while watching the slides. Using a 7-point Likert scale (0 = *not at all*, 6 = *a great deal*), participants rated how distressed, upset, angry, disgusted, fearful, sad, and revolted they had felt during each slide set. Ratings were used to create a seven-item negative emotion composite for each slide set; alphas ranged from .77 to .83.

Behavior Measures

Participants' behavioral responses to the slides were videotaped and later rated by three coders who were blind to experimental stimuli and conditions. Coders rated participants' responses to each slide on the following dimensions: (a) negative emotion-expressive behavior, (b) facial movement, (c) body movement, and (d) attempts to obscure vision—a control variable designed to assess whether participants prevented themselves from seeing the slides by shielding their gaze or looking away from the screen. Interrater reliabilities were adequate (r = .69 to .83). For subsequent analyses, three composite scores—one for each of the three slide sets—were computed for each of the four dimensions. These scores were computed by averaging the three coders' ratings for participants' responses to the six slides in each set. Each participant thus had three scores (one for each set) for each of four behavioral dimensions.

Memory Measures

We wished to study whether emotion suppression affects memory resulting from natural, spontaneous interactions with the world (i.e., incidental memory) rather than memory resulting from strategic memorization techniques (i.e., intentional memory) (Anderson, 1995). Thus, we used three unanticipated measures to assess participants' memory for information presented during the slide viewing period. First, we administered a cued-recall test that showed participants the slides a second time (with no sound) and instructed them to write down the information that had been presented earlier with each slide. Second, we administered a cued-recognition test that showed participants the slides a third time and instructed them to answer three four-alternative forced-choice questions for each slide, with one question for each information type. Third, we had participants make self-estimates of how well they remembered the information presented during each of the three slide sets using a 7-point Likert scale (0 = *not at all*, 6 = *a great deal*). For cued-recall and cued-recognition memory measures, we collapsed across information type (name, occupation, and injury) for each test and calculated a percentage correct score for each subject; alphas ranged from .76 to .88. For self-estimates of memory, we collapsed across participants' ratings of how well they remembered the information presented in each slide set.

Procedures

On arrival, participants were seated in a comfortable chair with a 20-inch television monitor placed at a distance of 1.75 meters. The experimenter informed participants that the study was designed to understand how people use visual and biographical information when forming impressions of people who had been injured. Specifically, participants were told that they would see several slides of people who had all been severely injured at one time or another and that they would hear each person's name, occupation, and type of accident. Participants were told that some of the slides would show people who appeared healthy because their injuries had happened a long time ago (the low negative emotion slides in sets one and three). Participants were told that other slides would show people who appeared gravely injured because they had been photographed shortly after sustaining their injuries (the high negative emotion slides in set two). The affective impact of the slide presentation was enhanced by warning participants in advance that many people find the slides they were about to see upsetting but that they could close their eyes, look away, or stop the experiment at any time.

Participants were instructed to pay close attention as they viewed the slides and listened to the information

TABLE 1: Study 1: Means and Standard Deviations for Experience and Behavior Measures

	First Set		*Second Set*		*Third Set*				
Measure	*No Suppression*	*Suppression*	*No Suppression*	*Suppression*	*No Suppression*	*Suppression*	*Condition*	*Set*	*Condition × Set*
Experience									
Negative emotion	$.78^{a}$ (.83)	$.86^{a}$ (.78)	3.29^{b} (1.02)	3.02^{b} (1.10)	$.93^{a}$ (.84)	$.67^{a}$ (.57)	.7	154.9*	2.5
Behavior									
Negative emotion	$.07^{a,b}$ (.09)	$.01^{c}$ (.03)	1.15^{d} (.90)	$.03^{a,c}$ (.09)	$.11^{b}$ (.15)	$.00^{c}$ (.01)	45.2*	23.2*	21.1*
Facial movement	$.39^{a}$ (.29)	$.11^{b}$ (.11)	1.24^{c} (.93)	$.11^{b}$ (.17)	$.44^{a}$ (.29)	$.12^{b}$ (.15)	44.9*	14.8*	15.3*
Body movement	$.44^{a}$ (.37)	$.21^{b}$ (.28)	$.65^{c}$ (.55)	$.09^{b}$ (.23)	$.54^{a}$ (.34)	$.22^{b}$ (.28)	29.0*	.8	4.0*
Obscures vision	$.28^{a,b}$ (.40)	$.14^{a}$ (.24)	$.36^{b,c}$ (.44)	$.15^{a}$ (.25)	$.57^{c}$ (.76)	$.21^{a,b}$ (.32)	7.7*	4.8*	1.8

NOTE: $N = 58$. Complete experience reports were available for 57 participants; complete behavior ratings were available for 54 participants. Numbers in a given row that do not share a subscript differ from one another at $p < .05$, two-tailed.
*F significant at $p < .05$.

about each one. This was important, it was explained, because they would be asked to fill out questionnaires concerning their impressions of the people shown in these slides. To bolster this impression-formation cover story, we did in fact obtain impression ratings, but we did not analyze them.

