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Self-Control and Emotion Regulation in Social Context

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy
in Psychology

by

Ben Wong Shulman

2019

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ABSTRACT OF THE DISSERTATION

Self-Control and Emotion Regulation in Social Context

by

Ben Wong Shulman

University of California, Los Angeles, 2019

Professor Theodore Francisco Robles, Chair

Self-regulation requires bringing one's thoughts, feelings, and behavior in line with one's goals. Although this capacity is essential for social functioning, most studies have focused on processes within individuals. However, emerging theory and evidence indicate that self-regulation shapes the quality of people's relationships, and conversely, people's relationships affect the way they self-regulate. Across two studies, this dissertation investigated this reciprocal interplay. In addition, recent theories suggest that high-frequency heart rate variability (HF-HRV) may index self-regulation capacity and effort. In both studies, I assessed associations between HF-HRV and self-regulation, in order to test this biological marker. Study 1 tested how a self-control challenge affected the quality and consequences of couples' interactions. Undergraduate couples ($N = 148$ individuals) were randomly assigned to sit with a bowl of cookies (or radishes, in the control condition), and not eat any. Afterwards, they discussed points of disagreement and appreciation in their relationship. The self-control challenge worsened couples' interactions, as reflected in observer ratings of their behavior, self-reports of affect and attitudes, and a behavioral measure of aggression. Many of these effects were stronger for couples with lower relationship quality. Study 2 tested whether thinking of a supportive relationship (or an acquaintance, in the control condition) affected participants' negative emotional responses, and their emotion regulation.

Although we had a large sample ($N = 206$) and excellent statistical power, we found no evidence that prompting participants to think of a supportive relationship affected their emotional responses, or self-regulation. In both studies, we found little support for the hypothesized associations between HF-HRV and self-regulation.

The dissertation of Ben Wong Shulman is approved.

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2019

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VITA

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Self-Control and Emotion Regulation in Social Context

Self-regulation requires bringing one's thoughts, feelings, and behavior in line with one's goals (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Carver & Scheier, 1982). Although this capacity is essential for social functioning, most studies have focused on processes within individuals. However, emerging theory and evidence indicate that self-regulation shapes the quality of people's relationships, and conversely, people's relationships affect the way they self-regulate (Beckes & Coan, 2011; Coan, 2011; Fitzsimons & Finkel, 2010, 2011). This dissertation presents two studies which investigated this reciprocal interplay. These studies focus on two components of self-regulation: self-control and emotion regulation. In addition, recent theories suggest that high-frequency heart rate variability (HF-HRV) may index self-regulation capacity and effort. Both studies assessed associations between HF-HRV activity and self-regulation, in order to test this biological marker. Below, I briefly outline each study.

Study 1: Self-Control in an Interpersonal Setting — Couples' Discussions

Study 1 tested how a self-control challenge affected the quality and consequences of couples' interactions. Self-control is difficult to sustain, and self-control challenges may exacerbate couples' subsequent interactions (Finkel & Campbell, 2001; Finkel, DeWall, Slotter, Oaten, & Foshee, 2009). However, past work in this area has not directly examined how self-control challenges affect couples' interactions, and has relied instead on retrospective self-reports, hypothetical scenarios and false-feedback provocations. Study 1 tested how facing a self-control challenge affected the quality and consequences of couples' *behavior*. Undergraduate couples ($N = 148$ individuals) were randomly assigned to sit with a bowl of cookies (or radishes, in the control condition), and not eat any. Partners were assigned to conditions separately, and we used actor-partner analyses to estimate the effect of each partner's food condition. After the self-control challenge, participants discussed points of conflict in their relationship (the *Disagreement* discussion). They then completed self-report measures about their mood and feelings about their partner, and a behavioral measure of aggression (the Voodoo Doll task; DeWall et al., 2013). Finally, participants discussed qualities they appreciated in their

partner (the *Appreciation* discussion). In addition, a team of research assistants (separate from those who ran the study sessions) rated each partner's behavior in video recordings of the Disagreement and Appreciation discussions. The primary goals of this study were (a) to test how facing a self-control challenge affected couples' interactions together, and their feelings afterwards; (b) to examine whether these effects were stronger for couples who were less satisfied and committed in their relationship; (c) to examine associations between self-regulation and HF-HRV.

