COGNITION AND EMOTION, 2004, *18* (8), 1079–1097

Behavioural, affective, and physiological effects of negative and positive emotional exaggeration

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Emotion regulation is essential for the production of socially appropriate affect and successful interpersonal functioning. The relative inability to modulate affect, known as ''emotional dysregulation'', is associated with many common mood disorders (such as major depressive disorder or bipolar spectrum disorders). Thus, understanding the physiological processes underlying emotional regulation is extremely important. This experiment was designed to explore the affective, behavioural, and physiological responses associated with a rarely studied emotion regulation technique—exaggeration. A total of 52 undergraduate participants watched a 2 minute video designed to elicit either feelings of amusement (positive affect) or disgust (negative affect). Physiological recordings—including skin conductance, interbeat interval (IBI), high frequency (HF) power spectrum of heart rate variability (HRV), and sympathovagal balance (LF/HF)—were recorded for the 2 minutes prior to, during, and after mood induction. As expected, persons asked to exaggerate their responses were rated as behaviourally showing increased arousal relative to individuals in the natural-watch condition. With regard to IBI, those in the exaggerate condition experienced significantly greater IBI reductions (increased heart rate) during reactivity and IBI increases during recovery relative to those in the natural-watch condition (who showed the opposite pattern of response). Moreover, persons in the exaggerate condition evidenced increased sympathovagal balance in response to the emotional videos relative to those in the natural-watch condition. Results generally support and extend previous research findings designed to assess the impact of response-focused affect modulation strategies. Suggestions for future research are presented.

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The authors thank Jennifer Goodpaster and Rhiannon Hamilton for their assistance in this research.

http://www.tandf.co.uk/journals/pp/02699931.html DOI:10.1080/02699930441000085

During a particularly stressful time at work, a colleague informs you of a recent success they have experienced. While happy for them, you do not feel as genuinely excited for them as perhaps you should. Or, conversely, a peer tells you about their morning car troubles in a most histrionic manner. You feel sad for them, but not as strongly as you feel a need to reflect. Both of these situations call for the modulation, and specifically the exaggeration, of an emotional response.

Emotion regulation, which has been defined as ''the processes by which individuals influence which emotions they have, when they have them, and *how they experience and express these emotions*'' (italics added, p. 275, Gross, 1998b), is a common human experience (Morris & Reilly, 1987; Rippere, 1977). So common is emotion regulation that it is most noticeable when absent: All Axis II personality disorders and more than half of the nonsubstance-related Axis I disorders involve emotional dysregulation (American Psychiatric Association, 1994; Gross & Levenson, 1997). The psychophysiology underlying emotional regulation is important to understanding more than just affective disorders: Emotional dysregulation is also a risk factor for cardiovascular disease (CVD) (Denollet et al., 1996; Murray & Lopez, 1997). Not surprisingly, data suggest that the diagnosis of an affective disorder likewise increases the probability for experiencing CVD (Barrick, 1999; Sher, 2001).

In part due to its predictive value, emotion regulation (and especially its underlying psychophysiology) has received increased attention over the past two decades. James Gross and colleagues have been particularly helpful in parsing the physiological, behavioural, and affective consequences of two different response modulation strategies, termed ''antecedent'' and ''response-focused''. Antecedent strategies are employed before the emotion response has been fully activated (Gross, 2002), and includes the well-researched strategy of reappraising an emotional event (e.g., when watching a disgust-eliciting film of an amputation, one might cognitively focus on the overriding benefit the patient will receive from the surgical procedure). Response-focused strategies, including affective suppression and exaggeration, are attempts to modulate behavior once an emotion has commenced.

Data suggest that antecedent- and response-focused strategies correspond to different affective, physiological, and behavioural patterns. In one study, Gross (1998a) asked undergraduate students to watch a disgust-eliciting film in a ''natural'' manner, and then to either suppress or reappraise a subsequent disgusting film. Although both modulation techniques produced decreased behavioural expression of emotion compared to the ''natural-watch'' condition, those asked to reappraise the film self-reported less of an emotional response as compared to those in the natural-watch and suppression conditions. Suppressors also showed increased sympathetic activation (measured by skin conductance, finger pulse amplitude, and finger temperature) relative to those in the natural-watch or reappraise conditions (1998a). The above data are not unique, and much evidence has accumulated suggesting that emotional suppression is associated with decreased behavioral response, increased sympathetic arousal, and no difference in self-reported affect to negative films (disgust, sadness, and embarrassment) but decreased positive affect to amusing stimuli (e.g., Gross & Levenson, 1993, 1997; Richards & Gross, 1999; Wegner, Shortt, Blake, & Page, 1990; Wegner & Zanakos, 1994; Weinberger, Schwartz, & Davidson, 1979).

