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Physiological Down-Regulation and Positive Emotion in Marital Interaction

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Previous studies have demonstrated that 1 function of positive emotion is the undoing of physiological arousal produced by negative emotions. These studies have used single-subject paradigms, in which emotions were induced by films in college-age individuals. In the present study, we examined the relationship between physiological down-regulation and positive emotion in a sample of 149 middle-aged and older married couples engaged in a 15-min discussion of an area of marital conflict. During the conversation, autonomic and somatic physiological activity was measured, and emotional behaviors were recorded and subsequently coded. We found that during 20-s periods of down-regulation (where physiology transitioned from high arousal to low arousal), couples showed an increase in positive emotional behavior compared with periods without down-regulation. The finding was quite robust, suggesting that the undoing effect of positive emotion generalizes across age, sex, and marital satisfaction. The advantages of using positive emotion as an emotion regulation strategy are discussed.

Keywords: positive emotion, psychophysiology, emotion regulation, couples, aging

Early theories of emotion and the empirical studies that ensued focused primarily on negative emotions, such as anger and fear. Influenced by evolutionary and functional considerations, emotions were seen as activating adaptive behaviors, such as fighting and fleeing, that were presumed to have helped our ancestors survive and reproduce (Panksepp, 1998). In these accounts, negative emotions were also seen as being accompanied by fairly distinctive patterns of facial display (Ekman & Friesen, 1971), action tendencies (Frijda, 1986), and autonomic nervous system activity (Levenson, 1992, 2003). In this work, positive emotions received scant notice. After all, unlike negative emotions, positive emotions appeared to share a single common facial signal (the smile), did not immediately call to mind well-defined action patterns, and did not produce high-amplitude autonomic activation.

Fast forward into present time, and the landscape has changed dramatically. Positive emotions are now at the forefront of emotion theory and research (Fredrickson, 1998; Fredrickson & Levenson, 1998; Frijda, 2001; Keltner & Haidt, 2003; Seligman & Csikszentmihalyi, 2000). Significant advances have occurred in our understanding of the facial expressions (e.g., Messinger, Fogel, & Dickson, 2001), behaviors (Fredrickson, 2005), functions (Fredrickson, 2005; Isen, 1999; Levenson, 1988), and physiology (Fredrickson & Levenson, 1998) associated with positive emotion in both human and nonhuman species (e.g., Knutson, Burgdorf, & Panksepp, 1998).

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Functional Accounts of Positive Emotions

Several functional theories of positive emotion have been proposed that span social, cognitive, and physiological domains. For example, Bowlby's (1980, 1989) attachment theory posits that the development of appropriate personality and social relations in adulthood is dependent on the affectionate behaviors of the mother in a child's infancy and early childhood. Moreover, a long line of animal and human research suggests that positive interaction with attachment figures (e.g., a parent or romantic partner) is important for regulating stress (Coan, Schaefer, & Davidson, 2006; Sbarra & Hazan, 2008), as well as for promoting help-seeking tendencies (Gillath et al., 2006) and altruistic behaviors (Mikulincer, Shaver, Gillath, & Nitzberg, 2005). Empirical work has also suggested that positive emotions structure social relationships and promote social cohesion and resources, such as family and friends, in adult life (e.g., Fredrickson, 2001; Oatley & Jenkins, 1992). Positive emotions may also heighten cognitive functioning by increasing creativity, efficiency, performance, and flexibility in problem-solving tasks (e.g., Fredrickson, 2001; Isen, 1990; Isen & Daubman, 1984; but see Forgas, 2001, for a contrasting view).

In our work, we have been interested in the role that certain positive emotions play in "undoing" (Levenson, 1988) the physiological arousal caused by negative emotion. This idea is consistent with the notion that one function of positive emotions is to facilitate tension reduction. Tomkins (1962) viewed the "the smiling-joy response" as resulting from decreases in the density of stimulation, or neural arousal, that accompanies strong emotions. In his model, tension reduction "caused" the smile. In our model (Levenson, 1988), the smile is a signal associated with a positive emotion that has the capacity to "cause" the tension reduction. More specifically, we proposed that some positive emotions help return the body to homeostasis by hastening the undoing, or *down-regulation*, of physiological arousal caused by negative emotions. Both correlational and experimental laboratory studies have supported this idea (Fredrickson & Levenson, 1998;

Fredrickson, Mancuso, Branigan, & Tugade, 2000). Because our previous work was conducted using single-subject paradigms, it is not clear whether positive emotions also have the capacity to down-regulate physiological arousal in dyadic and other social contexts.