Study 2: Thinking of Supportive Relationships and Regulating Negative Emotion

Study 2 tested whether thinking of a supportive relationship affected participants' negative emotional responses, and their emotion regulation. Recent theories suggest that supportive relationships can buffer people's negative emotional reactions and could even enhance their emotion regulation (Coan, 2011; Beckes & Coan, 2011). Indeed, past work indicates that simply thinking of supportive relationships can buffer people's self-reported experiences of stress, anxiety, and pain (Jakubiak & Feeney, 2016; Smith, Ruiz, & Uchino, 2004; Eisenberger et al., 2011; Younger, Aron, Parke, Chatterjee, & Mackey, 2010). However, past studies on the effects of supportive relationships have not directly examined participants' broader reports of negative emotion, nor have they assessed whether supportive relationships impact emotion regulation. Undergraduate participants ($N = 206$) were randomly assigned to reflect on their relationship with someone they felt close to and supported by (the *Close* condition), or to reflect on their relationship with an acquaintance (the *Acquaintance* condition). Afterwards, all participants completed an emotion-regulation task, which assessed how strongly participants reacted to upsetting photos, and how effectively they regulated their negative emotions using reappraisal. At the end of the study, participants were given a bowl of candy to eat from while answering questionnaires, ostensibly as part of a tasting task. The amount of candy consumed served as a measure of self-control, indicating their success at resisting this tempting, unhealthy food. The primary goals of this study were to test how thinking of a supportive relationship affected participants' (a) negative emotional reactions, (b) emotion regulation, (c) ability to sustain

self-regulation during and after the emotion-regulation task, and (d) to examine associations between self-regulation and HF-HRV.

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Study 1

Self-Control in an Interpersonal Setting: Couples' Discussions

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Abstract

Self-control challenges may often lead to relationship conflict. However, previous studies in this area have relied on retrospective self-reports, hypothetical scenarios and false-feedback provocations. We tested how a self-control challenge affected the quality and consequences of couples' interactions. Undergraduate couples ($N = 148$ individuals) were randomly assigned to sit with a bowl of cookies (or radishes, in the control condition), and not eat any. Afterwards, they discussed points of disagreement and appreciation in their relationship. The self-control challenge worsened couples' interactions, as reflected in observer ratings of their behavior, self-reports of affect and attitudes, and a behavioral measure of aggression. Many effects were stronger for couples with lower relationship quality. We also examined participants' high-frequency heart rate variability (HF-HRV), to test theories that this biological marker may index self-regulation capacity and effort. However, we found little support for the hypothesized associations between HF-HRV and self-regulation.

Close relationships are important sources of support, but they can also be rife with conflict (Coyne & DeLongis, 1986). This balance is particularly pertinent for romantic relationships, in which partners are highly dependent on each other (Kelley & Thibaut, 1978). If conflicts are not well-managed, they can lead to reciprocated negativity, and even aggression (Gottman, 1998; Finkel, DeWall, Slotter, Oaten, & Foshee, 2009). Self-control may moderate the tenor of couples' interactions. However, many situations challenge people's self-control, such as when their desire for immediate gratification conflicts with their higher-order goals (Milyavskaya & Inzlicht, 2016). For example, someone aiming to improve their diet and exercise might be tempted by a slice of cake, or contemplate ending their workout early. Sustained self-control is taxing, and self-control challenges may exacerbate couples' subsequent interactions, making them less likely to act constructively, and at greater risk of conflict and aggression (Finkel & Campbell, 2001; Finkel et al., 2009). However, past work has not directly examined how self-control challenges affect couples' interactions, and has relied instead on retrospective self-reports, hypothetical scenarios and false-feedback provocations. The present study tests how facing a self-control challenge affects the quality and consequences of couples' *behavior*.

Self-Control Fatigue: Studies of Individuals

When tested individually, people often show poorer self-control after facing a self-control challenge. For instance, participants who resisted the temptation to eat chocolates gave up more quickly on challenging geometric puzzles afterwards (Baumeister, Bratslavsky, Muraven, & Tice, 1998). The initial theory explaining such results, the Strength Model of self-control, described these effects as *depletion*, and proposed that these decrements occur because self-control relies on a limited resource (Baumeister et al., 1998; Baumeister, Vohs, & Tice, 2007). However, recent cognitive theories have proposed that depletion is not the result of a dwindling self-control resource. Instead, these models propose that as the effort required to sustain self-control becomes aversive, people feel fatigued, and are unmotivated to continue (Inzlicht, Schmeichel, & Macrae, 2014; Kurzban, Duckworth, Kable, & Myers, 2013; Saunders & Inzlicht, 2015). Moreover, the

putative resource of the Strength Model's account of depletion has not been identified, and remains controversial. Nevertheless, both Strength and Motivational theories build on the same premise, that sustaining self-control is challenging. Indeed, a meta-analysis of 83 published studies, together including 198 experiments, revealed a moderate depletion effect, $d = 0.62$ (Hagger, Wood, Stiff, & Chatzisarantis, 2010), although evidence of publication bias and failures to replicate suggest this effect size is an overestimate (Carter, Kofler, Forster, & McCullough, 2015; Carter & McCullough, 2014; Hagger et al., 2015; Lurquin et al., 2016). However, these replications failures were all studies of individuals. The present study tests the effect of self-control depletion on couples.

