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Individual Differences in Automatic and Controlled Regulation of Emotion and Task Performance

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To examine the previously suggested, but unexamined, relation between emotions and task performance, we propose that individuals differ in their capacity to use fast emotional regulation processes (FERPs), which we define as processes that begin less than 350 msec after being exposed to an emotion evoking stimulus. Results of three laboratory studies show that individual differences in FERPs, but not slow emotional regulation processes (SERPs), predict emotional regulation performance. Results of Study 1 showed that FERPs significantly predicted editing task performance, task satisfaction, and depression after controlling for trait affectivity; whereas SERPs did not show any significant predictions. Study 2 replicated and extended the results of Study 1, and successfully addressed internal validity concerns related to SERPs. In Study 3, FERPs were shown to predict both performance measures when verbal ability and Conscientiousness were controlled. The combined results of these three studies suggest that FERPs may play a critical role in predicting task performance.

Applied researchers have become increasingly concerned with emotions at work in the last decade (e.g., Farr, 2004), in part because of the assumption that emotional processes influence performance (Arvey, Renz, & Watson, 1998; Rafaeli & Kluger, 2000). A key aspect of emotional processes that may often affect performance is the capacity of an individual to regulate emotions. According to theories in emotional regulation (Gross, 1999), emotional regulation processes vary on a continuum involving levels of consciousness. Recent works include preconscious

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emotional processes (e.g., Erber & Erber, 2001; Handley, Lassiter, Nickell, & Herchenroeder, 2004); however, most research has not directly addressed preconscious, automatic emotional regulation processes, focusing instead on conscious processes (e.g., Diefendorff & Gosserand, 2003; Grandey, 2000; Gross & John, 2003).

We expect that when emotional regulation processes are very fast, as with preconscious processes, they can prevent unwanted emotions from disrupting higher level cognitive processes that rely heavily on working memory; slower regulation of emotions may not be nearly as efficient. To examine the general utility for enhancing task performance, we compare fast emotional regulation processes (FERPs) and slow emotional regulation processes (SERPs) in the studies reported in this article. Our definition of FERPs involves a time constraint often thought to be fast enough to preclude conscious processing (< 350 msec), but our concerns are not so much with the conscious–unconscious distinction as with showing that very FERPs have unique benefits for task performance and may involve capacities that vary widely among individuals.

Although emotional regulation may have broader meanings (Gross, 1999), we narrowly define emotional regulation during cognitive tasks as a process that involves the suppression of irrelevant emotions, which may come from the environment, prior experience, or the task itself, and the activation of relevant emotions. We adopted this definition because it allows us to conceptualize both activation and suppression processes as operating together in regulating emotions, while giving more emphasis to suppression processes.

EMOTIONAL REGULATION AND TASK PERFORMANCE

Many recent studies suggest that the ability to suppress competing information is a very general self-regulatory process that helps keep individuals on track in many types of task activities. For example, highly skilled performance in many domains requires that distractors, which are activated by the context, be suppressed automatically; otherwise they will interfere with the interpretive and control structures that are in use (e.g., Diefendorff et al., 1998; Shah, Friedman, & Kruglanski, 2002). A recent meta-analysis (Johnson, Chang, & Lord, in press) shows very strong support for the proposition that instantiating goals both suppress information related to competing goals and activate goal-relevant information.

In combination, this research shows that the protection of working memory from interfering cognitions is critical to effective task performance. An analogous argument is that for many tasks to be performed efficiently, emotion suppression may also need to operate quickly, likely before inappropriate emotions can enter consciousness or change motivational orientations. It is also likely that there are individual differences in the capacity to manage the activation and suppression of emotions, which may be either domain specific or domain general. To test this idea, one needs to measure the capacity to suppress irrelevant emotional content using FERPs and SERPs and show whether they have different potentials to predict performance on cognitive and emotional tasks. These are the objectives of our research program.

FAST AND SLOW EMOTIONAL PROCESSES

One common theme that most emotion scholars would support is that there are fast and slow routes to activating emotions (e.g., Gross, 1999; Wegner & Bargh, 1998). Often referred to as the low and high road (LeDoux, 1994), faster processes involve the direct activation of regions in the amygdala by sensory stimuli, without mediation by the neocortex, whereas slower processes route sensory information to the neocortex before reaching the amygdala. Recent neurobiological views of consciousness (Dehaene & Naccache, 2001) also imply that considerable amount of processing occurs at preconscious level and these processes may influence cognitive performance without ever becoming conscious.

Applying this logic to FERPs and SERPs, we suggest that FERPs often can suppress inappropriate emotions before they can trigger conscious cognitions, goals, or feelings. Our concern is with individual differences, and we believe that either because of skill development in emotional regulation or because of genetic differences in temperament that may affect the activation of emotions, some individuals can regulate emotions more rapidly than others, and these individuals would tend to emphasize FERPs compared to SERPs. For such individuals, a much higher percentage of task irrelevant emotion will be eliminated preconsciously. In contrast, for other individuals who rely primarily on SERPs, what were initially preconscious processes will last long enough to produce cognitions, goals, or feelings that become conscious. Thus, SERPs allow emotions to create more working memory load and they allow the deflection of goal striving processes more often than will FERPs. In contrast, FERPs should be better able to protect conscious processing resources and motivational processes.

Degree of skills in regulating emotions may be a critical difference producing fast rather than slow emotional regulation processes. Unskilled efforts to directly control emotions are likely to rely on processes that are composed on-the-spot, a procedure which takes time (Newell, 1990) and needs access to consciousness. Consequently, such efforts typically fail when individuals are experiencing high cognitive load (Wegner, 1994) or have very little time to suppress unwanted emotions (Page, Locke, & Trio, 2005). For example, a busy customer service clerk may not be able to deliberately smile at customers after an interaction with a rude customer, but a clerk who is not so busy may be able to consciously suppress the anger associated with the rude customer and convey a more pleasant emotion to customers. Consistently, Sutton and Rafaeli (1988) reported that clerks in busy stores showed positive emotions less often than those in less busy stores. However, even in busy situations, individuals who possess well practiced abilities in regulating their emotions preconsciously may be able to automatically temper their own emotions (Bargh, 1994; Wegner & Bargh, 1998). Furthermore, experienced individuals may proceduralize aspects of emotional regulation, reducing the need to rely on working memory (Anderson, 1987).

Another route to fast and efficient regulation of emotional reactions may be more indirect and flexible, operating through explicit goals. Similar to implementation intentions (Diefendorff & Lord, 2003; Gollwitzer, 1999), which prime an individual to automatically operate in a certain way when specific environmental circumstances are encountered, emotional regulation goals formed prior to an emotional event such as experiencing an uncivil customer or disappointing performance feedback could help an individual to use FERPs. Once employees have prioritized the goal to regulate emotions, such goals may operate at a preconscious level when triggered by relevant circumstances (e.g., a rude customer or poor task feedback), and the preconscious activation of goals may have the same effect as intentional (conscious) goal activation (Chartrand & Bargh, 1996). Thus, both experience and a priori emotional regulation goals could facilitate emotional regulation in cognitively demanding situations, shifting the balance from SERPs to FERPs, although hard-wired individual differences may also limit shifts to FERPs.