Physiological Calming and Soothing in Marital Interaction

Much of human emotion and emotion regulation occurs in interpersonal contexts (Jenkins & Oatley, 1996). Despite this, most laboratory studies of emotion have used single-subject paradigms. One exception to this trend can be found in laboratory studies of marital interaction. A central focus of this work has been to identify emotional qualities of couple interactions that are associated with relationship satisfaction and dissatisfaction and stability and instability. Starting in the 1980s, we began conducting studies of marital interaction that included measurement of subjective emotional experience, emotional behavior, and autonomic nervous system activity (Levenson & Gottman, 1983). One of the powerful themes that emerged from this work was the association between successful emotion regulation during conflictive interaction and marital satisfaction and stability. This association was found both in couples' emotional behaviors and in their level of autonomic arousal (Gottman & Levenson, 1992; Levenson & Gottman, 1985). Specifically, it appears that couples in highly satisfied marriages are better able to regulate negative emotion and autonomic arousal than couples in less satisfied marriages. In an ongoing longitudinal study of long-term marriages, in which many of the surviving marriages have now lasted more than 50 years (Levenson, Carstensen, & Gottman, 1993), we were particularly struck by the artful way in which the most satisfied couples managed their negative emotion. These couples introduced positive emotions, such as affection and humor (Carstensen, Gottman, & Levenson, 1995), to "soothe" and "calm" the interaction, thus reducing the level of negativity to a point where they could continue to work on the issues at hand. The ability to regulate negativity in marital interactions may also have important implications for whether couples ultimately stay together or divorce. In a sample of newlywed couples, Gottman, Coan, Carrere, and Swanson (1998) found that de-escalation of negative emotion and increased expression of positive emotion during marital conflict were predictive of marital stability 6 years later.

In our work on marital interaction, overall levels of physiological activation (especially in measures that reflect sympathetic nervous system activity) proved to be an important "readout" of the emotional tone of the marriage. Moreover, low levels of physiological activation during conflictive marital interactions have been associated with a number of positive outcomes, including higher levels of (a) marital satisfaction (Levenson & Gottman, 1983), (b) future marital stability (Gottman et al., 1998; Gottman & Levenson, 1992), (c) satisfaction with retirement (Kupperbusch, Levenson, & Ebling, 2003), and (d) physical and mental health (King & Levenson, 1996, 1997; McCarthy, King, & Levenson, 2002).

The Present Study

The present study combined prior research on the undoing effects of positive emotions with research on physiological down-regulation during conflictive marital interaction. Specifically, we tested the hypothesis that, during these interactions, moments when the couple's physiology transitioned from an aroused state to a calm state would be more closely associated with positive emotional behavior than moments when this type of physiological down-regulation did not occur. In addition to assessing the relationship between physiological down-regulation and positive emotion per se, the study design allowed for examination of possible differences in this relationship associated with participant sex (both husbands and wives were studied) and level of marital satisfaction (couples with a range of marital satisfaction were included).

The present study is unique in several ways. First, unlike previous studies of the undoing effect of positive emotions, which used single-subject paradigms, this study used a dyadic interaction paradigm and is therefore more representative of the social contexts in which emotions and emotion regulation typically occur (Jenkins & Oatley, 1996). Second, in previous studies, we induced a positive emotion or identified the occurrence of a positive emotion and then examined the physiological concomitants. Here, we started by identifying moments of physiological down-regulation and then determined the emotional concomitants. Third, because all previous studies have focused on younger adults, little is known about how the undoing effect of positive emotions functions in later life. Theory and evidence suggest that emotion regulation (Gross et al., 1997) and positive emotions (Carstensen, 1992; Carstensen & Charles, 1998; Carstensen et al., 1995) are particularly important in later life. By examining the relationship between physiological down-regulation and positive emotion in a middle-aged and older sample, we can shed additional light on the nature of emotional functioning in later life.