Just before viewing the first set of slides, participants were randomly assigned to one of two instructional conditions. The no-suppression condition ($N = 29$) instructions were as follows:

> We will show you the slides in just a moment. Please view them carefully and listen to the accompanying background information.

Suppression condition ($N = 29$) participants were given the following instructions:

> We will show you the slides in just a moment. Please view them carefully and listen to the accompanying background information. It is very important that you look at all the slides, but as I mentioned before, please feel free to close your eyes, look away, or say "stop" if you find any slide too distressing.[3] In addition, it is extremely important for the sake of this study that if you have any feelings as you watch the slides, please try your best not to let those feelings show. In other words, as you watch each slide, please try to behave in such a way that a person watching you would not know you are feeling anything at all. So, watch the slides carefully, but please try to behave so that someone watching you would not know you are feeling anything at all.

Participants then saw three sets of slides. Prior to the second and third sets, suppression participants were reminded not to let any feelings show. Following the initial presentation of all three slide sets, participants were asked to solve quantitative problems for 10 minutes. On completion of this distractor task, participants viewed the slide sets two more times and took two self-paced memory tests. Finally, the experimenter thanked and debriefed the participants.

RESULTS AND DISCUSSION

Manipulation Checks

Before assessing the effects of emotion suppression on incidental memory, we examined the effectiveness of our negative emotion-eliciting slides and suppression instructions. Specifically, we tested (a) whether the three slide sets elicited negative emotion and (b) whether suppression participants showed fewer behavioral signs of negative emotion than no-suppression participants but equivalent signs of negative emotion experience.

Did the emotion manipulation work? Because the suppression instructions had the potential to influence emotional responses, we examined how well our slides worked using no-suppression participants' responses only. As Table 1 shows, negative emotion reports were significantly greater than zero during the first slide set, $t(28) = 5.4$, $p < .001$, and third slide set, $t(28) = 6.2$, $p < .001$, indicating that these slides successfully called forth negative emotion experience. Also as expected, Table 1 shows that negative emotion experience was greater during the second slide set than during either the first or third slide sets. Thus, we elicited two levels of negative emotion experience, which permitted us to explore whether the effects of suppression on memory depend on the strength of to-be-suppressed emotion.

Did the suppression manipulation work? To confirm that our suppression instructions prompted the inhibition of overt emotion-expressive behavior, we conducted 2 (condition: no suppression, suppression) × 3 (set: first, second, third) ANOVAs for each of the four behavioral measures, with condition treated as a between-participants factor and set treated as a within-participants factor. Significant Condition × Set interactions for three of the four behavioral measures (i.e.,

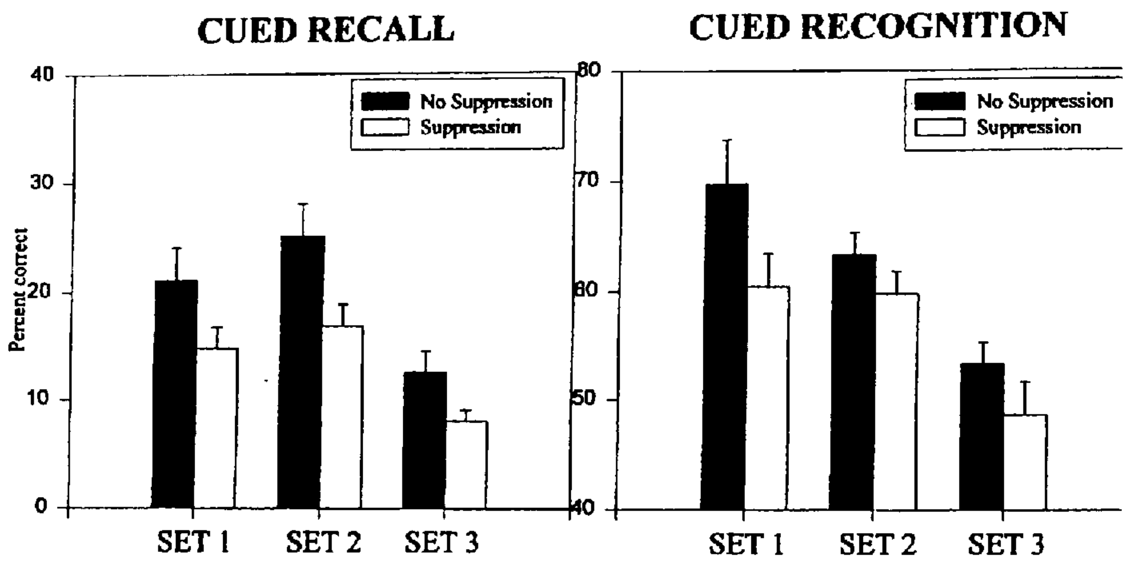

Figure 1 **Percentage of correct memory scores by instructional condition and slide set in Study 1.**
NOTE: Set 1 = first slide set; Set 2 = second slide set; Set 3 = third slide set.

negative emotion-expressive behavior, facial movement, and body movement) revealed that suppression participants showed less emotion-expressive behavior than did no-suppression participants across all three slide sets. This difference was most pronounced during the second (i.e., highly emotional) slide set.