In sum, we have argued that although both FERPs and SERPs are likely to be important, FERPs are likely to have advantages in both protecting working memory and facilitating goal striving, and thus should yield more effective performance on demanding tasks. FERPs have an additional quality that should be noted. Because they may involve processes that are largely preconscious, people may be less aware of FERPs and less able to accurately report on their operation. Thus, they are not very amenable to self-assessment through techniques involving self-report methods. If this reasoning is correct, then FERPs should show incremental validity over self-report measures of emotional tendencies. In addition, FERPs should show incremental validity over measures of intelligence because they are relatively independent of conscious cognitive processing. This reasoning led to the following three hypotheses which were tested in three experimental studies that adapted cognitive techniques to measure FERPs and SERPs.

- H1: FERPs will predict performance on tasks with an emotional component.
- H2: FERPs will predict task performance above and beyond self-report measures of emotional tendencies.
- H3: FERPs will predict task performance above and beyond intelligence.

All three studies described in this article used a highly similar methodology, which is fully described in Study 1. In Studies 2 and 3, we only note changes from this core methodology.

STUDY 1

Method

Participants

Seventy-seven female and 24 male students (*N* = 101) from a Midwestern university whose first language was English (or who started to learn English before the age of 10) participated in this study. Seventy-four participants were working at least part time. The ethnicity of participants was 79 White, 20 African American, 1 Asian American, and 1 Native American. Mean age was 25.18 (*SD* = 8.79) with a range of 17 to 52.

Measuring Suppression With Fast and Slow Processes

Measuring priming and suppression. Suppression and priming both address the carryover effects of prior activities on the accessibility of subsequent information, but they produce opposite effects (see Bargh & Chartrand, 2000, for a concise review of the priming paradigm). Priming facilitates subsequent access to previously activated information, whereas suppression retards subsequent access to previously suppressed information. Because priming and suppression have opposite effects on information accessibility, procedures that index prior suppression are often called *negative priming.* Negative priming procedures were developed in the visual selection literature, and they involve both activation and inhibitory mechanisms (Houghton & Tipper, 1994).

The typical negative priming paradigm involves multiple trials on two sequential tasks, with each trial involving a priming task followed by a probe task. The effects of the inhibitory or activation mechanism used during the initial prime task can be measured by observing response time (RT) in the subsequent probe task. During the prime task, typically two words or other symbols are presented simultaneously (e.g., cat and dog), but one word is a target to be remembered, whereas the other serves as a distractor to be ignored. The subsequent probe task may measure RT to either the previous target, which measures priming, or to the previous distractor, which measures suppression. To eliminate accessibility differences among words across the multiple trials in this procedure, the same word (e.g., cat) is used as a target or distractor on different trials. Thus, accessibility and suppression effects are not confounded with the accessibility of specific words.

Also, to keep participants from anticipating the switch from distractors to targets across trials, negative priming procedures intermix activation, suppression, and neutral trials. Neutral trials are trials where the prime and probe stimuli have no common words, such as a prime trial of “cat dog” followed by a probe trial of “hat.” For this reason, most studies use within-subjects comparisons to define suppression or priming in which each participant serves as his or her own control. Consequently, negative priming typically is operationalized as a slowing of probe trial responses to previous prime trail distractors relative to RTs for neutral probe responses; whereas, priming is operationalized as a speeding up of probe trial responses to previous targets relative to neutral probe responses.

Stimulus onset asynchrony, FERPs, and SERPs. An important experimental parameter is the amount of time between the onset of the priming stimulus and the onset of the probe stimulus. This parameter is referred to as *Stimulus Onset Asynchrony* (SOA). The length of the SOA can determine whether there is sufficient time for conscious processes to be used in suppressing distractors or activating targets or whether time is so short that only automatic processes can be used. Specifying the precise SOA that would differentiate preconscious from conscious processing is difficult, as this threshold likely varies from task to task as well as across individuals. According to Blair and Banaji (1996), if the SOA is less than 500 msec, the response to the probe is generated by automatic processes; whereas, if the SOA is substantially longer than 500 msec, then the response is generated by conscious processes. Our extensive pilot testing suggested that a 350 SOA condition restricted processing to preconscious processes, but others (Hermans, De Houwer, & Eelen, 2001; Hutchison, Neely & Johnson, 2001) maintain that faster SOAs are required to exclude conscious processes. However, our concern was with the suppression of emotions associated with facial stimuli, and neurological evidence has shown that activation of emotion specific brain structure in facial emotion recognition happens between 160 and 380 msec after stimulus onset (Streit et al., 1999). Therefore, we use a 350 msec SOA to index FERPs and a SOA of 2000 msec to index SERPs. We also believe that this distinction likely separates preconscious from conscious suppression processes. We also used a 600 msec SOA which produced results very similar to the 350 SOA, but to conserve space and simplify results, we do not discuss these findings, which are available from the first author.

Distractor suppression paradigm. Although we used the negative priming paradigm to measure suppression, we refer to our specific procedure as a distractor suppression paradigm because this is more descriptive of actual procedures used. Like most studies of negative priming (Fox, 1995), our paradigm used has both prime and probe trials, but the priming trial includes both a target stimulus (e.g., an angry face) and a distractor stimulus (e.g., a sad face), which always differed in the emotions conveyed (e.g., anger versus sadness). On the subsequent probe trial, the participant responded to a written probe word stimulus which was either consistent in emotions with the target (priming), consistent with the distractor (distractor suppression), or unrelated to either the target or the distractor (control). Our probe word required a lexical decision on the part of the participant, who was asked to indicate whether the probe stimulus was a meaningful word. Thus, priming is indicated by the reduced RT to probe words conveying the same emotion as the target face, and it is a marker of the strength of the association and the spread of activation between the prime and the probe word (i.e., faster RTs imply stronger association). In contrast, the increased RT to distractor-consistent probe words reflects the effectiveness of suppression mechanisms (i.e., effectiveness in the spread of inhibition from the prime to probe task). Effective suppression means that it is harder to access the appropriate word meaning, which produces longer RTs relative to the control condition.

It also should be mentioned that in tasks involving RT measures, the information in participants' responses can be channeled into either RTs or errors in responses (Hyman, 1953). In other words, if the experimental situation forces all respondents to make responses in too short a time, then individual differences in RT cannot be observed. Instead, individual differences will show up in differences in the number of errors. For example, Van Overwalle, Drenth, and Marsman (1999) found that imposing a time limit in responses (300 msec) eliminated any priming effect in RT but directed the effect to the number of errors. This study adopts a longer time limit; however, the possibility that effects will be reflected in errors rather than RTs still remains. Therefore, in this study, errors were also included in the analysis of the RT data.

Design of the Distractor Suppression Task (DST)

Prime stimuli. The emotion primes in this task used diagrams of human faces expressing emotions. We chose faces as emotional primes because studies in cognitive neuroscience have found that faces expressing emotions can provoke emotional responses at a fast rate because there are dedicated neural systems in the brain for perceiving faces (Streit et al., 1999). We adopted a six discrete emotion model (angry, disgust, fear, happy, sad, and surprise; Rosenberg & Ekman, 1995) that has been often used in facial expression research. Among the basic emotions, one positive (happy) and two negative (sad and angry) emotions were selected for this study because these three emotions were clearly identified by participants in other emotion research (e.g., Shaver, Schwartz, Kirson, & O'Connor, 1987). The specific stimuli were face diagrams created by a computer graphic program and pilot tested by Girondi and Lord (1998). Drawings of faces conveying happy, sad, and angry emotions, which are presented in Figure 1, were based on key features that Ekman and Friesen (1975) found to be related to each emotion.