Method

Participants

The data used in the present study came from an ongoing longitudinal study of long-term marriages (Levenson et al., 1993). In this study, 157 middle-aged ($n = 82$) and older ($n = 75$) couples were recruited from the Berkeley, California, community, beginning in 1989. Middle-aged couples had to have been married for at least 15 years, with the older spouse between 40 and 50 years of age. Older couples had to have been married for at least 35 years, with the older spouse between 60 and 70 years of age. The sample was recruited so as to be representative of the economic, religious, and marital satisfaction makeup of couples in these age groups in the area. Reflecting the demographics of the Berkeley area, the sample can be characterized as Caucasian, upper-middle class, white collar, well-educated, and Judeo-Christian. Full details on the recruitment strategy and sample demographics have been published previously (Levenson et al., 1993).

Procedure

The procedures used in this study are based on those developed by Levenson and Gottman (1983). After couples arrived at the laboratory, recording devices were attached for obtaining physiological measures. Couples engaged in three conversations, discussing (a) the events of the day, (b) a problem area of continuing disagreement in their marriage, and (c) a mutually agreed-on pleasant topic. Each conversation lasted 15 min and was preceded by a 5-min silent period. During the silent periods and discussions, a broad sample of physiological measures was obtained (see below) and a video recording was made of the interaction. Because it produces the greatest amount of emotion and associated physiological arousal, only data from the problem area discussion were used for the present study.

Apparatus

Physiological. We obtained seven physiological measures from each spouse using a system consisting of a Grass Model 7 12-channel polygraph and a microcomputer: (a) Cardiac interbeat interval—Beckman miniature electrodes with Redux paste were placed in a bipolar configuration on opposite sides of the subject's chest and the interval between successive R-waves of the electrocardiogram (EKG) was measured in milliseconds. (b) Finger pulse amplitude—the trough-to-peak amplitude of the finger pulse was measured, providing an index of the amount of blood in the periphery. (c) Pulse transmission time to the finger—a UFI photoplethysmograph was attached to the second finger of the nondominant hand. The time interval was measured between the R-wave of the EKG and the upstroke of the peripheral pulse at the finger. (d) Pulse transmission time to the ear—a UFI photoplethysmograph attached to the right earlobe recorded the volume of blood in the ear. This time interval was measured between the R-wave of the EKG and the upstroke of the peripheral pulse at the ear. (e) Finger temperature—a Yellow Springs Instruments thermistor was attached to the palmar surface of the first phalange of the middle finger of the dominant had with surgical tape. (f) Skin conductance level—a constant voltage device passed a small voltage between Beckman regular electrodes attached to the palmar surface of the middle phalanges of the first and third fingers of the nondominant hand using sodium chloride in Unibase as the electrolyte. (g) General somatic activity—an electromechanical transducer attached to a platform under the subject's chair generated an electrical signal proportional to the amount of body movement in any direction. This set of physiological measures was selected to sample broadly from major systems (cardiac, vascular, thermoregulatory, electrodermal, somatic muscle), to allow for continuous measurement, to be as unobtrusive as possible, and to include measures used in our previous studies of marital interaction (e.g., Levenson & Gottman, 1983) and of the undoing effects of positive emotion (Fredrickson & Levenson, 1998). Using a computer program written by one of the authors (RWL), second-by-second averages were calculated for each physiological measure for each spouse.

Audiovisual. Two video cameras and two microphones were used to obtain frontal views of each spouse's face and upper torso and to record the spouses' conversations. The computer enabled synchronization between video and physiological data by controlling the operation of a device that superimposed the elapsed time on the video recording and a second device that recorded a synchronization tone on one of the audio channels of the videotape recording.

Marital Satisfaction

Marital satisfaction was assessed using two well-established self-report inventories, which we have used in our previous marriage research: (a) the Marital Adjustment Test (Locke & Wallace, 1959), which consists of 15 items emphasizing agreement between spouses in various life domains and amount of leisure time spent together; and (b) the Marital Relationship Inventory (Burgess, Locke, & Thomes, 1971), which consists of 22 items measuring satisfaction with affection and sexuality in the marriage, overall satisfaction with the marriage, as well as areas of agreement. As we have done previously, for each couple, the average of both spouses' scores on these measures was calculated as an index of the couple's overall marital satisfaction. Couple marital satisfaction scores ranged between 45 and 138, with a mean of 111.31 (SD = 15.94). Consistent with the fact that these were long-term marriages, the mean satisfaction level was higher than the population norm (approximately 100), but still included a wide range of marital satisfaction levels.