To confirm that the suppression instructions selectively decreased emotional behavior without affecting negative emotion experience, we conducted a 2 (condition: no suppression, suppression) × 3 (set: first, second, third) ANOVA with the negative emotion experience composite. Neither condition nor Condition × Set interaction effects were significant, indicating that suppression participants experienced just as much negative emotion as no-suppression participants. Thus, it appears that suppression participants did not regulate their emotional behavior by decreasing negative emotion experience. Moreover, suppression participants did not regulate their emotion by obscuring their vision. In fact, a condition effect for the obscures vision variable indicated that suppression participants were somewhat less likely ($M = .16$, $SD = .22$) to obscure their vision during slide viewing than were no-suppression participants ($M = .41$, $SD = .41$), $F(1, 52) = 7.68$, $p < .01$.

Memory Performance

Did suppression affect memory? To test the effects of emotion suppression on memory, we conducted 2 (condition: no suppression, suppression) × 3 (set: first, second, third) ANOVAs for cued-recall and cued-recognition test scores, with condition treated as a between-participants factor and set treated as a within-participants factor. As shown in Figure 1, significant condition main effects for cued recall, $F(1, 56) = 9.2$, $p = .004$, and for cued recognition, $F(1, 56) = 4.4$, $p = .04$, both indicated that suppression led to poorer memory under conditions of low and high negative emotion. There also was a set main effect for cued recall, $F(2, 55) = 24.6$, $p < .001$, and for cued recognition, $F(2, 55) = 18.9$, $p < .001$, indicating that participants in both conditions remembered information presented during the third slide set less well than information presented during the first two slide sets. Neither Condition × Set interaction term was significant for cued-recall or cued-recognition memory tests, indicating that emotion suppression impaired memory to a similar degree across all three slide sets. Thus, the effects of suppression on memory did not appear to depend on the strength of to-be-suppressed emotion.

Were participants aware of suppression's effects on memory? To test whether suppression participants were aware of their memory impairment, we conducted a two-level (condition: no suppression, suppression) ANOVA using participants' self-estimates of overall incidental memory. Results indicated a condition effect: As compared to no-suppression participants ($M = 2.2$, $SD = 0.8$), suppression participants ($M = 1.8$, $SD = 0.6$) reported remembering the information presented along with the slides less well,

$F(1, 56) = 5.7$, $p = .02$. Thus, the memory impairment due to suppression was sufficiently pronounced to influence suppression participants' subjective judgments of their memory test performance.

Summary and Evaluation

As described in the introductory paragraphs, our literature review suggested two competing hypotheses concerning the cognitive consequences of emotion suppression. Study 1 provided clear support for the hypothesis that emotion suppression degrades memory. Relative to participants who freely expressed their emotions, participants who suppressed their emotions performed worse on both cued-recall and cued-recognition tests of material presented during the slide viewing period. To our knowledge, this is the first direct evidence that emotion regulation influences memory processes.

Interestingly, comparable deficits were evident for both recognition and recall memory. The fact that the cues present at retrieval in the recognition memory test failed to close the performance gap between those who did and those who did not suppress suggests that emotion suppression may have exerted its deleterious effects at the time of encoding. In addition, emotion suppression exerted equivalent effects on memory performance whether the demands to reduce overt emotion-expressive behavior were considerable, as was the case during the second (highly emotional) slide set, or modest, as was the case during the first and third (less emotional) slide sets. Thus, the cognitive consequences of emotion suppression do not appear to be proportional to the amount of behavior that is suppressed.

STUDY 2

Study 1 provided promising initial evidence that emotion suppression impairs incidental memory. Study 2 extended these initial findings in three important ways.

First, we tested the robustness of the cognitive consequences of emotion suppression using a new and larger sample of research participants. Both the sample size and the effect sizes of Study 1 were modest, and we thought a replication necessary to have full confidence in our findings.

Second, we examined more closely whether our suppression instructions selectively inhibited emotion-expressive behavior, as opposed to emotion experience. Study 1 provided indirect evidence that our instructions had worked as expected: Suppression participants (a) reported comparable levels of emotional experience and (b) showed less emotion-expressive behavior as compared to no-suppression participants. However, suppression participants might have actively tried to inhibit both emotion experience and expression but only succeeded in the latter case. In Study 2, we collected more measures to confirm that our suppression instructions led to efforts to inhibit behavior and not experience.

Third, we tested one mechanism hypothesized to underlie the effects of emotion suppression on memory, namely, sympathetic activation. In Study 2, we continuously measured electrodermal and cardiovascular responding throughout the experimental session to determine (a) whether suppression would produce heightened sympathetic activation within this slide-viewing paradigm and (b) whether this activation would mediate the cognitive effects of emotion suppression on memory.

To achieve these three goals, we conducted a second study that employed the same slide-viewing procedure used in Study 1. In addition to the behavior, experience, and memory measures used in Study 1, we also obtained new instructional impact and physiological measures.