Probe stimuli. All emotion words were first selected from Girondi (1996). Then the words were counterbalanced according to their frequencies as compiled by Kucera and Francis (1967). The probe words included six words related to happy emotions, which were each used twice, six words related to angry, and six words related to sad emotions. We also used six words from the surprise emotion

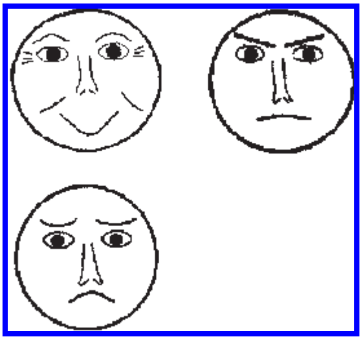

FIGURE 1 Happy, angry, and sad face diagrams.

category that were not used as primes to control for possible between-trial effects in which the responses to the probe could be influenced by the emotional content of prime stimuli in previous trials. In sum, there were a total of 24 meaningful words. In addition, a total of 24 nonwords of the same length were included as control probes. These nonwords were created by changing the first character in the probe words included in this experiment.

Prime-probe combinations. The emotion categories used were happy, sad, angry, and surprise (probe trial only). Because our prime trial presented both targets and distractors, there were five possible combinations of prime and probe stimuli which defined within-subjects effects: a probe word consistent with the prime target emotion (activation); a probe word consistent with the prime distractor emotion (suppression); an angry, sad, or happy probe word unrelated to either the prime target or distractor emotions (control); a probe word related to surprise (surprise control); and a probe stimulus that was a nonword (nonword control). All possible combinations of prime and probe emotions were used creating activation, suppression, control, surprise control words, and nonword control conditions.

Measures

Emotional tendencies. Two self-report measures of emotional tendencies were included to allow us to assess the discriminant validity of our experimental measure of suppression. Dispositional affectivity was measured using the Positive and Negative Affect Schedule scale (PANAS; Watson, Clark, & Tellegen, 1988) worded with respect to a “general” time frame. Because personality dimensions, especially Extraversion and Neuroticism, have been found to predict emotional reactions (e.g., Carver, Sutton, & Scheier, 2000; Watson et al., 1988), we also included the short version of NEO–PI (NEO–FFI; Costa & McCrae, 1994).

This questionnaire includes 60 items on a 5-point scale measuring the Big Five personality dimensions.

Dependent measures. One crucial requirement of criteria is that they are specified at the same level as their emotion-based predictors. Therefore, we chose criteria that had both a short time frame and a substantial emotional component. The scrambled sentences task (SST) used by Wenzlaff and Bates (2000) provided one criterion. Each item of the task contains six words that can be unscrambled to form a sentence by selecting five words that form either positive or negative statements (e.g., an item, "happy miserable be I expect to," can be unscrambled either as "I expect to be happy" or "I expect to be miserable."). Participants were instructed not to form a negative statement, to work quickly, not to correct mistakes, and to complete as many sentences as possible. Accuracy was not stressed in this task, because emphasizing accuracy might elicit conscious regulation processes. We included a total of 40 items from the original SST task, and participants were given 6 min to complete the task. Because participants did not have enough time to complete the task and were instructed to work fast, we expected that their responses might be facilitated by FERPs. Each participant's score, which was the ratio of negative sentences in the total number of unscrambled sentences, reflects their lack of success in activating appropriate emotions while doing this task, and thus the score should be negatively related to effective distractor suppression.

An editing task, which also required emotional regulation, provided another performance criterion measure. Participants were asked to edit three emotionally laden stories (happy, sad, and neutral stories, in that order) that include spelling errors. The original stories were adopted from various sources, and were evaluated on their emotional content and intensity by three expert judges: Judges showed perfect agreement that the stories were evoking the intended emotions and that the emotions were "relatively strong" (at least over 8 on a 10-point Likert-type scale). Then, the stories were modified to have the same length and to include 15 spelling errors in each story. To reduce the possibility of completely ignoring the content of the story and focusing only on spelling errors, participants were also instructed to remember the content of the story. Randomly sampled participants remembered the content correctly when they were verbally asked about the content of the stories. Participants were given 7 min to finish the task, which was slightly short for average readers at college level, but long enough for most readers to finish at least the second story based on a result of pilot studies. This time pressure was used to minimize the potential for conscious attempts to regulate emotions, and again suggests that FERPs would be related to performance. Our performance measure was based on the number of correctly identified spelling errors on the second editing task. Therefore, the score on the editing task should be positively related to effective distractor suppression.

There were two additional measures that were related to emotions. The Beck Depression Inventory–II (BDI–II; Beck, Steer, & Brown, 1996) was included as an emotion-related dependent measure. The BDI–II measures the extent of depressive symptoms such as depressed mood and hopelessness. It includes 21 items with 4 possible choices. If the DST is addressing emotional processes, it should be moderately related to the BDI–II. A task satisfaction measure with a 10-item semantic differential scale (Stone, 1977) was also included as a dependent measure. For this measure, participants were asked to respond on a 7-point scale. Gardner (1986) used the scale in his study and reported a Cronbach's alpha of .97.

Procedure

After filling out informed consent, participants began the experiment by completing the PANAS, NEO–FFI, and BDI–II questionnaires. Then they performed the DST on a computer following the procedure shown in Figure 2. The target and the distractor primes were marked by showing faces in either blue or green, respectively, and the color was counterbalanced across participants. Participants were instructed to focus on the emotion that the target prime was expressing because they would be asked to identify the emotion at the end of each probe trial. We called this identification the *emotion categorization task.*

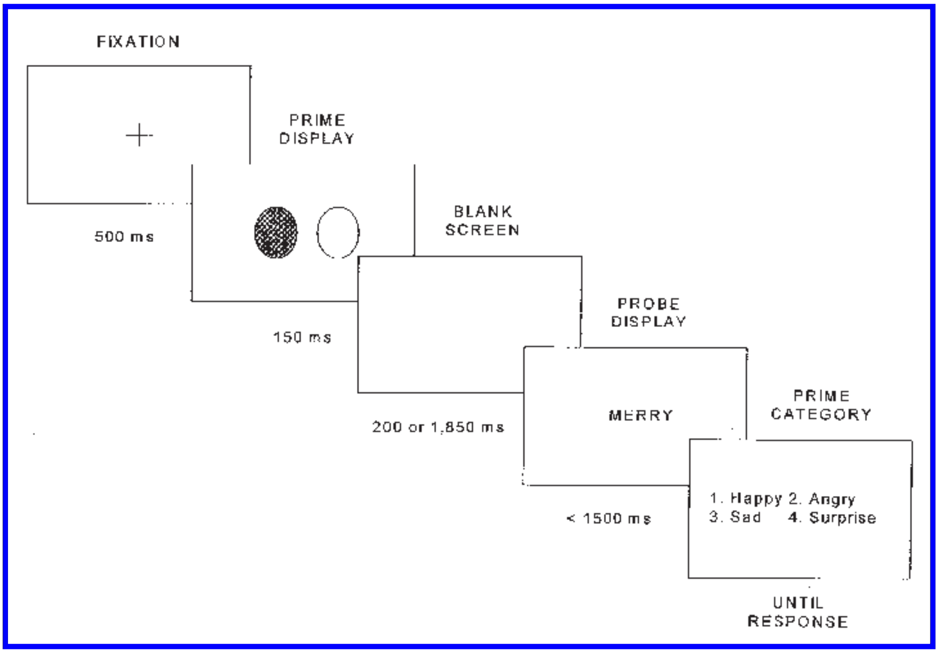

FIGURE 2 Experimental procedure of Study 1.