Data Reduction

Identifying physiological down-regulation events. Using the second-by-second data obtained for each physiological measure during the problem area conversation, we averaged each measure for each spouse into ninety 10-s periods (the 5-min preconversation period was not analyzed). We converted the 10-s period averages into z scores using the mean and standard deviations for the entire 15-min conversation. The z scores were reverse scored as needed (i.e., cardiac interbeat interval, finger pulse amplitude, finger pulse transmission time, ear pulse transmission time) so that larger values reflected greater physiological arousal.

We identified 10-s periods for each spouse that could be classified as "aroused" or "calm." For a period to be classified as "aroused," the z scores had to be greater than or equal to 1.0 for at least three physiological measures. For a period to be classified as "calm," the z scores had to be less than 1.0 for all physiological measures.

Finally, for each spouse, we identified *physiological down-regulation events*. These were 20-s periods in which the first 10-s period was classified as "aroused" and the following 10-s period was classified as "calm."[1] For each couple, physiological down-regulation events were tallied when they occurred in either spouse. All 10-s periods that did not occur within a down-regulation event were categorized as periods of non–down-regulation.

Affective data.[2] Videotapes of the problem area conversation were coded using the Specific Affect Coding System (SPAFF; Gottman & Krokoff, 1989; SPAFF Version 2.0, Gottman, 1989), which identifies the prevailing emotion of speakers and listeners in a conversation. In SPAFF, trained raters working from videotapes assign emotion codes on the basis of verbal content, voice tone, context, facial expression, gestures, and body movement. SPAFF

[1] Finger temperature was omitted in the identification of periods of physiological down-regulation because it reacts slowly to shifts in affective state and thus is unlikely to change significantly within 20 s.

[2] For complete information about SPAFF coding and its reliability in this study, see Carstensen et al. (1995). The present description is a summary of the affective data reduction in that article.

treats behavior as continuous (rather than segmenting it into time blocks or turns at speech), and thus codes can be given at any time. Using a computerized dial, coders assign the code that best describes the spouse's emotion at a particular time, and that code stays in effect until another code is thought to better reflect the spouse's current emotional state.

For speakers, the positive emotion codes were interest, affection, humor, validation, and joy. The negative emotion codes were anger, contempt, disgust, belligerence, domineering, defensiveness, fear/tension/worry, sadness, and whining. There was also a neutral speaker code. For listeners, the codes were positive, negative, and neutral, based on the facial expressions of the listener. There was an additional negative code for listener disengagement called stonewalling.

Reliability for the SPAFF coding was determined using second-by-second agreement of coders throughout the 15-min conversation. Cohen's kappa, which controls for agreement by chance and provides a single reliability index for the entire coding system (Bakeman & Gottman, 1987), was computed. For the present study, the overall mean kappa was 0.64, and the mean z score (kappa divided by the standard deviation of kappa) was 19.25 ($p < .001$). The mean kappa for speaker codes was 0.60 and the z score was 15.02 ($p < .001$). For listener codes, the mean kappa was 0.71 and the z score was 16.92 ($p < .001$). These reliability values are comparable to those typically reported for SPAFF coding (Coan & Gottman, 2007).

Computing positive emotion ratios. SPAFF codes were collapsed into positive, negative, and neutral emotion categories following the classification scheme described above. Neutral codes were omitted from the analyses because they reflected periods in which emotion was absent or not expressed in the conversation. Because of low base rates of listener positive and negative codes, only speaker codes were used in subsequent analyses. For each couple, we computed a *positive emotion ratio* for down-regulatory events by calculating the ratio of positive emotion codes to total emotion codes (i.e., sum of positive and negative codes) that occurred during all periods of down-regulation. For each couple, we also computed a positive emotion ratio for non–down-regulatory events using the emotion codes that occurred during all periods of non–down-regulation. Thus, each couple had one positive emotion ratio for down-regulatory events and one positive emotion ratio for the non–down-regulatory events.

Results

From the initial sample of 157 couples, physiological data from five couples and affective data from another three couples were unusable because of equipment failure or experimenter error. Thus, the final sample consisted of 149 couples (77 middle-aged and 72 older).