METHOD

Participants

Participants were 85 female undergraduates who participated in individual experimental sessions to fulfill a course requirement.[4] Participants ranged in age from 16 to 23 years ($M = 18.8$ years), with 51% identifying themselves as Caucasian, 25% as Asian, 9% as Latino, 8% as African American, 1% as Native American, and 6% as other.

Slides and Behavior, Experience, and Memory Measures

The three slide sets, the accompanying information (names, occupations, and injuries), and the measures of behavior, experience, and memory were identical to those used in Study 1. In addition, the present study included new measures designed (a) to test the specificity of the suppression instructions and (b) to record physiological responding during the slide-viewing period.

Instructional Impact Measures

To obtain direct evidence that our suppression instructions selectively targeted emotion-expressive behavior as opposed to emotion experience, we asked participants to use a 7-point Likert scale (0 = *not at all*, 6 = *a great deal*) to rate the extent to which they had tried to alter (a) their inner experience of emotion and (b) their outer expression of emotion during the slide-viewing period.

Physiological Measures

Continuous physiological recordings were made using a custom SAI bioamplifier and an Ohmeda Finapres 2300 blood pressure monitor.[5] To assess cardiovascular activity, we measured the following:

Table 2: Study 2: Means and Standard Deviations for Experience and Behavior Measures

	First Set		*Second Set*		*Third Set*				
Measure	*No Suppression*	*Suppression*	*No Suppression*	*Suppression*	*No Suppression*	*Suppression*	*Condition*	*Set*	*Condition × Set*
Experience									
Negative emotion	$.55^{a}$ (.57)	$.47^{a}$ (.63)	2.38^{b} (1.14)	2.07^{b} (1.39)	$.60^{a}$ (.68)	$.56^{a}$ (.65)	.9	180.7*	.6
Behavior									
Negative emotion	$.13^{a}$ (.35)	$.05^{a,c,d}$ (.17)	$.74^{b}$ (.76)	$.13^{a,c}$ (.30)	$.12^{a,c}$ (.26)	$.00^{d}$ (.03)	16.5*	36.2*	18.2*
Facial movement	$.50^{a,d}$ (.61)	$.23^{b}$ (.29)	1.00^{c} (1.03)	$.30^{a,b}$ (.39)	$.52^{d}$ (.47)	$.23^{b}$ (.25)	16.6*	12.8*	7.1*
Body movement	$.39^{a}$ (.40)	$.18^{b}$ (.25)	$.63^{c}$ (.59)	$.15^{b}$ (.27)	$.62^{c}$ (.55)	$.37^{a}$ (.48)	16.9*	7.4*	3.6*
Obscures vision	$.09^{a,c}$ (.15)	$.06^{a,c}$ (.11)	$.18^{c}$ (.35)	$.10^{a,c}$ (.22)	$.18^{b,c}$ (.21)	$.09^{a}$ (.18)	3.9*	3.3*	.6

NOTE: $N = 85$. Complete experience reports were available for all participants; complete behavior ratings were available for 80 participants. Numbers in a given row that do not share a subscript differ from one another at $p < .05$, two-tailed.
*F significant at $p < .05$.

1. Interbeat interval. Beckman miniature electrodes were placed in a bipolar configuration on opposite sides of the participant's chest. The interbeat interval was calculated as the interval (in milliseconds) between successive R waves.
2. Diastolic and systolic blood pressure. A finger cuff containing a photoplethysmographic volume transducer and an inflatable air bladder was affixed to the third finger of the nondominant hand to measure the intraarterial pressure within the finger (in mm mercury).
3. Finger temperature. A thermistor was attached to the palmar surface of the distal phalange of the fourth finger to record temperature in degrees Fahrenheit.

To assess electrodermal activity, we measured the following:

4. Skin conductance level. A constant-voltage device was used to pass a small voltage between Beckman regular electrodes attached to the palmar surface of the middle phalanges of the first and second fingers of the nondominant hand.

Responses were digitized using custom software, which also computed second-by-second period averages for each of the five measures. In addition, change scores were calculated for each physiological measure by subtracting the baseline average from each slide-viewing period average.[6]

Procedures

On arrival, participants were seated in a comfortable chair in a well-lit 3 × 6 meter room. The experimenter and the introduction used were the same as in Study 1. Physiological sensors were attached, and after a short adaptation period, participants were told to "sit quietly for about a minute" so that a resting baseline could be obtained. After this baseline period, the procedure for Study 2 conforms to that of Study 1. Forty-four participants were randomly assigned to the no-suppression condition; 41 were assigned to the suppression condition.

RESULTS AND DISCUSSION

Manipulation Checks

As shown in Table 2, reports of negative emotion experience confirmed that we successfully elicited negative emotion experience. The first and third slide sets called forth low levels of negative emotion that were significantly greater than zero, and the second slide set called forth significantly greater negative emotion experience than the other two slide sets. Table 2 also shows that the suppression instructions worked as intended. Whereas no-suppression participants made more negative emotion expressions during the second (i.e., highly emotional) slide set than during the other slide sets, suppression participants did not; they behaved in the same unemotional way across all three slide sets. As in Study 1, suppression had no impact on emotion experience, suggesting that the suppression instructions selectively targeted emotion-expressive behavior and not emotion experience.