For each trial in the DST, an orienting stimulus (+) was presented for 500 msec, followed by the prime faces for 150 msec, and then the two faces disappeared. The probe word was then presented 200 msec (or 1850 msec) after the target-distractor prime faces disappeared, and it remained on the screen until participants made responses. The combination of the 150 msec prime word duration plus the interstimulus interval during which the screen was blank thus yielded SOAs of 350 or 2000 msec. Each participant performed the DST in both SOA conditions, with the 350 or 2000 msec blocks of trials being presented in random orders.

The probe task was a lexical decision task which involved deciding whether the probe was a meaningful word. Participants only needed to press one of the two keys indicating "yes" or "no." RT measured the time from when the probe word appeared until a response was made. To minimize unrelated conscious processing, participants were asked to respond to probes as quickly as possible. If a response was slower than 1500 msec, a warning sound occurred and a message to respond more quickly was given. To make sure that participants actually focused on the target face prime, they categorized the target prime at the end of each trial in terms of the four emotion categories shown in Figure 2 (the emotion categorization task). If participants made errors in the emotion categorization tasks, a warning message with a tone was given. After finishing all 20 practice trials and 288 experimental DST trials, participants completed a task satisfaction measure. As a last step, participants performed the SST and the editing tasks. After finishing all tasks, participants completed demographic questionnaires and were debriefed.

Results

Demographic and Questionnaire Data

Descriptive statistics and the correlations of measures are presented in Table 1, which includes Cronbach's alpha coefficients on the diagonal. Consistent with prior research, the PANAS positive affectvity (PA) and negative affectivity (NA) dimensions showed a negative but modest correlation. PA was also negatively correlated with Neuroticism and the BDI–II, and positively with Extraversion. NA showed positive correlations with Neuroticism and the BDI–II, and a negative correlation with Extraversion. In addition, alpha coefficients of questionnaire measures were all satisfactory and comparable to findings of previous studies.

Calculation of independent variables. There were two error measures in addition to the RT indicators in this study: errors for the probe word and nonword judgment (probe errors) and errors for the recalled emotion category of the target face (category errors). Overall, participants showed more category errors (M = 20.32, SD = 13.38; M = 13.97, SD = 10.28, for 350 and 2000 SOAs, respectively)

TABLE 1
Descriptive Statistics and Correlations for Questionnaire Measures in Study 1

	M	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1. Age	25.18	8.79	—								
2. Sex[a]	.24	.43	.08	—							
3. Positive affect	33.74	7.75	.01	.06	(.90)						
4. Negative affect	20.14	7.87	–.24**	–.09	–.37**	(.88)					
5. Extraversion	30.41	5.74	.03	–.06	.48**	–.26*	(.74)				
6. Neuroticism	22.13	7.76	–.20*	–.11	–.37**	.62**	–.34**	(.82)			
7. BDI-II	10.83	8.31	–.02	–.08	–.62**	.60**	–.43**	.68**	(.90)		
8. Satisfaction	41.81	9.20	–.04	–.06	.07	–.08	–.03	.06	–.05	(.88)	
9. SST	.07	.07	–.00	.04	–.27**	.38**	–.21*	.27**	.24*	–.16	—
10. Editing Task	8.03	3.03	.04	–.14	–.05	–.13	.03	–.02	.00	.01	–.05

Note. BDI-II = Beck Depression Inventory-II; SST = scrambled sentences task. *N* = 101. The numbers in the parentheses are Cronbach's alpha coefficients.

[a]Male was coded as 1 and female as 0.

**p* < .05. ***p* < .01.

than probe errors ($M = 9.98$, $SD = 6.52$; $M = 7.40$, $SD = 6.05$, for 350 and 2000 SOAs, respectively). In calculating RT indicators, two criteria were adopted to exclude invalid data: a probe word error rate greater than 30% applied within each of the prime-probe combination conditions (activation, suppression, and three control conditions) and an overall error rate of greater than 30%. In addition, RTs which were too fast to be reasonable responses based on pilot study results (< 300 msec), and extreme RTs that were 2 or more standard deviations above the mean RT of each condition were excluded. Using the two criteria in calculating RT, 78 participants were retained in analyses including RT data from 350 SOA condition and 91 from 2000 SOA. The high error rate, however, may simply indicate that the time pressure was extreme and that error measures may be better measures of emotional regulation capacities in this task. Therefore, the DST indicators of emotional regulation processes were evaluated by considering results from independent analyses using either the RT or error data.

Descriptive statistics for RT data are presented in the left portion of Table 2. For each Study 1 measure, probe RTs in 350 SOA condition were significantly slower than the 2000 SOA condition ($p < .001$), which in combination with the highest error rate indicates the difficulty of the 350 SOA condition. Interestingly, the pattern of RT indicators within each SOA condition was not consistent with the logic of the negative priming paradigm. According to the logic, the suppression condition should result in a slower average RT than in the control condition. However, in both conditions, the suppression condition means at group level were faster than the control condition, although the differences were not statistically significant.

TABLE 2
Means of Reaction Times in Three Studies

	Study 1 (SOA)				*Study 2 (Prime Type, SOA = 350ms)*[d]								*Study 3*[e]	
	350ms[a]		*2000ms*[b]		*Faces 1*[c]		*Faces 2*		*Emotional Words*		*Neutral Words*		*350ms*	
Process	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Activation	766.73	152.34	708.43	134.79	753.38	176.89	726.19	171.62	770.88	173.11	746.71	144.85	706.17	173.32
Suppression	767.46	152.79	702.02	138.68	709.45	168.94	691.35	156.88	744.29	187.06	765.54	161.99	686.67	164.92
Control	774.71	154.93	706.54	144.17	734.82	174.55	716.79	162.62	765.01	184.64	770.03	167.81	716.59	182.90
Nonword control	901.83	133.26	826.22	128.57	855.33	145.97	831.29	140.28	860.98	158.57	876.42	138.08	812.07	173.67
Surprise control	763.43	153.33	692.02	138.84	746.74	177.02	713.25	176.83	768.46	182.03	767.25	143.36	704.12	178.96

Note. SOA = Stimulus Onset Asynchrony. The number of trials in each column was the same (# of trials = 96) except for Study 3 (# of trials = 384). Sample sizes were reduced because of excluding invalid data by the condition. Units are milliseconds.

[a]N = 78. [b]N = 86. [c]N = 91. [d]N = 71. [e]N = 98.

Nevertheless, there were still a substantial number of participants for whom suppression RT means were slower than control RT means (47.4% and 44% for 350 and 2000 SOA conditions, respectively).

Calculation of dependent variables. The SST task scores were calculated by computing the ratio of negative sentences to the total number of solved items following the scoring procedure of Wenzlaff and Bates (2000). Because participants were instructed not to form negative sentences, this is an inverse measure of performance. Ten participants' scores were excluded in the analysis because they did not follow the instructions: Typically, these participants tried to write down their answers instead of indicating the order of the words, which must have slowed down the speed of task performance.

In the editing task data, 13 participants' scores were excluded from analyses. Three participants could not finish reading the second story, and 10 participants tried to write down their answers instead of underlining the errors, which could slow down the speed of their task performance. Dropped cases in dependent variables were largely redundant with the cases dropped in the RT data, causing only minimal additional reductions in N size for analyses. The smallest N size was 71 for the RT measure in the 350 SOA in combination with the SST task.