Down-Regulation Event Frequencies

There were 220 physiological down-regulation events identified in the 149 problem area discussions. Of the 149 couples in the sample, 112 (56 middle-aged and 56 older) experienced at least one down-regulation event. The modal number of down-regulation events per conversation was 1 (range 0 to 5) and the mean was 1.48 ($SD = 1.22$). A one-way analysis of variance (ANOVA) revealed no differences between middle-aged and older couples in number of down-regulation events experienced, $F(1, 148) = 0.03$, *ns* (see Table 1). In addition, there was no correlation between number of down-regulation events experienced and marital satisfaction, $r(149) = .12$, *ns*. Thus, the frequency of physiological down-regulation events was independent of age and marital satisfaction.

Of the 220 physiological down-regulation events identified across couples, 113 were based on physiological change in the husband and 103 were based on physiological change in the wife. Four down-regulation events were based on simultaneous physiological change in both spouses. A one-way ANOVA revealed no significant differences between husbands and wives in the number of down-regulation events experienced, $F(1, 297) = 0.42$, *ns* (see Table 1). Thus, the frequency of physiological down-regulation events was independent of the sex of the spouse.

As expected, given that the discussion topic was a relationship problem, there were significantly fewer positive SPAFF codes than negative codes for the entire sample, $t(148) = 13.88$, $p < .001$. This pattern held for middle-aged couples, $t(76) = 9.74$, $p < .001$, older couples, $t(71) = 9.95$, $p < .001$, husbands, $t(148) = 11.32$, $p < .001$, and wives, $t(148) = 13.04$, $p < .001$, considered separately. Moreover, middle-aged and older couples did not differ in number of positive, $t(147) = 0.01$, *ns*, and negative, $t(147) = 0.79$, *ns*, SPAFF codes. Husbands and wives did not differ in number of positive SPAFF codes, $t(296) = 0.08$, *ns*, but as formerly reported in Carstensen et al. (1995), husbands in this sample received fewer negative SPAFF codes than wives, $t(296) = 2.17$, $p < .05$. Also reported in Carstensen et al., marital satisfaction in this sample was positively correlated with number of positive SPAFF codes, $r(149) = .22$, $p < .01$, and negatively correlated with number of negative SPAFF codes, $r(149) = -.36$, $p < .001$.

Table 1
Total Number of Down-Regulation Events and Mean (SD) Positive Emotion Ratios

Subject	n	Number of down-regulation events	Down-regulation positive emotion ratio	Non–down-regulation positive emotion ratio
All couples	149	220	0.27 (0.31)	0.23 (0.21)
Middle-aged couples	77	115	0.26 (0.31)	0.23 (0.22)
Older couples	72	105	0.29 (0.31)	0.24 (0.19)
Husbands	149	117[a]	0.33 (0.38)	0.26 (0.24)
Wives	149	107[a]	0.29 (0.37)	0.23 (0.22)

[a] Four of the husband and wife down-regulation events occurred simultaneously.

Physiological Down-Regulation and Positive Emotion

To test our primary hypothesis that physiological down-regulation events would be more closely associated with positive emotion than would non–down-regulation events, we analyzed couples' positive emotion ratios with a 2 (age: middle-aged vs. older) × 2 (event type: down-regulation vs. non–down-regulation) mixed model ANOVA (with event type treated as a within-subject factor).[3] A significant main effect of event type revealed that the ratio of positive emotion to total emotion was greater during down-regulation events than during non–down-regulation events, $F(1, 101) = 3.97$, $p < .05$ (see Figure 1). Thus, our primary hypothesis was supported. There was no evidence of age differences in this relationship: Neither the main effect of age, $F(1, 101) = 0.04$, *ns*, nor the Age × Event Type interaction, $F(1, 101) = 0.72$, *ns*, was significant.

The foregoing analyses were conducted at the couple level. To determine whether the relationship between physiological down-regulation and positive emotion differed between spouses, we calculated separate positive emotion ratios for husbands and wives during the couples' down-regulation and non–down-regulation events. We then ran a 2 (spouse: husband vs. wife) × 2 (event type: down-regulation vs. non–down-regulation) mixed model ANOVA (with event type treated as a within-subject factor). A significant main effect of event type revealed that, across husbands and wives, the ratio of positive emotion to total emotion was greater during down-regulation events than during non–down-regulation events, $F(1, 190) = 11.85$, $p < .01$. There was no evidence of spousal differences in this relationship: Neither the main effect of spouse, $F(1, 190) = 0.85$, *ns*, nor the Spouse × Event Type interaction, $F(1, 190) = 0.01$, *ns*, was significant. Thus, our primary hypothesis that physiological down-regulation events would be more closely associated with positive emotion than would non–down-regulation events was supported for both husbands and wives.