Self-Control, Conflict and Aggression

Although most research has focused on processes within individuals, self-control is essential for social functioning (Fitzsimons & Finkel, 2011). Self-control is particularly pertinent in romantic relationships, in which partners' high levels of interdependence create strong opportunities for support and conflict (Coyne & DeLongis, 1986; Kelley & Thibaut, 1978). However, because sustaining self-control is difficult, a self-control challenge could worsen couples' interactions, and their feelings afterwards. Couples may be less likely to act constructively, and at greater risk of conflict and aggression. For instance, in one study, participants who had been asked to suppress their emotional reactions to a film subsequently reported they would be less likely to react constructively to hypothetical scenarios of relationship conflict (Finkel & Campbell, 2001). Similarly, across several studies, participants who had just faced a self-control challenge reported greater likelihood of acting aggressively and showed more aggressive behavior, both toward strangers and their romantic partner (Finkel et al., 2009; DeWall, Baumeister, Stillman, & Gailliot, 2007). For example, participants who had first faced a self-control challenge in which they were asked to ignore words flashing on screen, subsequently retaliated more strongly in response to false, negative feedback, which was ostensibly from their partner. Those who had been asked to ignore the flashing words assigned their partners to spend more time holding uncomfortable yoga poses (Finkel et al., 2009).

Moderation by Relationship Quality

Based on motivational theories of depletion, we expect that the negative effects of a self-control challenge on couples' interactions will be lessened among couples' who are highly satisfied and invested in their relationship. Studies of individuals suggest that depletion effects are attenuated when people have stronger motivations to continue exerting self-control. For instance, depletion effects were attenuated when participants had stronger financial incentives, or simply believed that their self-control efforts served a useful purpose (Muraven & Slessareva, 2003). We expect that the negative impact of a self-control challenge will be attenuated among couples in higher quality relationships, who are more satisfied and invested together, because these couples will be more motivated to maintain positivity in their interactions.

Heart Rate Variability as an Index of Self-Control

Recent theories suggest that parasympathetic activity may index self-regulation, because the neural circuits supporting parasympathetic activity and self-regulation are co-localized in the brain (Porges, 2001; Thayer & Lane, 2009). Heart rate variability, the beat-to-beat variation in heart rate, reflects parasympathetic activity. As a result, heart rate variability may index of self-regulation. Specifically, variability in the high-frequency band of this signal, called *high-frequency heart rate variability* (HF-HRV), is linked to parasympathetic activity and self-regulation. Higher resting levels of HF-HRV may indicate a greater capacity for self-regulation, and temporary increases in HF-HRV may reflect efforts to self-regulate.

Although an emerging literature supports these theories, most past studies have focused on processes within individuals, largely removed from social context (*e.g.*, Johnsen et al., 2003; Fabes and Eisenberg, 1997; Segerstrom and Nes, 2007; Reynard, Gevirtz, Berlow, Brown, and Boutelle, 2011; Geisler and Kubiak, 2009; Geisler, Vennewald, Kubiak, and Weber, 2010; Geisler, Kubiak, Siewert, and Weber, 2013). We identified two studies that have observed associations between baseline HF-HRV and potential indices of self-regulation in social context (Fabes, Eisenberg, & Eisenbud, 1993; T. W. Smith et al., 2011; Butler, Wilhelm, & Gross, 2006). In one study, young married couples with higher baseline HF-HRV reported better relationship quality

(T. W. Smith et al., 2011). Although spouses reported their ratings of each other's behavior during a discussion task, this study did not report associations between baseline HF-HRV and couples' behavior. A second study tested associations between women's baseline HF-HRV and their emotional reactions during a conversation about an upsetting film (Butler et al., 2006). Women were randomly assigned to regulate their emotions during the conversation, or to respond naturally. Women with higher baseline HF-HRV experienced more negative and less positive emotion during the discussions (reflected in self-reports, and observer ratings of their behavior). Furthermore, this effect did not differ by emotion-regulation condition. The authors of this study suggested that higher baseline HF-HRV corresponded to greater emotional flexibility. However, we believe that theories of HF-HRV as an index of self-regulation predict that link between baseline HF-HRV and negative emotion should differ by condition. If higher baseline HF-HRV reflects greater capacity for self-regulation, then when participants are asked to down-regulate their negative emotions, those with higher baseline HF-HRV should show *less* negative emotion (*i.e.*, more effective regulation).