It has been suggested that, because all response-focused strategies require active modulation of expressive behaviour, one would expect increased sympathetic activation as a result of that effort (Gross, 2001). While logical, this hypothesis has yet to be sufficiently tested because the impact of other response-focused strategies has been largely ignored. One such regulatory technique is emotional exaggeration, which may be defined as the behavioural augmentation of an already initiated emotion. One study investigating exaggeration was performed by Jackson and colleagues (Jackson, Malmstadt, Larson, & Davidson, 2000). These researchers asked undergraduate participants to suppress, ''enhance'', or simply maintain their emotional experience in response to negative slides from the International Affective Picture Set (Center for the Study of Emotion and Attention, 1999). While performing this task, eyeblink startle magnitude and corrugator activity were measured as an indicator of negative affect (e.g., Bradley, Cuthbert, & Lang, 1990; Lang, Bradley, & Cuthbert, 1990; Lang, Greenwald, Bradley, & Hamm, 1993). As expected, emotional enhancement was associated with increased startle and corrugator activity. Earlier research uncovered increased sympathetic arousal among people exaggerating relative to ''inhibiting'' or naturally expressing a negative emotion (Lanzetta, Cartwright-Smith, & Kleck, 1976; Vaughan & Lanzetta, 1981) (for an overview of this work, see McHugo & Smith, 1996). Specifically, participants who were asked to exaggerate their facial expressions while anticipating and receiving an electric shock evidenced greater skin conductance reactivity relative to those asked to ''conceal'' their expressions (Lanzetta et al., 1976). Vaughan and Lanzetta (1981) later found increased heart rate and skin conductance reactivity among persons who asked to ''amplify'' their facial reactions while watching others receive an electric shock. These studies, while extremely helpful in terms of informing the present research, were limited by their focus on sympathetic arousal in response to negative affect modulation.

With regard to self-reported affect, few studies have evaluated the role of emotional exaggeration. The first experiment, mentioned previously, found increased self-reported negative affect among persons exaggerating their expression while waiting for and receiving electric shock (Lanzetta et al., 1976). Conversely, Muraven, Tice, and Baumeisler (study 1, 1998) asked undergraduates to either exaggerate or suppress their facial reactions to a negative film. When queried, participants in each group reported comparable levels of negative affect, suggesting that exaggeration may not alter the subjective experience of negative affect (Muraven et al., 1998). Given the relative dearth of research incorporating emotional exaggeration as well as conflicting data, much work lay ahead to understand the impact of other response-focused strategies.

The present study was designed to extend prior research in two important ways. First, using both positive and negative emotion-eliciting films, an infrequently researched response-focused strategy—exaggeration—was included along with a natural-viewing condition. Second, because it is extremely important to assess both sympathetic and parasympathetic arousal (Beauchaine, 2001; Cacioppo, Uchino, & Berntson, 1994b; Gianaros & Quigley, 2001; Rhodes, Harrison, & Demaree, 2002), more discrete indicators of *cardiovascular* functioning were incorporated. The absence of parasympathetic indices in prior emotion regulation research is particularly notable because low levels of parasympathetic arousal and flexibility have been found to predict CVD (Bigger, Fleiss, Rolnitzky, & Steinman, 1993; Brosschot & Thayer, 1998; Friedman & Thayer, 1998a, 1998b; Hayano et al., 1991; Lombardi et al., 1987; Saul et al., 1988; Singer et al., 1988; Stein & Kleiger, 1999; Tsuji et al., 1996). All physiological measures were recorded for the 2 minutes prior to, during, and after presentation of the film clip. At the myocardium, the high frequency power band (HF, an index of parasympathetic arousal) resulting from heart rate variability (HRV, Berntson et al., 1997; Task Force, 1996) procedures and the low frequency/high frequency ratio (LF/HF, a measure of sympathovagal balance, Malliani, Pagani, Lombardi, & Cerutti, 1991; Pagani et al., 1986; Task Force, 1996) were calculated for each of the three time periods. Tonic skin conductance level (TSL, a measure of sympathetic arousal, Johnsen, Thayer, & Hugdahl, 1995; Lang et al., 1993; Parsons & Chandler, 1969) and interbeat interval (IBI) were also recorded over each of the three time periods. ''Reactivity'' was derived by subtracting pre-movie data from during-movie data whereas ''recovery'' was assessed by subtracting during-movie data from post-movie data (i.e., Time 2 − Time 1 and Time 3 − Time 2, respectively, Quigley, Barrett, & Weinstein, 2002; Tomaka & Blascovich, 1994; Tomaka, Blascovich, Kelsey, & Leitten, 1993). Facial reactions were recorded during film presentation and, following the recovery period, participants self-reported their emotional experience (valence, arousal, and dominance) to the video.