Hypothesis Testing

H1 predicted a significant relation between FERPs and task performance. H2 predicted that these effects still would be significant after controlling for self-report emotional tendencies measures. Because tests of both hypotheses yielded very similar results, we report only the results controlling for self-report measures of emotional tendencies. However, we note in the text when there were noticeable differences in results produced by controlling for self-report measures of emotional tendencies. This can be viewed as a very conservative test of H1. To test these hypotheses, we conducted six separate analyses in which performance measures were regressed on either RT or error measures for each SOA, after controlling for age, gender, and the PANAS PA and NA measures, which were the best questionnaire predictors of criteria. Because RT measures reflect individual differences in processing speed, they must be corrected in some manner to remove this component in testing hypotheses. Research on suppression typically does this by comparing suppression RT to those for control conditions. When we included both of these terms in regressions, the beta coefficients indicated that the difference score could be used (Edwards, 1994). Therefore, we used the difference scores between RTs in suppression and control conditions.

Results in Table 3 show significant effects of FERPs even after controlling for the strong effects of PANAS dimensions. The 350 SOA RT explained additional 6.3% of the variance in the SST task after controlling for these measures, and explained 8.3% without control for the PANAS (for both $p < .05$). Predictions of editing task performance from both probe and category errors also remained signifi-

TABLE 3
Summary of Hierarchical Multiple Regression Analyses Predicting Task Performance After Controlling for Demographics and PANAS Dimensions at Step 1 in Study 1

	Scrambled Sentences			*Editing Task*		
Predictor Variable	R^2	ΔR^2	β	R^2	ΔR^2	β
Step 1[a]						
Age, Sex, PA, NA	.171**			.057		
Step 2						
350 SOA RT		.063*	.254		.002	–.050
350 SOA probe errors		.021	.151		.108**	–.350
350 SOA category errors		.015	.124		.050*	–.229
2000 SOA RT		.003	.053		.042†	–.213
2000 SOA probe errors		.010	–.103		.004	–.072
2000 SOA category errors		.000	–.013		.009	–.101

Note. PA = Positive Affectivity; NA = Negative Affectivity; PANAS = Positive and Negative Affect Schedule; SOA = Stimulus Onset Asynchrony; RT = response time. For RT predictors probe and control RTs were entered in the regression equation in the same step. Error predictors were transformed using logarithms. Actual sample sizes (N = 58–79 for RT; N = 88–1 for errors) for specific regressions varied with SOAs and because of the exclusion of invalid data and univariate, multivariate outliers.

[a]Step 1 results are from the analysis with the largest *df*.

†$p < .10$. *$p < .05$. **$p < .01$.

cant. However, neither the RT nor error measures were significant for the 2000 SOA condition. Therefore, H1 and H2 were supported, but only for the 350 SOA condition. These results show the potential of FERPs but not SERPs to capture a unique aspect of self-regulatory capacity that is important in managing emotions while performing tasks with emotional components. We also computed similar analyses for activation measures in Study 1 (and Study 2) finding that they did not predict performance, so they will not be discussed further, although they are available from the first author. Exclusion of the activation data also makes sense conceptually, because activation processes do not show the same ironic effects associated with suppression (Wegner, 1994; Wenzlaff & Bates, 2000).

In summary, H1 and H2 were supported in Study 1. In addition, error measures generally showed significant predictions of other emotion-related dependent variables. That is, in 350 SOA condition, probe errors predicted BDI–II at a marginal level ($p < .10$), and category errors predicted task satisfaction. Again, no significant effect was observed in the 2000 SOA condition.

Discussion

The results of Study 1 generally supported our expectations: Considering both RT and error components, the DST measure in fast SOA conditions significantly predicted performances on the SST and editing task even after controlling for the trait emotionality. These results are consistent with the argument made in the introduction that fast suppression of irrelevant emotions prevents these emotions from interfering with interpretive or control structures used for task performance. Arvey et al. (1998) strongly suggested significant links between emotional processes and task performance; however, no prior studies provided empirical evidence for this relationship. In contrast to results from the 350 SOA condition, identical measures from the same individuals based on 2000 SOA trials showed no ability to predict these same criteria. With a 2000 SOA, there is more time for intentional strategies to operate on priming trials, so that the RT (or error) measures based on the condition would index the capacity to use conscious as well as preconscious suppression processes. Thus, only FERPs predicted task performance.

There are several reasons why SERPs may not be a good indicator of task performance in this study. One may be that although slower acting suppression processes can still inhibit distractor emotions, they cannot do this before the distractor emotions interrupt processes critical for task performance. After all, proofreading and manipulating words to form sentences involve relatively fast cognitive processes that can be disrupted before conscious suppression processes can work. Another plausible reason that conscious suppression capacities may not be helpful is that they do not work well in situations with high cognitive load. Proofreading and unscrambling words to form sentences are tasks that would create high cognitive load, making conscious suppression ineffective (Wegner, 1994). In addition, the time pressure in the two performance tasks should produce additional cognitive load. In short, we think that the 2000 SOA measure reflects ERPs that are not as broadly useful as FERPs.

STUDY 2

Results from Study 1 showed the potential of FERPs to predict various criterion variables. However, the pattern of the RT data in Study 1 was not consistent with the logic of the typical negative priming paradigm: The average RT in the suppression condition was faster than the RT in the control condition. Although this result can be explained by Wegner's (1994) ironic process theory, it is contrary to predictions and therefore warrants replication. It is also possible that the processing of faces evoking emotion is qualitatively different than the processing of emotion-related words that are typically used in the negative priming paradigm. We also examined this possibility in the second study.

Study 2 replicated the DST used in Study 1 with an increase in the time limit to probe response from 1500 msec to 2000 msec. The DST in Study 2 also included two additional task sessions with emotional word and neutral word primes that also help address construct validity issues. The comparison between the face primes and the emotional word primes should help determine whether the RT pattern in

Study 1 was actually driven by the visual or emotional characteristics of the priming stimuli. If both conditions show the same pattern of results, it would suggest that the emotion characteristic was the critical factor. Finally, Study 2 also included minor modifications such as the inclusion of only one SOA condition (350 msec).

Method

Participants

A total of 75 students from another Midwestern university (59 women and 16 men) whose first language was English (or who started to learn English before the age of 10) participated in Study 2. Because of equipment failure, data from 4 participants were discarded; therefore the final sample size was reduced to 71. The mean age of the final sample was 20.31 (*SD* = 3.80) with a range of 18 to 41. Forty-eight participants were working at least part time. The ethnicity of participants was 66 White, 4 Asian, and 1 did not indicate her ethnicity.

Design

Except for two modifications, all parameters of the DST in Study 1 were retained to make comparisons between two data sets possible. First, we included only the 350 SOA condition because it usually took more than a half hour to finish only the computer tasks. The other modification in the DST was an increase in the time limit to the probe word response. It was suspected that the stringent time limit to the probe word response in Study 1 (1500 msec) increased the probe word error rate substantially, which made it impossible to calculate RTs for many participants: Although the error rate is a valid indicator of responses, the examination of RT data is necessary to appropriately assess the construct validity of the DST paradigm when applied to emotional stimuli. Therefore, the time limit of probe word response was increased to 2000 msec. Study 2 also used a response keypad (RB-420, Cedrus Corp.) with less than 1 msec error range, faster computers with better graphic capabilities, and better monitors to enhance accuracy.