To more directly test the specificity of our suppression instructions, we conducted two separate one-way ANOVAs on (a) self-reported attempts to regulate inner experience and (b) self-reported attempts to regulate outer expression. In these analyses, condition (no suppression, suppression) was treated as a between-participants factor. Analyses revealed no main effect for alteration of inner experience, $F(1, 83) = .41$, *ns*, indicating that suppression participants did not report greater alteration of their inner experience as compared to no-suppression participants. There was, however, the expected main effect for alteration of emotional expressivity, $F(1, 83) = 20.35$, $p < .001$: Suppression participants ($M = 3.2$, $SD = 1.9$) reported greater alteration of emotional expressivity as compared to no-suppression participants ($M = 1.5$, $SD = 1.7$). Together with the experience and behavior data presented in Table 2, these findings give us confidence that the suppression

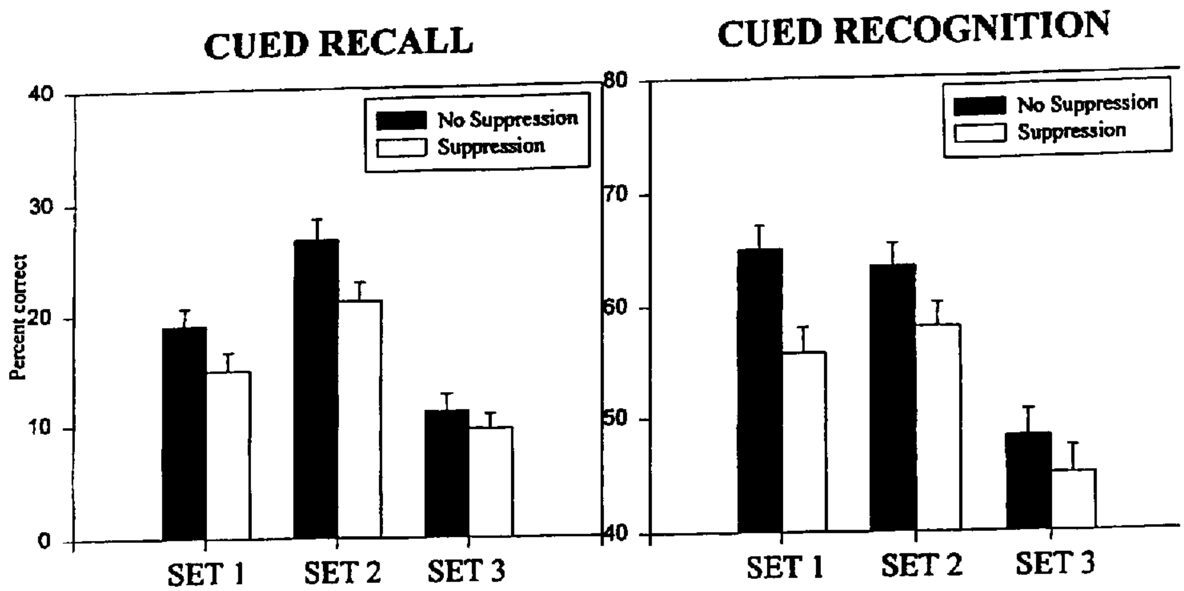

Figure 2 Percentage of correct memory scores by instructional condition and slide set in Study 2.
NOTE: Set 1 = first slide set; Set 2 = second slide set; Set 3 = third slide set.

instructions led to selective—and successful—efforts to decrease ongoing expressive behavior without prompting efforts to decrease experience.

Memory Performance

Objective memory measures. As in Study 1, we conducted two separate 2 (condition: no suppression, suppression) × 3 (set: first, second, third) ANOVAs for each of the two memory tests, with instructional condition treated as a between-participants factor and slide set treated as a within-participants factor. Consistent with Study 1, the ANOVAs revealed significant set and condition main effects. As shown in Figure 2, the condition main effects for cued recall, $F(1, 83) = 4.71$, $p = .03$, and for cued recognition, $F(1, 83) = 6.00$, $p = .01$, indicated that suppression led to poorer memory across the three slide sets. A set main effect for cued recall, $F(2, 82) = 4.71$, $p < .001$, indicated that information presented during the second slide set was remembered better than information presented during either the first set, $t(84) = 5.55$, $p < .001$, or the third set, $t(84) = 9.73$, $p < .001$. The set main effect for cued recognition, $F(2, 82) = 45.36$, $p < .001$, indicated that information presented during either the first set, $t(84) = 7.84$, $p < .001$, or the second set, $t(84) = 8.43$, $p < .001$, was remembered better than information presented during the third slide set; however, the information presented during the first and second slide sets was remembered equivalently, $t(84) = .23$, *ns*. Importantly, there were no Condition × Set interactions, indicating that emotion suppression degraded memory similarly across all three slide sets and, therefore, across circumstances calling forth both low and high levels of negative emotion. These findings clearly replicate the effects of emotion suppression demonstrated in Study 1.