The following hypotheses were made. (1) The facial behaviour of persons in the exaggerate condition would be rated as evidencing increased arousal, as well as increased positive and negative affect in response to the positive and negative films respectively, relative to those in the natural-watch condition. (2) As a response-focused strategy, exaggeration would produce greater variability of sympathovagal balance and TSL (increases during reactivity and decreases during recovery), and IBI (decreases during reactivity and increases during recovery). (3) Following the suppression literature (e.g., Gross & Levenson, 1997), it was expected that those in the positive-exaggerate condition would self-report increased positive affect relative to those in the positive-natural condition whereas those in both the negative-exaggerate and negative-natural condition would self-report comparable valences.

METHOD

Participants

A total of 52 undergraduate participants between the ages of 18 and 22 years were recruited from the Case Western Reserve University (CWRU) subject pool. All participants obtained extra credit toward their psychology course. This research was approved by the CWRU Institutional Review Board.

Movies

Because physiological measures are often time-dependent (e.g., HF, LF/HF), it was important to use movies of the same duration. In accordance with recommendations made by the European and United States Task Forces (Berntson et al., 1997; Task Force, 1996), 2 minute affective film clips were used. The first, designed to elicit feelings of disgust, was a clip showing scenes from an animal slaughterhouse. The other 2 minute video, designed to elicit feelings of amusement, included scenes of a famous comedian's monologue.

Physiological recording procedures

Participants were tested in the Affective Neuroscience Laboratory located within the Department of Psychology at CWRU. Participants were tested individually in a quiet (45.00 $\pm$ 0.32 dB) and comfortably lit (about 1300 lux) room. Each physiological data collection period (pre-, during-, and post-movie) was 2 minutes in length, in accordance with the European and American Guidelines (Berntson et al., 1997; Task Force, 1996).

Tachogram (ECG) data were collected at the left and right wrists via disposable Ag-AgCl snap electrodes (Biopac Technologies Model EL503) and digitised at 500 samples per second onto a Dell Optiplex GX200 computer. Data were amplified by Biopac (Santa Barbara, CA) ECG100C amplifiers set for a gain of 1000 and using low and high pass filters of 35 Hz and .05 Hz, respectively. The interbeat interval (IBI) power spectrum was computed by fast Fourier transform (FFT) and the data were linearly de-trended using the Mindware (Westerville, OH) HRV 1.62 computer application. This program computed the average normal R-R interval (IBI, the inverse of heart rate with better statistical properties, Berntson, Cacioppo, Quigley, & Fabro, 1994a) over each 2 minute period. To perform heart rate variability (HRV) analyses, the Mindware program: (a) identified the R-R intervals; (b) detected physiologically improbably R-R intervals based on the overall R-R distribution using a validated algorithm (Berntson, Quigley, Jang, & Boysen, 1990) (data were also hand artifacted); (c) detrended the data using a first order polynomial to remove the mean and any linear trends; (d) cosine tapered the data and submitted it to FFT; and (e) took the natural log integral LF power (0.04–0.15 Hz) and HF power (0.15–0.40 Hz). Using pharmacological blockades of the sympathetic and parasympathetic synapses, LF and HF have been found to be good estimates of sympathetic and parasympathetic arousal, respectively (Akselrod et al., 1981; Berntson et al., 1994a, 1994b; Cacioppo et al., 1994a; Grossman & Kollai, 1993; Murphy, Sloan, & Myers, 1991; Pomeranz et al., 1985).

Skin conductance data were also collected via the use of Biopac TSD203 transducers with Biopac Skin Conductance Electrode Paste placed at the non-dominant middle and fourth fingers. Data were amplified using Biopac's GSR100C amplifier using a gain of 10 μΩ and a low pass filter of 10 Hz. Mindware's EDA 1.2 computer program identified all galvanic skin responses, as defined as a .05 μS increase in skin conductance, and calculated tonic level (TSL) as the average conductance level outside of a response (i.e., data from individual skin conductance responses were excluded from the average).

It is important to note that movies clips were digitally shown using Mindware's Active Movie Player, which also embedded the physiological record with a digital trigger at the beginning and end of the movie. This trigger allowed for extremely accurate data analysis, and permitted the quantification of data into to three, discrete 2 minute periods (to the nearest ms).

Questionnaires

Questionnaires were administered to participants in order to determine: (a) their affective response to each movie, and (b) their demographic background. The following questionnaires were administered.

Demographic Questionnaire (DQ). In accordance with guidelines from the National Institute of Mental Health, participants were asked to report information regarding their age, gender (male or female), and racial background (American Indian/Eskimo, Arab/Arab-American, Asian/Asian-American, Black/African American, Pacific Islander, White/Caucasian, Multiracial, or Other).