Prime Sessions

These blocks of trials were the same as Study 1, except for the addition of emotional and neutral word primes. The emotional word prime session included three word primes: “Happy,” “Angry,” and “Sad.” Each session included only three prime stimuli to make the procedure comparable to the face prime session. The responses in the probe trial remained the same as in the face prime condition, yielding three conditions: activation (prime target–probe category match), suppression (prime distractor–probe category match), or control (no relation between the prime and probe categories). The neutral word prime session included three word primes:

"Train," "Ship," and "Plane," but these categories bore no relation to the emotional categories of the probe trial. Study 2 also included PANAS, task satisfaction measure, SST, and editing task. To shorten the time of the experiment, the NEO–FFI and BDI–II were excluded.

Results

Descriptive Statistics

Descriptives and correlations of demographic information and questionnaire measures are presented in Table 4 and Cronbach's alphas are presented on the diagonal. Again, consistent with prior research and Study 1, the PANAS PA and NA showed a nonsignificant negative correlation, and all scales showed satisfactory coefficient alphas. For each of the face prime sessions in Study 2, participants' emotional category errors (M = 19.87, SD = 13.78) and probe word errors (M = 9.96, SD = 9.74) were also similar to the emotional category errors (M = 20.32, SD = 13.38) and probe word errors (M = 9.98, SD = 6.52) in the 350 SOA condition in Study 1. The similar results were somewhat unexpected because Study 2 extended the time limit of probe response to reduce the probe word errors. However, the number of participants who made too many errors to include their data was substantially reduced (from 33% of participants in Study 1 to 10% in Study 2), and information on responses was directed more to RT measure in Study 2.

Descriptive statistics for the Study 2 RT data are presented in the middle columns of Table 2, which show several notable results. First, the patterns of data from all conditions involving emotional primes, either words or faces, were very similar to each other and to the pattern of Study 1 data: mean RTs in suppression condition were faster than mean RTs in control condition, and this pattern held for

TABLE 4
Descriptive Statistics and Correlations for Questionnaire Measures in Study 2

	M	*SD*	*1*	*2*	*3*	*4*	*5*	*6*
1. Age	20.45	3.55	—					
2. Sex[a]	.20	.40	–.05	—				
3. Positive affect	33.74	7.75	.09	.05	(.87)			
4. Negative affect	20.14	7.87	.01	–.12	–.17	(.80)		
5. Satisfaction	36.14	10.87	.02	–.00	–.01	–.04	(.93)	
6. SST	.13	.14	–.09	.23†	–.11	–.07	.02	—
7. Editing task	7.36	3.28	.09	–.13	.00	.14	–.05	–.30*

Note. SST = scrambled sentences task. N = 69–71. The numbers in the parentheses are Cronbach's alpha coefficients.

[a]Male was coded as 1 and female as 0.

†$p < .10$. *$p < .01$.

62% to 64% of the participants in these conditions. It is also noteworthy that face primes seemed to accelerate responses to probe words: the face prime condition showed much faster mean RTs than the word prime condition. It also should be noted that the suppression RTs for emotion primes in Study 2 were much faster than both activation and control RTs, whereas such a pattern was not observed in neutral word prime condition. The mean RT in the neutral word prime condition ($M = 770.03$) was the slowest among controls, and as expected, the use of this as an alternative control condition in computing suppression or activation effects for the word condition had little impact on results.

Predicting Performance Criteria

The effects of the DST on criterion variables were investigated using the same analysis strategy as Study 1. The results show the incremental variance after controlling for age, sex, and the PANAS measures at step 1. As in Study 1, when the difference score (Edwards, 1994) between suppression and control RTs was entered in the regression equation after all control variables, the effect on SST, $\Delta R^2 = .062$, $F(1, 57) = 4.11$, $p < .05$, and editing task, $\Delta R^2 = .059$, $F(1, 56) = 4.22$, $p < .05$, were both significant. None of the error measures significantly predicted criteria, indicating that the response information was directed to RTs in Study 2. This effect was expected because participants had more time to respond to the probe task in Study 2.

The same analyses were conducted for suppression measures based on the emotional word prime condition. These analyses are useful in assessing whether we are measuring more than a general ability to suppress competing cognitions with our facial negative priming measure. Interestingly, the RT measures in the emotional word condition showed a significant effect on editing task, $\Delta R^2 = .070$, $F(1, 54) = 4.91$, $p < .05$, but not on the SST, $\Delta R^2 = .026$, $F(2, 54) = .788$, *ns*. In addition, error measures did not predict criteria.

To examine whether facial emotion has unique characteristics, we entered the two difference scores from face prime and emotional word prime conditions in the regression model. The beta coefficients of difference scores in the face prime condition, $\beta = -.282$, $t(58) = 2.32$, $p < .05$, and emotional word condition, $\beta = -.263$, $t(56) = 2.13$, $p < .05$, were comparable for editing task performance. However, the same kind of analysis with SST performance resulted in markedly different results [face prime condition, $\beta = .253$, $t(59) = 2.04$, $p < .05$; emotional word condition, $\beta = .000$, $t(57) = .00$, *ns*]. The combined results suggest that face primes and emotional word primes share some of their ability to predict task performance, but the facial priming stimuli are more general predictors. One interpretation of this finding is that heredity has "wired" people to automatically respond to facial expressions (Öhman, Lundqvist, & Esteves, 2001), so that the ability to regulate responses to emotional faces is a particularly good indicator of one's capacity for FERPs.

Discussion

The results of Study 2 strengthened our confidence in Study 1 results. For most participants (63%), the RT was still faster for probes in the suppression condition than for control probe words or for probe words in the activation condition. One reason why suppression RT means could be faster than control RT means is that because the time pressure (350 msec SOA) was too extreme to allow effective suppression, emotional probes may have become hyperaccessible for many participants when they were unsuccessfully suppressed, which is consistent with the predictions of ironic process theory. Indeed, in a recent series of three studies, Page et al. (2005) also found hyperaccessibility (as indicated by increased rebound effects) for to-be-suppressed information in very fast SOA conditions (150 msec) but not in slower (2000 msec) conditions.

Another possibility pertains to the fact that the target and distractor primes were both presented at the same time. Suppression helps get rid of primed stimuli that are not needed for current tasks (Stoltzfus, Hasher, Zacks, & Ulivi, 1993), and thus serves a "housekeeping function." If suppression processes were still attempting to "clean-up" working memory when the probe was presented, they may be currently operating on the distractor rather than the target, and the distractor would be easier to be identified as a word. Again, efficient FERPs should reduce this tendency. Therefore, effective distractor suppression processes might enhance the task performance in this situation, too, as it does on many other goal-related tasks (Johnson et al., 2006). Nonetheless, our results in both Studies 1 and 2 show that this hyperaccessibility was only true for some individuals, and importantly, these same individuals tend to have difficulty in performing cognitive tasks with a strong emotional component.

The DST indicators based on emotional primes (i.e., faces and words conveying emotions) predicted task performance measures significantly whereas the ones with neutral words did not. In addition, the DST indicators based on emotion faces showed more general effects on task performance measures than the ones based on emotion words. Indeed, there is considerable evidence (see Öhman et al., 2001) that facial emotions can be processed automatically, making them particularly hard to suppress. Also, it is well known that processing of emotional stimuli involves limbic system and frontal lobe structures that are not activated with the processing of neutral words (LeDoux & Phelps, 2000). We suspect that these aspects of emotions make them particularly hard to ignore for most people and thus were responsible for the significant effects of emotion related primes and the more general effects of face primes.