Subjective memory measure. As in Study 1, we tested whether suppression participants were aware of the cognitive costs of emotion suppression by conducting a two-level (no suppression, suppression) one-way ANOVA with participants' ratings. Results revealed the predicted main effect: As compared with no-suppression participants ($M = 2.0$, $SD = 0.8$), suppression participants ($M = 1.7$, $SD = 0.8$) reported remembering the slide information less well, $F(1, 83) = 3.18$, $p < .05$ (one-tailed).

Did Suppression Lead to Sympathetic Activation?

To determine whether emotion suppression increased sympathetic activation, we conducted 2 (condition: no suppression, suppression) × 3 (set: first, second, third) ANOVAs with the change scores for each of the five physiological variables, with condition treated as a between-participants factor and set treated as a within-participants factor. Results of these analyses are presented in Table 3. Three of the four cardiovascular channels (i.e., diastolic blood pressure, systolic blood pressure, and finger temperature) showed condition effects; cardiac interbeat interval and skin conductance level did not. Blood pressure increases and finger temperature decreases were greater among suppression partici-

TABLE 3: Study 2: Mean Change From Baseline and Standard Deviations for Cardiovascular and Electrodermal Measures

	First Set				*Second Set*				*Third Set*						
Measure	*No Suppression*		*Suppression*		*No Suppression*		*Suppression*		*No Suppression*		*Suppression*		*Condition*	*Set*	*Condition × Set*
Cardiovascular															
Interbeat interval	$.76^{a,c,d}$	(39.3)	-12.00^{a}	(65.50)	17.12^{b}	(53.4)	$24.76^{b,c}$	(82.9)	21.18^{b}	(52.60)	$18.63^{b,d}$	(56.1)	0.1	10.4*	1.2
Diastolic pressure	$.72^{a,c}$	(2.28)	2.96^{b}	(4.23)	1.07^{a}	(3.18)	2.44^{b}	(4.26)	$-.36^{c}$	(3.85)	$1.96^{a,b}$	(4.82)	6.6*	4.0	1.2
Systolic pressure	$3.80^{a,d}$	(6.08)	8.90^{b}	(10.10)	$3.58^{a,d}$	(6.31)	5.83^{a}	(10.0)	$-.99^{c}$	(7.47)	2.58^{d}	(9.45)	4.1*	18.0*	2.2
Finger temperature	$-.35^{a,c}$	(1.03)	$-.90^{b}$	(1.23)	$-.16^{a,b}$	(2.70)	$-.97^{b}$	(1.48)	$.40^{c}$	(3.30)	$-.98^{a,b}$	(2.10)	4.8*	1.6	1.6
Electrodermal															
Skin conductance	$-.13^{a,c}$	(.78)	$.13^{a,d}$	(.97)	$.20^{b,d}$	(.78)	$.07^{b,c}$	(1.04)	$-.20^{a,c}$	(.81)	$-.06^{a,b}$	(1.14)	0.0	12.4*	2.7

NOTE: $N = 74$; greater numbers indicate increased activation for blood pressure and skin conductance. Smaller numbers indicate increased activation for finger temperature and interbeat interval.
*F significant at $p < .05$. Condition, $df = (1, 72)$; set, $df = (2, 71)$; and Condition × Set, $df = (2, 71)$.

pants than no-suppression participants. These increases in blood pressure and vasoconstriction suggest that emotion suppression led to enhanced sympathetic activation of the cardiovascular system, replicating and extending prior findings that relative to no emotion regulation, emotion suppression leads to greater sympathetic activation of the cardiovascular system (Gross, 1998; Gross & Levenson, 1993, 1997).

Did Sympathetic Activation Mediate the Effects of Suppression on Memory?

Showing that suppression and no-suppression participants differed in terms of their sympathetic responding is necessary to argue that these autonomic responses mediated the effects of emotion suppression on memory. However, such a demonstration is not sufficient, because physiological and cognitive consequences could well be independent. To test whether the observed physiological changes mediated the effects of suppression on incidental memory, we conducted two partial correlation analyses.

In these analyses, we created physiological composite scores for each of the three measures that distinguished between the two instructional groups. We did this by averaging scores for systolic blood pressure, diastolic blood pressure, and finger temperature across the three slide sets. We then conducted partial correlation analyses to determine whether significant correlations between condition and memory scores (cued recall and cued recognition) would remain after we had controlled for the effect of all three composite physiological variables. In these analyses, we scored instructional condition so that a negative correlation would mean that suppression led to impaired memory. For recognition memory, the correlation with condition was $-.24$, $p < .05$. For recall memory, the correlation with condition was $-.28$, $p < .05$. In neither case did partialling the physiological measures decrease the strength of the association between condition and memory, represented by correlations of $-.25$ and $-.23$, respectively. The conclusion that sympathetic activation did not mediate the cognitive consequences of emotion suppression is further supported by the fact that across all participants—half of whom watched the slides without emotion-regulation instructions—variation in physiological responding did not account for individual differences in memory performance.