The Self-Assessment Manikin (SAM). The SAM (Bradley & Lang, 1994) was used to measure the three aspects of emotional experience—valence, arousal, and dominance—that may have been affected by movie viewing. The SAM is a Likert-type scale which depicts five figures ranging from sad to happy (1–5), relaxed to aroused (1–5), and submissive to dominant (1–5). After each movie, participants were asked to select one figure for each emotional aspect (valence, arousal, and dominance) that most closely approximated their affective response to the film they viewed. The SAM has been frequently administered to assess people's reactions to affective stimuli (e.g., Bradley, Cuthbert, & Lang, 1996; Lang et al., 1990, 1998).

Discrete Emotions Questionnaire (DEQ). This questionnaire was originally used by Gross and Levenson (1995) in order to better understand the intensity of different emotions felt in response to the video clips and to ensure that the desired emotion was being successfully elicited by each film (i.e., disgust and amusement). Participants were asked to rate 16 emotional feelings on a 9-point Likert scale from 1 (*Not at all*) to 9 (*The most I've ever felt*). We were primarily interested in six discrete emotional states (i.e., amusement, anger, contentment, disgust, fear, and sadness) whereas the other 10 emotional descriptors may be elicited by very different emotional experiences or are redundant (arousal, confusion, contempt, embarrassment, happiness, interest, pain, relief, surprise, and tension).

Procedures

On arrival, participants were asked to read and sign an informed consent form approved by the CWRU Institutional Review Board and then to respond to the DEQ. On completion of questionnaires, the electrode application procedures described above were initiated. Participants, who were randomly assigned to the disgust/amusement and natural watch/exaggerate conditions (4 groups) were seated in a sound attenuated chamber approximately 45 inches from a Mitsubishi 19-inch Diamond Pro 920 Color Monitor. Persons assigned to the natural-viewing condition were instructed to, ''watch [the film] as naturally as you can; Try to pretend that you're sitting at home watching TV. Now, I know you wouldn't normally have electrodes hooked up to you at home, but just try to relax and watch the clips naturally. Any questions?'' Conversely, participants assigned to the exaggerate condition were asked to, ''try to exaggerate your emotional reaction to the clip ... I want you to exaggerate your outward, facial reaction to the clip so that if somebody watched the videotape of you watching the clip, they would know exactly what you were feeling. Any questions?'' The door to the chamber was then closed and participants were given 10 minutes to become physiologically stable and to acclimatise to their surroundings. After 10 minutes, physiological recording began and the monitor read: ''Please sit still and relax'' for 2 minutes (Baseline; Time 1), which was followed by a 2 minute movie presentation (amusement or disgust; Time 2), and then another 2 minute recovery period during which the monitor read: ''Please sit still and relax'' (Time 3). Movie sound was played at approximately 50 dB using Roland MA8BK Powered Speakers and, during Time 2, participants were filmed using a Panasonic CCTV Color Camera. Following the recovery period, electrodes were removed and participants were asked to respond to the SAM and the DEQ, indicating how they felt in response to the movie they observed. At the end of the experiment, subjects were debriefed and thanked for their participation.

RESULTS

Participant information

Thirteen subjects were included in each of the four groups (disgust-natural, disgust-exaggerate, amusement-natural, amusement-exaggerate). The 27 female and 25 male participants had a mean age of 18.45 (SD = 0.81) and analyses revealed no significant group differences with regard to age, $F(3, 47) = 1.42$, $p >$ .05, or gender, χ^2 (3) = 4.60, $p > .05$. Thirty-six, 11, 2, 2, and 1 participants were Caucasian/White, Asian/Asian-American, Black/African-American, Multiracial, and Other, respectively, and no Group differences regarding Ethnicity were observed, χ^2 (12) = 14.28, $p > .05$.

Affective response to the movies

A Film (Amusement or Disgust) $\times$ Viewing Condition (Natural or Exaggerate) MANOVA of SAM data (valence, arousal, and dominance) revealed no main effect of Condition on valence, $F(1, 48) = 2.31$, $p > .05$, arousal, $F(1, 48) = 0.27$, $p > .05$, or dominance, $F(1, 48) = 1.99$, $p > .05$, parameters. Main effects of Film were significant with regard to valence, $F(1, 48) = 162.25$, $p < .0001$, and arousal, $F(1, 48) = 4.66$, $p < .05$ parameters, but not for dominance, $F(1, 48) =$ 3.28, $p > .05$. Specifically, persons viewing the amusement film reported significantly more positive affect (amusement M = 4.48, SD = 0.57; disgust M = 1.9, SD = 0.87) and less arousal (amusement M = 2.69, SD = 1.16; disgust M = 3.25, SD = 0.79) relative to those viewing the disgust film. A Condition $\times$ Film interaction effect was noted for the arousal parameter, $F(1, 48) = 6.03$, $p < .05$, but not for valence, $F(1, 48) = 0.90$, $p > .05$, or dominance, $F(1, 48) = 3.28$, $p >$ .05. A pairwise comparison, made using Tukey's Honestly Significant Difference (HSD) test to control for experimentwise error ratio (Winer, 1971), revealed that natural viewing of the disgust film was associated with significantly more arousal than natural viewing of the amusement film (natural viewing: amusement M = 2.31, SD = 1.11; disgust M = 3.50, SD = 0.82). Results of Tukey's HSD test also revealed that arousal within the amusement-exaggerate (M = 3.18, SD = 1.12) and disgust-exaggerate (M = 3.00, SD = 0.58) groups were not statistically different from one another or to either natural-viewing group. These results prohibit us from ruling out the possibility that each group had a population mean equivalent to both of the exaggerate groups.