STUDY 3

In previous studies, the DST indicators significantly predicted performances on the SST and editing task, as well as task satisfaction and general depression. In addition, the DST indicators were also moderately correlated with trait emotionality (e.g., PANAS dimensions and Extraversion and Neuroticism). However, because of the verbal components of the DST measure and criterion tasks in the studies, there may be a potential confounding variable (i.e., verbal intelligence) that is a powerful predictor of performance on this type of tasks. The confounding of intelligence may be especially problematic with the error indicators of the DST because those who are more error prone would make more errors in any type of tasks. To control for ability (and personality) factors associated with error proneness, we included measures of verbal intelligence and Conscientiousness as control variables in this study.

In analyzing the RT data from the DST, the speed of responses and errors should be considered at the same time. RT, however, may not be a very practical indicator because often it is not reliable and it requires complex calculation processes. In contrast, the amount of error is simpler to understand and score. Also, several other studies using a "deadline" procedure that requires fast responses from respondents showed that this procedure consistently directs priming effect to errors (e.g., Draine & Greenwald, 1998; Van Overwalle et al., 1999). In addition, Cunningham, Preacher, and Banaji (2001) found that the result based on the deadline procedure paralleled RT-based results. In Study 3, therefore, the time limit of the response was set at 1500 msec, which was used in Study 1, resulting in significant effects of the error measures. Therefore, the results from the analysis of the error measures are stressed in Study 3. Although the RT data were fully analyzed, we expected that they would not predict performance. In short, Study 3 attempted to replicate the findings of previous studies and test whether the DST could predict task performance after controlling the effect of verbal intelligence (H3).

Method

Participants

Participating in this study were 103 students taking various sections of the Introduction to Marketing course and the Social Psychology course at a Midwestern university. Data from three participants had to be excluded because either their first language was not English or they did not start learning English before their age of 10. Among the valid 100 participants, 65 were women. Age of participants ranged from 19 to 45 with a mean of 22.42 (*SD* = 4.47). The ethnicity of participants, based on the reports of three test administrators, was exclusively White except for the three nonqualified participants. Participants were offered extra credits for the course and also a chance to win one of seven $50 prizes for the participation.

Measures

We used the verbal intelligence subtest score of the Wechsler Abbreviated Scale of Intelligence (WASI; The Psychological Corporation, 1999), the short version of a widely used IQ test. As in Study 1, NEO–FFI, BDI–II, and task performance tasks (the SST and editing tasks) were also included.

Procedure

There were two sessions in this study: the DST and the intelligence test sessions. Participants in groups of two to four began the DST session by completing the personality questionnaire. Then they performed the DST on a computer. The parameters of the DST were identical except that the time limit for responses to the probe words was set at 1500 msec as in Study 1. After finishing the DST, participants were asked to complete a task satisfaction measure and then performed the editing and SST tasks. After finishing the first session, participants were asked to come back for the individual session measuring their depression and intelligence levels in a week. In the second session, participants took the intelligence test (WASI) individually. After finishing the WASI, they filled out the BDI–II.

Results

Data from the DST were examined for invalid responses. Four participants showed too many probe errors (higher than chance level of 50%) and too fast RTs (faster than 200 msec), which suggested a random response pattern, and they were excluded from the analysis involving the DST measure. Another participant showed a random response pattern in emotion categorization task and the category error data of this participant were excluded from the analysis.

Analyses were focused on two error measures (i.e., probe and emotion category error measures) in the DST. It should be noted, however, that the pattern of RT data successfully replicated the patterns of the results found in the previous studies as presented in the last column of Table 2. Descriptives and correlations between variables with reliability estimates on diagonal are presented in Table 5. As expected, and consistently with results from Study 1 and Study 2, the two DST error measures were significantly correlated with emotion-related variables, including BDI–II and task satisfaction. However, the error measures showed weak correlations with the two personality dimensions. The error measures were also strongly correlated with the verbal intelligence score.

Before testing hypotheses, data were cleaned and examined for violations of assumptions of regression analysis. Both probe and category error distributions

TABLE 5
Descriptive Statistics and Correlations Among Variables in Study 3

	M	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1. Age	22.37	4.41	—										
2. Sex[a]	.33	.47	.08	—									
3. Verbal IQ	109.57	11.54	.11	.22*	—								
4. Category error	53.46	33.03	.10	–.07	–.34**	(.90)[c]							
5. Probe error	30.87	29.58	.01	–.06	–.54**	.62**	(.88)[c]						
6. Neuroticism	21.13	7.45	.09	–.18†	–.23*	.16	.12	(.85)					
7. Extraversion	32.72	5.21	–.18†	–.10	–.00	–.27*	–.13	–.28**	(.69)				
8. Conscientiousness	33.97	5.13	.17	–.10	–.06	–.07	–.24*	–.29**	.23*	(.74)			
9. BDI-II	7.71	6.89	–.05	.11	–.22*	.30**	.18†	.55**	–.19†	–.28**	(.87)		
10. Satisfaction	35.85	11.05	.07	.05	.26*	–.40**	–.32**	–.15	.18†	.18†	–.30**	(.93)	
11. Editing	8.03	2.93	.17†	–.19†	.20*	–.14	–.17	.16	–.15	.11	–.04	.12	—
12. SST[b]	.15	.14	.16	.20*	–.12	.37**	.20*	.11	–.21*	–.05	.44*	–.21*	–.09

Note. BDI-II = Beck Depression Inventory-II; SST = scrambled sentence task. *N* = 97–100. The numbers in the parentheses are Cronbach's alpha coefficients.

[a]Male was coded as 1 and female as 0. [b]Higher scores on the SST indicate lower performance. [c]These numbers are based on the test–retest reliability estimate using first and second halves of the trials.

†$p < .10$. *$p < .05$. **$p < .01$.

showed moderate positive skewness and were transformed using logarithm function. H1 was tested by a series of regression analyses. Performance on the SST and the editing tasks were regressed on each of the probe and category error measures after controlling for demographic variables including age and sex. As a result, probe error significantly predicted the SST performance, $\Delta R^2 = .061$, $p < .01$, and the editing task, $\Delta R^2 = .050$, $p < .05$. Category error also significantly predicted the SST, $\Delta R^2 = .076$, $p < .01$, and the editing task, $\Delta R^2 = .056$, $p < .05$. Therefore, H1 was supported and the results of previous studies were successfully replicated. However, the difference score between suppression and control RTs was not significantly related to performance on either SST or the editing tasks.

H2 was tested by regressing the SST and editing task performance scores on each of the two error measures after controlling for demographic and personality dimensions (e.g., Neuroticism and Extraversion). As a result, probe error significantly predicted the SST, $\Delta R^2 = .058$, $p < .05$, and the editing task performance, $\Delta R^2 = .061$, $p < .01$, and, category error also predicted the SST, $\Delta R^2 = .073$, $p < .01$, and the editing task performance, $\Delta R^2 = .070$, $p < .01$. Thus, H2 was supported, successfully replicating the results of Study 1.

To test H3, which predicted that the DST would show unique effects on task performance above and beyond verbal intelligence, scores on the editing task and the SST were regressed on the two error measures separately after controlling for demographic variables, verbal intelligence, and Conscientiousness, to control for inherent error proneness of respondents which may confound error measures.[1] As shown in Table 6, both probe and category errors showed moderately strong and significant effects on SST and the editing task even after controlling for both verbal intelligence and Conscientiousness. Therefore, H3 was supported.

Discussion

The results of Study 3 successfully replicated previous studies. The DST measures significantly predicted performances on the SST and editing tasks, and the effects were independent of trait personality dimensions that were included as a measure of trait emotionality. In addition, the DST measures were significantly related to depression and task satisfaction. These replicated results added to our confidence in the validity of the DST in measuring FERPs.