Summary

Study 2 replicated and extended Study 1 in several important ways. First, Study 2 replicated the finding that emotion suppression impaired cued-recall and cued-recognition memory for information presented during the suppression period. Second, Study 2 confirmed that the suppression instructions affected only efforts to inhibit emotion-expressive behavior (and not emotional experience), thereby establishing that our memory findings are the result of one specific form of emotion regulation, namely, emotion suppression rather than a hybrid of efforts to regulate both emotional experience and its expression. Third, Study 2 showed that suppression led to increased sympathetic activation, as indicated by increased systolic and diastolic blood pressure and decreased finger temperature. However, mediational analyses revealed that these physiological changes were not responsible for the observed cognitive consequences of emotion suppression.

GENERAL DISCUSSION

Adults—in Western culture at least—typically do not express all that they feel (Gross, John, & Richards, in press; Tomkins, 1962). Emotion suppression allows us to modulate our emotion-expressive behavior and thus work peaceably with people we do not like, verbalize our anger rather than act it out, and avoid needless friction in social encounters. Despite these social benefits, however, the studies reported in this article suggest that emotion suppression has its costs. In two studies, we found that emotion suppression impaired memory for information encountered while individuals inhibited ongoing emotion-expressive behavior. In the following sections, we discuss these findings and draw out implications for cognitive performance and social interaction.

Consequences of Emotion Suppression

Survey and interview data suggest that people frequently attempt to suppress their emotional responses (DePaulo, Kashy, Kirkendol, Wyer, & Epstein, 1996; Gross et al., 1998). In conjunction with otherstudies (Gross, 1998; Gross & Levenson, 1993, 1997), the present research indicates that the affective consequences of these attempts include (a) clear decreases in emotion-expressive expressive behavior, (b) no change in negative emotion experience, and (c) clear increases in sympathetic nervous system activation that appear to be most reliable for measures of cardiovascular activation.

In addition to replicating and extending prior findings regarding the behavioral, experiential, and physiological consequences of emotion suppression, the present studies break new ground regarding the cognitive consequences of emotion suppression. Findings demonstrate that both cued-recall and cued-recognition memory for information encountered during the period of suppression was impaired and that suppression participants were aware of this impairment (as evidenced by their self-reports of memory). Moreover, this impairment was equivalent for information encountered under conditions of both low and high negative emotional responding. Intuitively, one might have expected more pronounced memory degradation for information encountered under conditions of more intense emotion because presumably, suppression participants would have had to work harder to restrain these relatively more intense behavioral impulses. However, within the narrow range of emotional intensities explored in these studies, no evidence emerged for this view. Results therefore suggest the intriguing possibility that emotion suppression may be an all-or-none process that consumes a fixed amount of cognitive resources no matter how considerable or modest the behavior to be suppressed.

Our results converge nicely with a recent report that regulating emotional experience and emotional expression simultaneously degrades performance of subsequent cognitive tasks (Baumeister, Bratslavsky, Muraven, & Tice, 1998). Baumeister et al. have interpreted this proactive impairment in terms of the "ego depleting" effects of self-regulation, arguing that attempts to control impulses present during one task deplete a finite pool of resources important for performing subsequent tasks. Our studies extend this line of work by demonstrating that at least one form of emotion regulation, namely, emotion suppression, may deplete resources important for performing concurrent tasks. One important direction for future research is to assess the generalizability of this finding by focusing on whether suppression in more personally involving or complex emotional situations also affects memory, as well as other indices of cognitive functioning. Another crucial issue is whether other widely used forms of emotion regulation—such as cognitive reappraisal, rumination, or distraction—have cognitive consequences as well.

Why Does Suppression Impair Memory?

Two related literatures led us to frame our hypotheses concerning the effects of emotion suppression on memory in terms of increased autonomic activation. One of these literatures has demonstrated that suppression enhances sympathetic activation (Gross, 1998; Gross & Levenson, 1993, 1997). The second literature has shown that enhanced physiological arousal—variously defined—either enhances or impairs cognitive functioning (for a review, see Christianson, 1992; Easterbrook, 1959; Neiss, 1988). Together, these two literatures suggested that emotion suppression should lead to increased autonomic activation, which in turn, should alter cognitive performance. The point of unclarity seemed to be whether sympathetic activation would enhance or impair cognitive performance.

As expected, suppression led to increased sympathetic activation of the cardiovascular system. To our surprise, however, statistically controlling for these changes had no effect whatsoever on the strength of the association between memory performance and suppression. Thus, our cardiovascular and electrodermal measures of sympathetic activation did not account for the cognitive consequences of emotion suppression. Of course, alternative measures of these response systems (cf. Blascovich & Kelsey, 1990) or measures of other peripheral or central response systems that we did not collect (e.g., electrocortical, skeletomotor) might well shed light on the memory-suppression relation. We believe additional study of the physiological consequences of emotion suppression may locate patterns of activation that do in fact help to explain the cognitive consequences of emotion suppression.