To assess the impact of film type and viewing condition on discrete emotional experience, a Film $\times$ Condition MANOVA of DEQ data (amusement, anger, contentment, disgust, fear, and sadness) was performed. Analyses

TABLE 1
Self-reported Discrete Emotions Questionnaire (DEQ) data by Film Type and Viewing Condition

	Natural viewing				*Exaggerate*			
	Amusement		*Disgust*		*Amusement*		*Disgust*	
DEQ variable	*Mean*	(*SD*)	*Mean*	(*SD*)	*Mean*	(*SD*)	*Mean*	(*SD*)
Amusement	5.46	(1.13)	2.00	(1.87)	6.00	(2.16)	1.93	(1.50)
Anger	1.39	(1.12)	5.00	(2.31)	1.23	(0.60)	4.15	(2.41)
Disgust	1.77	(1.74)	6.31	(2.18)	1.62	(1.12)	6.46	(2.37)
Contentment	4.54	(1.81)	2.08	(1.71)	5.08	(1.94)	1.23	(0.44)
Fear	1.00	(0.00)	2.62	(1.94)	1.08	(0.28)	2.31	(1.60)
Sadness	1.08	(0.28)	5.00	(2.74)	1.00	(0.00)	4.77	(2.13)

revealed no main effect of viewing condition or interaction effect of Film Type × Viewing Condition on any of the DEQ variables (see Table 1).

Pairwise comparisons were additionally made within each film type (amusement or disgust) to determine which discrete emotions were produced from the videos. Using data from the amusement film only, it was determined that participants experienced amusement (M = 5.73, SD = 1.71) and contentedness (M = 4.81, SD = 1.86) significantly more than disgust (M = 1.69, SD = 1.44), anger (M = 1.31, SD = 0.88), fear (M = 1.04, SD = 0.20), or sadness (M = 1.04, SD = 0.20). Conversely, participants viewing the disgust film self-reported significantly greater levels of disgust (M = 6.39, SD = 2.23), anger (M = 4.58, SD = 2.35), and sadness (M = 4.89, SD = 2.41) relative to amusement (M = 1.96, SD = 1.66), contentedness (M = 1.65, SD = 1.30), and fear (M = 2.46, SD = 1.75). These results indicate that the two film clips reliably elicited only positive or only negative emotions, respectively.

Valence and arousal ratings of behavioral display

Participants were videotaped during film presentation and later rated on Likert scales with regard to positivity (1 = *negative emotion*, 7 = *positive emotion*) and arousal (1 = *low arousal*, 7 = *high arousal*) of emotion expressed on their face. Alpha coefficients between the two raters (who were blind to experimental hypotheses and conditions) were excellent for both valence (α = .98) and arousal (α = .82) ratings. Thus, valence and arousal data were averaged across raters and used as dependent measures for a Film × Condition MANOVA. Analyses revealed a significant main effect of film type with the amusement video eliciting greater positive affect (amusement M = 5.77, SD = 0.86; disgust M = 2.75, SD = 0.95), $F(1, 48)$ = 155.35, p < .0001, and arousal (amusement M = 4.81, SD

= 1.29; disgust $M = 3.92$, $SD = 1.92$) relative to the disgust condition, $F(1, 48) = 4.65$, $p < .05$. A significant main effect of Condition was also detected with persons in the exaggerate condition showing increased arousal (exaggerate $M = 5.10$, $SD = 1.33$; natural-watch $M = 3.64$, $SD = 1.70$), $F(1, 48) = 12.70$, $p < .001$, but not positivity (exaggerate $M = 4.37$, $SD = 2.01$; natural-watch $M = 4.15$, $SD = 1.52$) relative to those in the natural-watch condition, $F(1, 48) = 0.76$, $p > .05$. A Film $\times$ Condition interaction was also detected with regard to positivity, $F(1, 48) = 5.30$, $p < .05$, revealing that persons asked to exaggerate their response to the amusement ($M = 6.15$, $SD = 0.66$) and disgust ($M = 2.58$, $SD = 1.04$) films showed more positive and negative affect, respectively, relative to those in the neutral-watch conditions (amusement $M = 5.39$, $SD = 0.89$; disgust $M = 2.92$, $SD = 0.86$). The facial expressiveness codings made by two independent judges supported our hypothesis that exaggerating emotions leads to increased facial arousal, as well as increased positive and negative affect in response to the amusement and disgust films, respectively.