Both studies also supported the hypothesis that changes in HF-HRV may reflect self-regulatory effort. In the study of married couples, wives showed decreased HF-HRV after a negative discussion task, which the study's authors thought might reflect their self-regulatory fatigue (T. W. Smith et al., 2011). Similarly, in the study in which women discussed an upsetting film, those who were asked to down-regulate their negative emotion showed increased HF-HRV (Butler et al., 2006). Although the literature examining HF-HRV as a marker of self-regulation is growing, studies examining these associations in social context are few, and none has examined the effects of a self-control challenge.

The Present Study

Past work examining self-control in interpersonal contexts has relied on retrospective self-reports, or responses to hypothetical scenarios or false-feedback provocations. To address this issue, we tested the impact of a self-control challenge on romantic partners' conflict *behavior*. Partners were randomly assigned to a self-control challenge: to sit with a bowl of warm cookies,

but not eat any (the *Cookie* condition). In the control condition, participants sat with a bowl of radishes (the *Radish* condition; Baumeister et al., 1998). Partners were assigned to conditions separately, and we used actor-partner analyses to estimate the effect of each partner's food condition. After the self-control challenge, participants discussed points of conflict in their relationship (the *Disagreement* discussion). They then completed self-report measures about their mood and feelings about their partner, and a behavioral measure of aggression (the Voodoo Doll task; DeWall et al., 2013). Finally, participants discussed qualities they appreciated in their partner (the *Appreciation* discussion).

We hypothesized that the Cookie condition would lead to more negative interactions between partners, and cause them to feel less positively and more aggressively toward each other. We also hypothesized that these effects would be weaker among couples who were highly satisfied and committed in their relationships. We hypothesized that that higher baseline HF-HRV would be associated with less negative interactions, and more positive and less aggressive feelings between partner (main effects). We also hypothesized that the effect of the Cookie condition would be weaker among participants with higher baseline HF-HRV (moderation effects). Finally, we hypothesized that changes in HF-HRV during the Disagreement discussion (relative to baseline) would mediate the effects of the Cookie condition, such that lower HF-HRV would account for the more negative interactions, less positive and more aggressive feelings between partners.

Method

Participants

Participants were 74 undergraduate couples ($N = 148$ individuals, 73 women, 75 men), in which one or both partners were recruited through the psychology department subject pool. Participants in the subject pool were compensated with research credit. Participants not in the subject pool were invited by their partner and were compensated with a \$20 gift card. Participants' relationship duration, satisfaction and investment shown in Table 2. Participants mean age was 20.47 years old ($SD = 2.66$ years). Participants were primarily Asian (43%),

Latino (19%), non-Latino White (18%), multi-racial (14%), and Middle Eastern (5%).

Procedure

Each session was run by two research assistants, a man and a woman. The female research assistant led the couple through tasks together, while the male research assistant controlled the electrocardiography equipment. For tasks which partners completed separately, the male and female research assistants led participants through the tasks in separate rooms.

Participants were recruited for a study of hunger and communication and were asked to avoid eating for at least 2 hours before coming to the lab. They provided informed consent, and then went to separate rooms where research assistants placed electrodes on their torso for electrocardiography. The research assistant of the same gender as the participant placed the electrodes and helped remove them at the end of the study. They provided informed consent, and then went to separate rooms where research assistants placed electrodes on their torso for electrocardiography. The research assistant of the same gender as the participant placed the electrodes and helped remove them at the end of the study. Participants then returned to the same room and completed baseline measures of heart activity. More details of these tasks are given in the Supplemental Materials. We focus two of these tasks, which provide the most relevant baselines for our analyses in this paper.

1. *Paced Breathing*: Participants matched their breathing to the fixed rhythm of a rising and falling tone. This task controls for the influence of individual differences in breathing rate on heart activity and provides more reliable measurement of resting HF-HRV than when participants are breathing freely (Pinna et al., 2007; Berntson et al., 1997).
2. *Photo viewing*: Participants then completed a photo viewing task in which they described a series of photos to their partner. This task was completed using a laptop computer, and was paced so that each partner described photos for two minutes. We selected photos which were previously rated as mildly positive and evoking low arousal. This task provides a measure of resting HF-HRV which accounts for fluctuations that occur while participants are speaking.