We also believe that study of the phenomenological and attentional consequences of emotion suppression is needed to test competing explanations for why emotion suppression should degrade memory. For example, it may be that the conscious inhibition of emotion-expressive behavior degrades memory because it is a complex self-regulatory process that involves changes in self-monitoring and self-focus (e.g., Pyszczynski & Greenberg, 1987), which decrease attentional resources for encoding—and therefore remembering—external events (Ellis & Ashbrook, 1988). On this view, successful emotion suppression is thought to require an internal dialogue in which individuals must remind themselves to suppress, self-monitor for signs of unwanted emotional impulses, and conduct on-line evaluations of how well they are doing (e.g., Pyszczynski & Greenberg, 1987). These self-focused cognitions, although crucial for successfully inhibiting emotion, may have the unfortunate consequence of consuming finite attentional resources that otherwise would be used to process information in the world. The result of this attentional shift from things external to things internal could readily account for memory impairments such as those observed in the present studies. Viewed in this way, then, emotion suppression would have much in common with other cognitively effortful self-regulatory tasks, such as thought suppression (Wegner, 1994), mood regulation through rumination (Lyubomirsky & Nolen-Hoeksema, 1995), and interpersonal deception (DePaulo, Rosenthal, Rosenkrantz, & Green, 1982). Future studies involving thought sampling, eye tracking, and implicit tasks of self-focus could assess whether self-focused attention mediates the relation between emotion suppression and memory.

Implications for Cognitive Performance and Social Interaction

What implications do our findings have for the pervasive notion that emotion impairs intellectual performance (e.g., Sarason, 1972; Wine, 1971) and memory (e.g., Christianson & Nilsson, 1984)? Historically, there has been an emphasis on the disrupting effect of emotion per se (Hebb, 1946; Mandler, 1993). Our research suggests that regulating emotion might itself impose an additional cognitive burden above and beyond any effects of emotion. Thus, measuring—and even manipulating—emotion regulatory processes seems likely to give us important information about what it is about certain emotion-eliciting contexts that impairs cognitive functioning.

The present findings also encourage reflection on the links between emotion regulation and social interaction. For example, when we suppress during social interactions in everyday life, might we reduce the amount of information we can draw upon later to form later judgments and decisions about these encounters? If so, emotion suppression might be relevant to enhanced stereotypical thinking (e.g., Devine, 1989; Macrae, Bodenhausen, Milne, & Ford, 1997), stereotype vulnerability (e.g., Steele, 1997), actor-observer effects (e.g., Jones & Nisbett, 1971), and inaccurate social inferences (e.g., Gilbert, Krull, & Pelham, 1988). These important issues are clearly amenable to empirical study by manipulating emotion regulation in social situations and measuring resultant judgments and memory.

CONCLUSION

Emotion and cognition are far more intermixed in our daily lives than one might expect given the history of study of these phenomena. The present research is a contribution to the larger project of putting these two domains into closer contact. We found that suppression produces not only behavioral and physiological consequences but also clear cognitive consequences as well. Interestingly, the cardiovascular activation associated with suppression did not appear to mediate these cognitive consequences. We have suggested that other physiological changes, as well as increased self-focused attention, may play a mediational role. Whatever their causes, the cognitive consequences of emotion suppression and other forms of emotion regulation clearly represent a rich field for future inquiry.

NOTES

1. Four additional participants were dropped from analyses. Two refused to look at the negative slides (both in the no-suppression condition) and two suspected a memory test (one suppression, one no suppression). Women were selected for study because they tend to be more emotionally expressive than men (Kring & Gordon, 1998).

2. Six additional slides were shown: three at the beginning of the first slide set and three at the end of the last slide set. These slides were used to absorb any possible primacy and recency effects and therefore were not included in the analyses. Slides were drawn from the International Affective Picture System (IAPS) (Lang & Greenwald, 1988) and supplemented by other pretested slides drawn from obscure sources to bring the total number to 24.

3. We told participants they could close their eyes, look away, or say "stop" at any point during the session at the behest of the Committee for the Protection of Human Subjects.

4. Five additional participants were dropped from analyses. One was dropped due to experimenter error (no suppression), two refused to look at the negative slides (one suppression, one no suppression), one failed to follow instructions (suppression), and one suspected a memory test (no suppression).

5. Complete physiological records were available for 74 participants (38 suppression, 36 no suppression). Two participants wore clothing that made proper electrode placement impossible (one suppression, one no suppression); 9 participants had incomplete records due to experimenter error (four suppression, five no suppression). Physiological analyses were conducted using participants with complete physiological records only. In secondary analyses, we assessed the effects of emotion suppression on objective memory scores and self-estimates of memory in these 74 participants only. Objective memory test results were virtually identical to those of the full sample: Significant main effects for condition were revealed for both cued recall, $F(1, 72) = 3.97$, $p = .05$, and cued recognition, $F(1, 72) = 5.05$, $p = .03$, indicating that suppression participants showed poorer memory than non-suppression participants. The condition main effect for self-estimates of memory did not attain significance, $F(1, 72) = 1.99$, $p = .16$; however, the direction of means was consistent with Study 1. Suppression participants ($M = 1.7$, $SD = 0.8$) reported remembering the information less well than no-suppression participants ($M = 2.0$, $SD = 0.8$).

6. Before conducting analyses using change scores, we tested for baseline differences between instructional groups. There were no differences for any of the physiological measures.

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