Physiological reactivity and recovery

''Reactivity'' was derived by subtracting pre-movie data from during-movie data whereas ''recovery'' was assessed by subtracting during-movie data from post-movie data (i.e., Time 2 − Time 1 and Time 3 − Time 2, respectively, Quigley et al., 2002; Tomaka & Blascovich, 1994; Tomaka et al., 1993). Using IBI, LF/HF, HF and TSL reactivity and recovery data as dependent variables, a MANOVA was performed with between-subjects factors of film type and viewing condition.[1] (See Table 2.)

The MANOVA using IBI reactivity and recovery as dependent variables revealed a significant main effect of Condition on both reactivity, $F(1, 48) = 22.21$, $p < .001$, and recovery, $F(1, 48) = 18.90$, $p < .001$. Specifically, persons in the exaggerate condition experienced decreased IBI ($M = -21.02$ ms, $SD = 45.92$ ms) whereas persons in the natural-watch condition experience increased IBI ($M = 40.97$ ms, $SD = 47.57$ ms). The converse was true during the recovery period (exaggerate $M = 40.18$ ms, $SD = 49.11$ ms; natural-watch $M = -26.46$ ms, $SD = 59.57$ ms). While the increased IBI (decreased HR) among natural-watchers may initially appear counterintuitive, such a response may be the result of their simply orienting to the stimulus (Stekelenberg & van Boxtel, 2002). Conversely, the decreased IBI (increased HR) found among exaggerators

[1] We repeated all analyses of physiological reactivity and recovery using mixed-model 2 (Film Clip) $\times$ 2 (Viewing Instructions) $\times$ 2 (Time period: During Film vs. Post-Film) ANCOVAs, with the latter variable as a within-subjects factor and with the baseline (pre-film) value of the relevant physiological variable as a covariate. This approach avoids the use of difference scores, and reduces the number of statistical tests required to assess physiological reactivity and recovery in this experiment. The ANCOVA analyses replicated the results obtained using difference scores. However, we report the reactivity and recovery scores because they generally are easier to understand.

TABLE 2
Physiological reactivity and recovery data by Film Type and Viewing Condition

	Reactivity (Time 2 – Time 1)									*Recovery (Time 3 – Time 2)*								
	Natural-Viewing				*Exaggerate*					*Natural-Viewing*				*Exaggerate*				
	Amusement		*Disgust*		*Amusement*		*Disgust*		*p for condition*	*Amusement*		*Disgust*		*Amusement*		*Disgust*		*p for condition*
Variable	*Mean*	*(SD)*	*Mean*	*(SD)*	*Mean*	*(SD)*	*Mean*	*(SD)*	*reactivity*	*Mean*	*(SD)*	*Mean*	*(SD)*	*Mean*	*(SD)*	*Mean*	*(SD)*	*recovery*
IBI (ms)	34.53	(47.09)	47.41	(49.06)	–24.01	(58.25)	–18.03	(31.31)	< .001	–17.09	(44.90)	–35.83	72.03	38.23	58.34	41.12	40.15	< .001
LF/HF	0.48	(4.87)	–1.23	(2.74)	2.62	(4.86)	1.01	(1.55)	< .05	1.03	(5.29)	–0.16	3.56	–2.88	5.05	0.10	2.16	> .05
HF (In ms^2)	0.34	(1.20)	1.05	(2.55)	.04	(1.09)	–.09	(0.70)	> .05	–0.42	(0.88)	0.12	1.16	–0.04	0.96	–0.05	0.60	> .05
TSL (μS)	1.33	(1.48)	1.86	(2.55)	1.57	(1.17)	1.27	(1.13)	> .05	–0.77	(1.24)	–0.67	0.89	–1.04	0.80	–0.80	0.38	> .05

IBI = interbeat interval; LF/HF = low frequency/high frequency; TSL = tonic skin conductance level.

may reflect the increased metabolic requirements for active emotion modulation and/or facial muscle recruitment (e.g., Gross, 2001).

Significant baseline differences on LF/HF data were observed, $F(1, 48) = 7.77$, $p < .01$, (this was *not* the case for all other physiological data). Specifically, persons in the natural-watch condition ($M = 4.46$, $SD = 4.08$) evidenced significantly greater baseline LF/HF relative to those in the exaggerate condition ($M = 2.02$, $SD = 1.76$). Thus, for LF/HF data, the Film $\times$ Condition ANOVA was performed using a covariate of baseline (Time 1) LF/HF (Pedhazur & Schmelkin, 1991). A main effect of Condition was observed on LF/HF reactivity, $F(1, 48) = 4.36$, $p < .05$. Specifically, persons in the exaggerate condition experienced significantly greater increases in sympathovagal balance relative to those in the natural-watch condition (exaggerate $M = 1.82$, $SD = 3.63$; natural-watch $M = -0.37$, $SD = 3.97$). No other main or interaction effects were observed.