Participants were then randomly assigned to their food condition. In the Cookie condition, participants sat with a bowl of warm chocolate chip cookies. In the Radish condition participants sat with a bowl of radishes. Partners were assigned to food conditions separately and completed the task in separate rooms. The research assistant explained that the participant would spend a few minutes sitting in front of the food to make their feelings of hunger more salient, but that it was important not to eat any of the food. The research assistant left the participant with the food for 3 minutes. Participants then answered the food-task manipulation check questions, and rated their positive and negative emotions (to serve as a rating before the Disagreement discussion).

Participants then returned to the same room for the Disagreement discussion. As a starting point, they completed a questionnaire in which each partner separately indicated how often they disagreed about common areas of disagreement in relationships (adapted from Gottman, Markman, and Notarius, 1977). The research assistant asked the participants to describe the last time they disagreed about their highest rated topics. The research assistant then left the room, and the couple discussed each partner's topic for the next 8 minutes.

After the Disagreement discussion, partners were again brought to separate rooms where they completed a behavioral measure of aggression, in which they could insert pins into a voodoo doll said to represent their partner (DeWall et al., 2013). While still in separate rooms, participants rated their positive and negative emotions once more (to serve as a rating after the Disagreement discussion). They also completed questionnaires about their discussion, their mood, their feelings toward their partner, relationship quality, and trait self-control, aggression, and eating behavior.

Participants then returned to the same room for the Appreciation discussion. They completed a questionnaire in which they chose two qualities they appreciated about their partner from a list of positive attributes. The research assistant then left the room, and the partners discussed their chosen attributes for the next 8 minutes. (More details about the Disagreement and Appreciation discussions are given in the Supplemental Materials) Participants were then debriefed and thanked. Each partner was also given contact information for student psychological

services, where they could find counseling if their experience in the study raised any issues.

Measures

We provide more information about each measure, including example items, in the Supplemental Materials.

Food task manipulation check. Participants completed a questionnaire asking how *hungry* they felt, how much they *wanted* to eat the food, and how *difficult* they found it to resist, rated on a 5-point Likert scale from *Not at all* to *Quite a lot*.

Disagreement discussion topics. To help participants arrive at topics for the Disagreement discussion, partners separately rated the extent to which they disagreed about 15 common issues, from *Never*, *Sometimes* or *Always*. This questionnaire was adapted from the Couples Problem Inventory (Gottman et al., 1977), with content adjusted to suit college-aged couples.

Appreciation discussion topics. To help participants arrive at topics for the Appreciation discussion, couples completed a questionnaire listing 33 positive qualities. Each partner separately circled two qualities from the list, which they appreciated about their partner.

Positive and negative emotions. Participants completed the *Positive and Negative Affect Scale* (Watson, Clark, & Tellegen, 1988). Participants rated their emotions before and after the Disagreement discussion, and these ratings were used to calculate their change in affect during the discussion. Participants indicated the degree to which they felt 20 positive and negative emotions. Responses were given on a 5-point Likert scale, from *Not at all* to *Extremely*. This scale showed good internal consistency ($\alpha = .91$ for positive items, $\alpha = .86$ for negative items).

Behavioral ratings. Research assistants viewed videotapes of the discussions and rated partners' behavior on 7 individual-level dimensions and 4 couple-level dimensions. Ratings were made by a separate group of research assistants, who had not run participants through the study, and were blind to participants' conditions and the study hypotheses. Each tape was independently rated by at least three raters, who used 9-point Likert scales from *None* to *A lot*. These ratings showed good inter-rater reliability. (*ICCs* are shown in Table 1). We conducted an

exploratory factor analysis to consolidate the individual-level ratings. This yielded a *Negativity* factor, which consisted of disapproval, dominance and negativity, and a *Positivity* factor, which consisted of attention and support, and positivity. (We report details of the ratings and factor analysis in the Supplemental Materials.) We conducted our substantive analyses of the behavior ratings using the individual-level Negativity and Positivity factors, ratings of unconstructiveness and positive mood, and couple-level ratings of negative and positive reciprocity, vulnerability and support, and mutual avoidance.

Disagreement validity check. Participants completed a questionnaire asking how *similar* the discussion was to other times they had discussed the topic; how *similarly they felt* during the discussion, compared to past times; how *strongly they felt* about the topic; and how *important* the topic was, rated on a 5-point Likert scale from *Not at all* to *Very*.

Aggressive impulses. Participants completed a measure of aggressive impulses toward their partner, in which they indicated how likely they were to engage in six different acts of aggression toward their partner. Responses were given on a 5-point Likert scale from *Not at all likely right now* to *Quite likely right now*. These items showed reasonable internal consistency, $\alpha = .71$.