To assess whether marital satisfaction moderated the association between positive emotion and down-regulation, we ran a repeated measures ANCOVA comparing positive emotion ratios for down-regulation and non–down-regulation events, with marital satisfaction as the covariate. The interaction between marital satisfaction and event type was not significant, $F(1, 101) = 1.63$, *ns*, revealing that the difference between down-regulation and non–down-regulation positive emotion ratios was not associated with differences in marital satisfaction. Thus, the relationship between positive emotion and physiological down-regulation did not differ as a function of marital satisfaction.

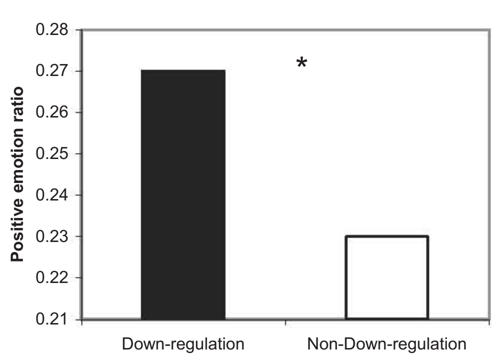

Figure 1. Positive emotion ratio during down-regulation and non–down-regulation events.

Discussion

Results from this study supported our primary hypothesis that moments of physiological down-regulation (i.e., those times where physiology transitions from high arousal to low arousal) would be associated with a greater ratio of positive emotion to total emotion than would moments where down-regulation did not occur. Thus, this study replicates previous findings suggesting that positive emotions have the capacity to "undo" physiological arousal (Fredrickson & Levenson, 1998; Fredrickson et al., 2000). Moreover, the present study extends previous work by showing that the undoing effect is found when (a) using a naturalistic social interaction paradigm in which couples discuss a marital problem (prior work studied single subjects watching films), (b) focusing initially on moments of physiological down-regulation and then examining emotion (prior work focused initially on moments of positive emotion and then examined physiology), and (c) studying middle-aged and older husbands and wives. These findings, combined with previous findings, suggest that the "undoing" effect of positive emotions (Levenson, 1988) is found with both experimentally induced and naturally occurring positive emotions (Fredrickson & Levenson, 1998). Moreover, the findings suggest that the undoing effect is quite robust, generalizing across age, sex, and marital satisfaction.

The undoing effect of positive emotion might serve as a useful form of emotion regulation in our daily lives. By evoking positive emotion in stressful situations, we may be able to reduce our experience of tension and arousal. In line with this, we regularly see people laughing at the goriest moments of horror films, sharing humorous stories at wakes, and giggling when faced with giving a public speech. Findings from the present study suggest that these types of behaviors act to reduce the physiological activation associated with negative emotional states (e.g., anger, disgust, fear, and sadness). Furthermore, evoking positive emotion may be a more advantageous way of regulating negative emotion than other emotion regulation strategies, such as suppression. Whereas this study and other studies (Fredrickson & Levenson, 1998; Fredrickson et al., 2000) have linked positive emotion with decreases in physiological arousal, suppression has been shown to increase physiological arousal (Gross & Levenson, 1997). Thus, emotion regulation strategies based on evoking positive emotion may have the long-term advantage of reducing demands on the autonomic nervous sys-

[3] Thirty-seven of the 149 couples in the study sample were excluded from this analysis because they did not experience any down-regulation events during the task. Nine additional couples were excluded because they exhibited neither positive nor negative emotion (their affect was essentially neutral) during their down-regulation events, and thus did not have calculable positive emotion ratios for these events. The remaining 103 couples did not differ from the total sample in terms of age group distribution (53 middle-aged, 50 older) or mean marital satisfaction score ($M = 111.87$, $SD = 15.75$).

tem, allowing us to redirect our physical and cognitive resources toward other challenges in the environment.