No main or interaction effects were revealed when using HF and TSL reactivity and recovery data as dependent variables.[2] Combining results from the above physiological analyses, it appears that increased HR among exaggerators may be largely driven by sympathetic activation. Specifically, while exaggerators show greater sympathetic (LF) to parasympathetic (HF) activation during movie presentation, there are no group differences with regard to HF reactivity/recovery. Thus, cardiac vagal control does not appear to be primarily responsible for differential HR between groups.

Last, independent sample *t*-tests were performed by Film and Condition using IBI, LF/HF, HF, and TSL data to determine whether groups experienced significant reactivity and recovery (i.e., significantly different from 0). Pooling across all those who experienced the amusement film, analyses revealed significant increases and decreases in TSL during reactivity, $t(25) = 5.63$, $p < .001$, and recovery, $t(25) = 4.48$, $p < .001$, periods, respectively. Similar results were found among those viewing the disgust film, as they evidenced significantly increased and decreased TSL reactivity, $t(25) = 4.08$, $p < .001$ and recovery, $t(25) = 5.56$, $p < .001$. Those in the natural-viewing condition evidenced significant increases in IBI, $t(25) = 4.39$, $p < .001$, and increases in TSL, $t(25) = 3.95$, $p < .001$, during reactivity and decreases in IBI, $t(25) = 2.27$, $p < .05$, and decreases in TSL, $t(25) = 3.47$, $p < .01$, during recovery. However, those in the exaggerate condition showed increased LF/HF ratios, $t(25) = 2.55$, $p < .05$, and increased TSL, $t(25) = 6.35$, $p < .001$, and *decreased* IBI, $t(25) = 2.33$, $p < .05$, during reactivity and *increased* IBI, $t(25) = 4.17$, $p < .001$, and decreased TSL,

[2] We collected both tonic skin conductance level (TSL) as well as nonspecific skin conductance responses (NS-SCR). The TSL and NS-SCR measures correlated at $r(52) = .77$ at Time 1, $r(52) = .59$ at Time 2, and $r(52) = .70$ at Time 3, respectively, all ps < .01. Using NS-SCR as the measure of electrodermal activity indicated the same pattern of electrodermal response as the TSL measure reported here.

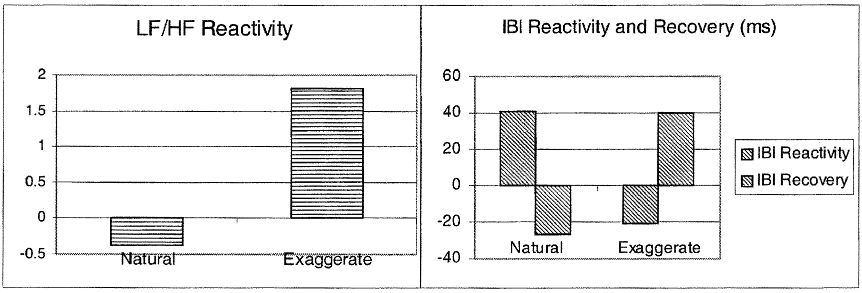

Figure 1. Low frequency/high frequency (LF/HF) and interbeat interval (IBI) reactivity and recovery data by Condition (both statistically significant).

$t(25) = 7.49$, $p < .001$, during recovery. See Figure 1 for a depiction of significantly different physiological changes by viewing condition.

DISCUSSION

There were two main purposes to the present experiment. First, this study was designed to investigate an infrequently researched emotion regulation strategy, namely, exaggeration, to better understand the general effects of response-focused strategies on affective, behavioural, and physiological patterns of response. Second, the present methodology used improved cardiovascular arousal measures (i.e., HRV) of both sympathetic and parasympathetic arousal at the myocardium rather than more peripheral measures of sympathetic activation (e.g., skin temperature, finger pulse amplitude, etc.). Enhanced assessment of cardiovascular reactivity/recovery is very important because persons who experience affect regulation problems (e.g., major depressive disorder, bipolar disorder, etc.) have an increased likelihood of experiencing cardiovascular (CVD) (Barrick, 1999; Denollet et al., 1996; Murray & Lopez, 1997; Sher, 2001).