Voodoo Doll pin insertion. Participants were told they could insert pins into a voodoo doll said to represent their partner (DeWall et al., 2013). Participants were told:

This doll represents your romantic partner. You will get to choose how many pins you would like to put in the doll that represents your romantic relationship partner. Insert pins into the doll as a way to let out any negative feelings you might be having as a result of the study. Insert zero to fifty-one pins depending on how angry you are with your partner.

Participants were reassured that their behavior on the task was confidential and to minimize their self-consciousness, were asked to place the doll back in the box the experimenter had brought it in when they were finished. After 2 minutes, the research assistant returned to collect the box.

Positive feelings for partner. Participants completed the Positive Feelings Questionnaire (O’Leary, Fincham, & Turkewitz, 1983). Participants indicated how they felt about their partner, answering 7 questions about how they felt about their relationship. Responses were given on a 7-point Likert scale, from *Extremely Negative* to *Extremely Positive*. These items showed good internal consistency, $\alpha = .86$.

Relationship quality. Participants completed the Inclusion of the Other in the Self scale, choosing the picture that best represented their relationship from a series seven Venn-diagram circles with different amounts of overlap (Aron, Aron, & Smollan, 1992).

Participants also completed the Perceived Relationship Quality Components scale (Fletcher, Simpson, & Thomas, 2000). Participants indicated their level of satisfaction, commitment, intimacy, trust, passion, and love in their relationship. Responses were given on a 7-point Likert scale, from *Not at all* to *Extremely*. These items showed good internal consistency, $\alpha = .94$.

Participants also completed the Investment subscale of the Investment Model Scale, indicating through 5 statements the degree to which they had invested in their relationship (Rusbult, Martz, & Agnew, 1998). Responses were given on an 8-point Likert scale, from *Do not agree at all* to *Agree completely*. These items showed reasonable internal consistency, $\alpha = .75$.

Trait aggression. Participants completed a short form of the Aggression Questionnaire (Buss & Perry, 1992; Bryant & Smith, 2001). Participants answered 12 questions each indicating their generally inclination toward physical aggression, verbal aggression, anger and hostility. Responses were given on a 5-point Likert scale, from *Extremely uncharacteristic of me* to *Extremely characteristic of me*. These items showed good internal consistency, $\alpha = .84$.

Trait self-control. Participants completed the Brief Self-Control Scale. Participants indicated through 13 statements how effectively they can exert self-control. Responses were given on a 5-point Likert scale from *Not at all* to *Very much*. These items showed good internal consistency, $\alpha = .83$.

Trait eating behavior. Participants completed the Dutch Eating Behavior Questionnaire. This which included 33 questions about participants' habitual eating behavior, focusing on their tendency to restrict their eating, and to eat in response to their emotions and to cues in their environment. Responses were given on a 5-point Likert scale from *Never* to *Very often*. These items showed good internal consistency, $\alpha = .92$.

Heart rate variability. Participants' heart activity was recorded using spot electrodes in a modified lead II configuration with two MindWare MW-1000a recorders transmitting to a MindWare BioNex amplifier, recording at 500 *hz* (MindWare Technologies Ltd., Gahanna, OH). We checked and edited recordings for artifacts using the algorithm of Berntson, Quigley, Jang, and Boysen (1990) with the MindWare HRV software. We also used this software to calculate HF-HRV values using spectral analysis of the linearly-detrended inter-beat interval time-series with a Hamming window, and the high frequency range defined as 0.12 -0.40 *hz*.

Data Analysis

We used multi-level linear models to account for the dependence of partners in couples. We fit random intercepts for each couple and treated predictors as fixed effects. We used Actor Partner Interdependence Models (Kenny, Kashy, & Cook, 2006) to estimate the unique effect of each partner's food condition. (Food conditions were coded using dummy variables, with 0 for Radish and 1 for Cookie.) Some of these models showed no couple-level variance in the intercept, and resulted in multi-level models which produced singular fits. In these cases we refit the models as single-level regression models. To analyze couple-level ratings of partners' joint behavior, we fit single-level regression models with the number of partners in the Cookie condition (0, 1 or 2) as the predictor.

To test the effect of food condition on participant's pin-insertion on the Voodoo Doll task we used a two-equation hurdle model (Mullahy, 1986). This accounts for the high levels of overdispersion in these data, caused by the fact that most participants (61%) did not insert any pins. Using this approach, we first fit a multilevel logistic regression model of participants' log odds of inserting pins, with participants' and their partners' food condition as predictors. Then,

for participants who did insert pins, we fit a multilevel zero-truncated poisson model which predicted the log number of pins inserted.