One of the biggest issues related to the DST was addressed in Study 3. That is, the predictability of the DST was directly compared to verbal intelligence. Interestingly, the DST measures were strongly correlated with verbal intelligence. In addition, verbal intelligence showed significant effects on the editing task. Nevertheless, the effects of the DST measures on the performance tasks were not re-

[1]We would like to thank an anonymous reviewer for this suggestion.

TABLE 6
Summary of Hierarchical Regression Analyses for Editing Task Performance and SST Performance After Controlling for Verbal Intelligence

SST			*Editing Task*		
Predictors	β	*t*	*Predictors*	β	*t*
Step 2			*Step 2*		
Age	.229	2.273*	Age	.205	2.021*
Sex	.154	1.534	Sex	–.157	–1.547
Conscientiousness	–.040	–.393	Editing task error	.130	1.279
Verbal intelligence	–.111	–1.102	Conscientiousness	.056	.535
Probe error	.306	3.043**	Verbal intelligence	.215	2.100*
			Probe error	–.226	–2.210*
		R^2 = .174**			R^2 = .190**
		ΔR^2 = .089*			ΔR^2 = .048*
Step 2			Step 2		
Age	.169	1.705	Age	.242	2.370*
Sex	.196	1.983*	Sex	–.182	–1.788†
Conscientiousness	–.070	–.703	Editing task error	.100	.998
Verbal intelligence	–.125	–1.262	Conscientiousness	.086	.836
Category error	.342	3.511**	Verbal intelligence	.219	2.138*
			Category error	–.213	–2.130*
		R^2 = .199**			R^2 = .187**
		ΔR^2 = .115**			ΔR^2 = .044*

Note. SST = scrambled sentence task. Step 1 included age, sex, editing task errors, Conscientiousness, and verbal intelligence as predictors. Actual sample sizes (N = 90–92) were varied because of the exclusion of univariate and multivariate outliers.

†p < .10. *p < .05. **p < .01.

duced by controlling for Conscientiousness and verbal intelligence. This result further strengthens our confidence that the error measures are not merely caused by innate error proneness or verbal abilities but reflect emotional regulation processes that are critical in performing the type of tasks included in this study.

GENERAL DISCUSSION

The results of these studies make two important contributions. First, they show that the DST paradigm can be used to assess individual differences in the ability to suppress emotions cued by facial expressions or emotional words, and that these individual differences predict task performance. Prior research had shown that distractor suppression measures based on verbal information could predict general regulatory effectiveness (Diefendorff et al., 1998). We have extended this effect to emotions and visual rather than verbal stimuli. A recent review of priming-based measures (Fazio & Olson, 2003) noted that there have been no prior attempts to relate priming measures to task performance, as we have done in this study. Second, by varying the SOAs for different trials, we were able to isolate the critical ability as being FERPs rather than SERPs. Both of these contributions provide guidance for future research aimed at understanding emotional regulation and related behavior in organizational situations.

In evaluating results from all three studies, it should be noted that our prediction of nonsignificant results of SERPs was supported along with our prediction of significant results for FERPs, which is a stronger form of hypothesis than merely predicting only significant results (Trafimow, 2003). In addition, we replicated the significant effects of Study 1 in the two follow-up studies and also showed that specific experimental procedures could largely determine whether RTs or errors predicted performance.

Negative Priming or Individual Differences?

The overall results of these studies showed that the logic of the negative priming paradigm has potential in investigating emotional processes. However, results indicated that the negative priming effect in the DST was better interpreted as an individual difference phenomenon than as a uniform group-level effect produced by different experimental conditions, which is typical in research adopting this paradigm. We examined the difference between each participant's mean RTs for suppression and control conditions, finding that 52.6% (Study 1), 62.1% (Study 2), and 65.3% (Study 3) of participants showed faster responses to the to-be-suppressed emotions, whereas the remaining proportions of participants showed more typical delayed responses to the to-be-suppressed emotions. These data help clarify the construct validity issue, strongly suggesting that the DST paradigm using emotional stimuli produces a hyperaccessibility effect that is better interpreted as an individual difference phenomenon than a uniform between-groups suppression effect.

It is also noteworthy that methodological changes from Study 1 (and Study 3) to Study 2 influenced whether errors or RTs were the better predictor of task performance. The faster requirement for probe RT responses in Study 1 and Study 3 produced greater predictability for the error components (although the 350 SOA RT effects were still significant in Study 1, but not in Study 3). In contrast, the incremental variance for the 350 SOA RTs was significant in Study 2 and closely replicated that of Study 1, but errors predicted nonsignificant amounts of incremental variance. We believe this is because Study 2 allowed more time for probe responses. Because errors are easier to score and understand than RTs, it may be advantageous to direct response information to errors. Draine and Greenwald's (1998) deadline procedure provides such a possibility.

In addition, there is some neurophysiological evidence bearing on the validity of our interpretation for the paradigm used in these studies. Research has shown that facial expressions of emotion lead to corresponding brain activities in the time frame used in this study paradigm (e.g., Ioannides, Liu, Kwapien, Drozdz, & Streit, 2000; Streit et al., 1999). For example, Streit et al. (1999) showed that facial emotion recognition evoked activations in different parts of temporal cortex between 100 and 270 msec, in inferior frontal cortex between 230 and 300 msec, and in amygdale at about 220 msec after stimulus onset. This evidence strengthens our belief that interpretation of emotional stimuli can occur in the time range of our fastest SOA, and that some individuals can quickly and preconsciously suppress interference from such interpretations, whereas others have more difficulty suppressing these interpretations.

Emotional Regulation or Intelligence?

An additional issue is whether our emotional regulation procedure merely reflects general intelligence, which could explain its capacity to predict performance on verbal tasks. In Study 3, the DST measure was directly compared to scores on an intelligence test, WASI (The Psychological Corporation, 1999). Error measures still showed strong predictions on both of the criterion tasks even after controlling for verbal intelligence and Conscientiousness. This result was obtained although the DST measures were strongly correlated with verbal intelligence. Although more research is needed, the effects of the DST cannot be fully explained by verbal intelligence or general error proneness.

Future Research

Future research should examine the incremental validity of our measure of FERPs compared to other self-report measures that directly address emotional regulatory processes such as the measures of emotional intelligence or more recent self-report measures of emotional regulation (Gross & John, 2003). It would also be helpful to differentiate our more automatic aspects of emotional suppression from more conscious constructs related to emotional control (Kanfer & Ackerman, 1996). Importantly, recent work by Page et al. (2005) also compared suppression processes in fast (150 msec) and slow (2000 msec) SOAs, and found results quite similar to ours: hyperaccessibility of to-be-suppressed information at fast but not slow SOAs. These results independently corroborate the importance of our distinction between FERPs and SERPs in emotional regulation. We expect that our focus on the real-time measurement of FERPs taps capacities that cannot be accessible through the traditional questionnaire method. Ideally, an understanding of emotional regulation would use measures and constructs reflecting both automatic and controlled regulation processes.

Because the DST can be used to assess both FERPs and SERPs, it may have implications for emotional labor research. As in other emotional regulation research areas, emotional regulation processes in emotional labor have been conceptualized at the conscious level (Grandey, 2000). However, we suggest that FERPs might be more important in many emotional labor situations because workers often do not have time to engage in conscious emotional regulation efforts. In addition, emotional labor using FERPs may cause less stress and consequently, create less burnout than emotional labor based on SERPs. The DST can be utilized to examine such a hypothesis. Also, the DST is likely to be much less vulnerable to faking than questionnaire-based measures of emotional regulation processes.

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