The film stimuli created for this research had a slightly different impact than originally intended. While the disgust and amusement films elicited significantly different levels of positive affect (as indicated by the SAM data), the emotions induced were not particularly discrete. Specifically, as assessed by the DEQ, the amusement film elicited feelings of both contentedness and amusement. Conversely, the disgust film elicited feelings of anger and sadness as well as disgust. Thus, this experiment may best be interpreted as investigating the impact of exaggerating positive and negative emotion rather than amusement and disgust, per se. Still, it is clear that the amusement and disgust films were excellent inducers of positive and negative affect, respectively. The use of standardised 2 minute film clips may offer a significant advantage over previous videos used for affect induction purposes (e.g., Gross & Levenson, 1995; Philippot, 1993), as controlling for film length allows for the use of advanced time-dependent physiological procedures (i.e., HRV) to assess activation within both branches of the autonomic nervous system.

Hypothesis 1 was supported by the present research. Specifically, persons in the exaggerate condition evidenced significantly higher levels of facial arousal/intensity relative to those in the natural-watch condition. Moreover, relative to those in the natural-watch condition, exaggerators who viewed the amusement and disgust films were rated as showing more positive and negative emotional expression, respectively. Thus, based on the manipulation checks, it appears that the stimuli and instructions used for both the Film and Condition variables were reasonably effective.

Hypothesis 2 was also largely supported. Specifically, persons in the exaggerate condition experienced significantly decreased and increased IBI during reactivity and recovery periods whereas those in the natural-watch condition evidenced the reverse pattern of response. Moreover, those asked to exaggerate their emotional expressions experienced significantly increased LF/HF during the reactivity period, which meshed well with their increased HR. Interestingly, no significant HF patterns emerged from the present experiment which may suggest that emotional experience and affect modulation may be more closely associated with sympathetic arousal relative to cardiac vagal control. Last, although TSL was robustly associated with emotional experience (both positive and negative), significant differences with regard to viewing condition were not revealed.

Hypothesis 3, which suggested that positive emotional exaggeration should produce increased self-reported affect, was not supported. It should be noted, however, that persons in the exaggerate condition did not show very powerful increases in positive and negative emotional expression to the amusement and disgust films, respectively, which is significantly different from prior ''suppression'' research in which participants robustly ''down-modulated'' their facial expression (e.g., Gross, 1998a; Gross & Levenson, 1993, 1997; Richards & Gross, 1999; Wegner et al., 1990; Wegner & Zanakos, 1994; Weinberger et al., 1979). One might expect, given the facial feedback hypothesis (Buck, 1980), that a more robust change to emotional expression may lead to greater changes of self-reported affect (not found in the present research). Alternatively, exaggeration of facial expression may not impact affective experience. Our inability to achieve a greater change to affective expression among those in the exaggerate condition may be due to the strong emotional stimuli used in the present research, thus producing a ceiling effect. Future investigations may benefit from instructing persons to exaggerate their responses to more subtle affective stimuli when assessing affective, behavioural, and physiological patterns of response.

Importantly, persons who received the exaggeration instructions had significantly reduced levels of baseline sympathovagal balance relative to those in the natural-watch condition. While this effect was unintended (and, in the future, we will likely provide instructions immediately before film presentation), the data lend themselves well to appreciating the impact of *cognitive* effort on response-focused affect modulation. Specifically, contrary to what has been suggested by others (e.g., Gross, 2001), cognitive effort (or, in this case, planning) may be associated with decreased sympathetic arousal. Thus, the increased sympathovagal reactivity experienced by those in the exaggerate condition may be entirely due to behavioural regulation (and, perhaps, *despite* any cognitive effects). However, these results should be interpreted with caution because some researchers have been unable to replicate the influence of sympathetic blockade on LF (Cacioppo et al., 1994a; Taylor, Carr, Myers, & Eckberg, 1998).

The present experiment has some additional limitations. First, especially because it appears that sympathetic arousal is closely associated with affective experience and emotion regulation, future research may benefit from a more sensitive measure of sympathetic arousal (such as pre-ejection period, Berntson et al., 1994b; Newlin & Levenson, 1979; Sherwood et al., 1997). Moreover, because the use of more sensitive measures of cardiovascular function (e.g., HRV) must be averaged over a significant period of time (2 minutes), it comes with the cost of not being able to look at the physiological data continuously. Thus, other research (e.g., Bradley, Codispoti, Cuthbert, & Lang, 2001; Bradley et al., 1996; Fredrickson & Levenson, 1998; Fredrickson et al., 2000) investigating the impact of emotion on rise and fall times may add pertinent information to how emotion is processed and modulated. Last, although the present research helps to uncover the physiological processes associated with increased affective display (i.e., increased sympathetic arousal and cardiovascular stress), it cannot substitute for the investigation of persons with emotion regulation problems during the processing of affective stimuli. Thus, future research should focus on such groups (as well as individuals with baseline physiological differences) in order to better appreciate their predisposition for cardiovascular disease.

Manuscript received 13 January 2003
Revised manuscript received 15 March 2004

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