We also tested whether relationship quality moderated these effects. We fit separate models testing participants' and partners' report of relationship satisfaction and investment as moderators. In addition, we tested whether these dependent variables were significantly associated with baseline HF-HRV, and whether baseline HF-HRV moderated the effects of the food condition. We used the paced-breathing task as the baseline measure of HF-HRV, and we fit separate models testing participants' and partners' baseline HF-HRV. These analyses paralleled those described above, with relationship quality, participants' baseline HF-HRV, and their interaction with partners' food conditions as predictors. For ratings of couples' joint behavior, we computed the average of both partners' baseline HF-HRV, and their reports of satisfaction and investment.

When we found a significant moderator, we followed up with test of simple slopes for the effects of the food condition and used the Johnson-Neyman technique to calculate the regions for which these slopes were significantly different from each other (Johnson & Neyman, 1936). To fit these models, we used the packages *lme4*, *lmerTest*, and *glmmTMB* in *R* (R Core Team, 2016; Bates, Mächler, Bolker, & Walker, 2015; Kuznetsova, Brockhoff, & Christensen, 2015; Magnusson et al., 2017).

We also tested whether participants' change in HF-HRV during the discussion tasks mediated the effects of the food condition. For these analyses, we computed the difference between each participants' HF-HRV during the discussions and their HF-HRV during the portion of the photo viewing baseline in which they had described photos to their partner. (We chose this baseline task to account for the influence of participants' speech on their HF-HRV during the discussions.) For ratings of couples' joint behavior, we computed the average of both partners' change in HF-HRV. We tested these hypotheses using the quasi-Bayesian estimation method of the R package *mediation*, and used 10,000 simulations for each model (Tingley, Yamamoto, Hirose, Keele, & Imai, 2014).

Missing Data. Most analysis variables were at least 95% complete, and we conducted analyses with these variables using restricted maximum likelihood estimation. For the HF-HRV analyses, we used data from participants whose heart recordings from that section were at least 90% complete and free of artifacts. With these criteria, 90.5% of participants had usable data for the paced breathing baseline task (used for our moderation hypotheses). For measures of HF-HRV change (used for our mediation hypotheses), 81.8% of participants had usable data to calculate their HF-HRV change during the Disagreement discussion, and 75.7% for HF-HRV change during the Appreciation discussion. (Missing HF-HRV data was due to technical difficulties with the heart-recording equipment).

Similarly, for ratings of affect change during the Disagreement discussion, 90.5% of participants' had complete data for ratings of negative affect change, and 87.8% for ratings of positive affect change. Additionally, 93.2% of participants had complete data for their ratings of relationship satisfaction.

To account for these rates of missing data, we used multiple imputation for analyses with these variables. We used the program *Blimp* to generate the imputations, and the *R* packages *mitml* and *mice* to pool analyses across imputed data sets (Enders, Keller, & Levy, 2016; van Buuren & Groothuis-Oudshoorn, 2010; Grund, Lüdtke, & Robitzsch, 2016). (We report details of the imputation process in the Supplemental Materials.)

Results

Preliminary Analyses

Food-task manipulation and randomization checks. Table 2 shows group differences by food condition in the food-task manipulation checks, Disagreement discussion validity checks, relationship duration, satisfaction and commitment, and trait self-control, aggression, and eating behavior. Participants in the Cookie condition reported wanting the food more ($\beta = 1.15$) and finding it more difficult to resist ($\beta = 0.80$, both $ps < .01$). Participants in the Cookie condition also reported eating in response to their emotions more often than those in the Radish condition ($\beta = 0.50$, $p < .01$). Consequently, we controlled for differences in

emotional eating in all subsequent analyses. (We also report the uncontrolled analyses in the Supplemental Materials.) The associations between ratings of emotional eating and our variables of interest are shown in Table 3. Participants did not otherwise differ by condition $ps > .07$.

Disagreement validity check. The ratings for the Disagreement discussion validity checks are shown in Table 2. Participants indicated that the Disagreement discussion was similar to other times they had discussed the topic, and that the topic was important to them.

Main Effects of Food Condition

Disagreement discussion observer ratings. Participants' and their partner's food condition did not affect observer ratings of their behavior during the Disagreement discussion ($ps \geq .31$).

Change in affect during the Disagreement discussion. Participants in the cookie condition ($\beta = -0.48, p = .01$) and those whose partners were in the cookie condition ($\beta = -0.49, p = .007$) showed a larger decrease in positive affect during the Disagreement discussion. (See Figure 1, panel A.) Participants' and their partners' food condition did not significantly affect participants' change in negative affect ($ps \geq .51$).

Positive feelings for partner. Participants whose partners were in the cookie condition reported lower positive feelings for their partners after the Disagreement discussion, ($\beta = -0.36, p = .023$). (See Figure 1, panel B.)