The undoing effects of positive emotion may be particularly important in the context of social interaction. Positive interactions with attachment figures have been shown to increase cooperative behavior (Gillath et al., 2006; Mikulincer et al., 2005), decrease stress (Coan et al., 2006; Sbarra & Hazan, 2008), and promote social development (Bowlby, 1980, 1989). Previous studies have also shown that positive emotions are important for structuring social relationships and promoting social cohesion (Fredrickson, 2001; Oatley & Jenkins, 1992). In married couples, research has shown that couples who incorporate positive emotions (i.e., affection and humor) into discussions of marital conflict have higher levels of marital satisfaction than couples who do not (Carstensen et al., 1995). Also, spouses who show lower levels of physiological activation during discussions of marital conflict tend to have higher levels of marital satisfaction (Levenson & Gottman, 1983) and higher future marital stability (Gottman & Levenson, 1992). Findings from the present study show a close temporal relationship between physiological down-regulation and the expression of positive emotion in conflictive marital interactions. The physiological down-regulation associated with expression of positive emotions may help couples restore physiological calm and enable them to reengage and work toward conflict resolution.

In the present study, ratings of marital satisfaction did not moderate the relationship between physiological down-regulation and positive emotion. This suggests that couples with high and low marital satisfaction displayed equivalent increases in expression of positive emotion, relative to total emotion, between non–down-regulatory and down-regulatory events. This was somewhat surprising; given that low marital satisfaction is associated with low positive emotion and high physiological arousal, one might expect the relationship between positive emotion and physiological down-regulation to be disrupted in couples with lower marital satisfaction. Contrary to expectations, our findings suggest that the association between physiological down-regulation and positive emotion is intact in middle-aged and older couples with a wide range of marital satisfaction levels. In contrast to these findings, a study of conflictive marital interaction in newlyweds by Gottman et al. (1998) found that in satisfied couples, the expression of positive emotions was more likely to be associated with reduction in the husband's heart rate than in dissatisfied or divorced couples. Discrepancies between findings from these studies might be attributed to methodological differences (the present study started by identifying soothing moments and then examined affect, defined soothing in terms of multiple physiological measures, and considered soothing in both spouses; Gottman et al. started by identifying affect and then examined soothing, defined soothing in terms of a single physiological measure [heart rate], and only considered soothing in the husband) and differences in subject samples (long-term marriages in the present study vs. newlyweds).

This study extends our understanding of the undoing effect of positive emotion; however, there are several limitations worthy of note. First, because the design was correlational, we do not know whether positive emotion caused the physiological down-regulation or vice versa, although previous studies using experimental designs (Fredrickson & Levenson, 1998; Fredrickson et al., 2000) have supported the capacity of positive emotions to reduce physiological arousal. Second, it would be useful to compare the strength of the relationship between positive emotion and physiological down-regulation bidirectionally in the same data set. This would involve contrasting starting with physiological down-regulation and examining affect, as in the present study, with starting with positive affect and examining down-regulation, as has been done in previous studies (Fredrickson & Levenson, 1998; Fredrickson et al., 2000; Gottman et al., 1998). Third, we adopted a single set of criteria for defining a physiological down-regulation event on an a priori basis. It would be useful in future work to examine a range of criteria (e.g., number of physiological measures, size of change, duration of response). Fourth, in prior work (Fredrickson & Levenson, 1998), we examined the capacity of positive emotion to reduce physiological arousal associated with negative emotion (having induced that negative emotion with films). In the present study, participants performed a task that is known to produce large amounts of negative emotion (a discussion of a marital conflict), but the dynamic and unstructured nature of the 15-min conversations makes it difficult to determine whether each physiological down-regulation event was preceded by an episode of negative emotion.

One major question for future studies is to determine the specific positive emotions that are most closely associated with physiological down-regulation. In a previous study (Fredrickson & Levenson, 1998), we found that both amusement and contentment were associated with decreases in physiological arousal. However, it may be that not all positive emotions have this "undoing" effect. Its correlational design notwithstanding, the present study could have provided a good opportunity to begin examining other positive emotions (e.g., affection, interest, joy, etc.). Unfortunately, the low base rate of down-regulation events gave us little power at the level of specific positive emotions.

Having demonstrated the robustness of the undoing effect of positive emotions (across age, gender, and marital satisfaction levels), we need to work toward identifying the mechanism by which it operates. Positive emotions induce a range of changes in the brain (Coan et al., 2006; Light, Coan, Frye, Goldsmith, & Davidson, 2009), the periphery (including marked changes in respiration that generate laughter, sighs, and gasps), and expressive behavior. All of these are good candidates for understanding the ways in which positive emotions act on the body to reduce physiological activation, especially the activation associated with experience of negative emotions.

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