Aggressive impulses against partner. Participants' and their partners' food condition did not significantly affect participants' self-reported aggressive impulses toward their partners ($ps \geq .15$).

Voodoo Doll pin insertion. Participants' and their partners' food condition did not significantly affect their likelihood of inserting pins, or the number of pins inserted ($ps \geq .09$).

Appreciation discussion observer ratings. As shown in Figure 1 (panel C), couples with more partners in the Cookie condition showed less positive reciprocity during the Appreciation discussion ($\beta = -0.44, p = .008$). Besides this effect, observer ratings of participants in the Appreciation discussion were not significantly affected by participants' food condition, or partners' food condition ($ps \geq .12$).

Moderation by Relationship Quality

Disagreement discussion observer ratings. Participants' partners' relationship investment moderated the effect of participants' food condition on observer ratings of participants' positive mood during the Disagreement discussion ($\beta = 0.26, p = .036$). Participants in the Cookie condition with less invested partners (below -0.78 SD less than the mean) showed more positive mood during the Disagreement discussion (see Figure 2, panel A). Besides the effects described above, relationship quality did not moderate the effect of the food condition on observer ratings of participants' behavior ($ps \geq .052$).

Change in affect during the Disagreement discussion. Relationship quality did not moderate the effect of participants' and their partners' food condition on their change in positive ($ps \geq .14$) or negative affect ($ps \geq .12$) during the Disagreement discussion.

Positive feelings for partner. Participants' partners' relationship satisfaction moderated the effect of participants' partners' food condition on participants' positive feelings for their partner after the Disagreement discussion ($\beta = 0.34, p = .033$). Participants with partners in the Cookie condition and whose partners were less satisfied (below -0.01 SD less than the mean) reported less positive feelings for their partner (see Figure 2, panel B). Besides this effect, relationship quality did not otherwise moderate the effect of food condition on participants' positive feelings for their partner after the Disagreement discussion ($ps \geq .071$).

Aggressive impulses. Participants' and their partners' relationship investment moderated the effect of their partners' food condition on their aggressive impulses ($\beta = -0.39, p = .026$ for participants' investment; $\beta = -0.37, p = .019$ for partners' investment; see Figure 4). Participants with partners in the Cookie condition who were less invested in their relationship (below -0.45 SD less than the mean; panel A) or whose partners were less invested (below -0.54 SD less than the mean; panel B) reported more aggressive impulses after the Disagreement discussion. This moderation effect was partly driven by a single outlier, who was 3.2 standard deviations above the mean on aggressive impulses. Without this participant in the analysis, the moderation by participants' investment was no longer statistically significant, ($\beta = -0.23, p = .15$). However, we examined this participant's responses and their data appeared to be valid.

(They appeared to be attentively engaged with the study's instructions.) Besides these effects, relationship quality did not otherwise moderate the effect of food condition on participants' aggressive impulses after the Disagreement discussion ($ps \geq .14$).

Voodoo Doll pin insertion. Among participants who inserted pins, their relationship satisfaction moderated the effect of their partners' food condition on the number of pins they inserted ($\beta = -0.53$, $p = .0063$; see Figure 5 panel A). Less satisfied participants (below -1.65 SD less than the mean) with partners in the Cookie condition inserted more pins. This moderation effect was partly driven by a single outlier, who inserted 9 more pins than the next highest participant. Without this outlier in the analysis, this moderation effect was no longer statistically significant, ($\beta = -0.50$, $p = .11$). This outlier was not the same participant as the outlier in the aggressive impulses moderation analysis. We also examined this participant's responses, and their data appeared valid. (They appeared to be attentively engaged with the study's instructions.)

Similarly, among participants who inserted pins, their partners' relationship satisfaction moderated the effect of participants' food condition on the number of pins they inserted ($\beta = 0.52$, $p = .0071$; see Figure 5 panel B). Participants in the Radish condition with less satisfied partners (below -1.04 SD less than the mean) inserted more pins.

Besides these effects, relationship quality did not otherwise moderate the effect of food condition on the number of pins participants inserted ($ps \geq .31$), nor did food condition affect their likelihood of inserting pins ($ps \geq .087$).

Appreciation discussion behavior. Participants' relationship investment significantly moderated the effect of the food condition on their negativity behavior during the Appreciation discussion ($\beta = -0.34$, $p = .012$). Participants in the Cookie condition who were less invested in their relationship (below -1.28 SD less than the mean) showed more negativity during the discussion. In contrast, participants in the Cookie condition who were highly invested (more than 1.14 SD above the mean) showed *less* negativity (See Figure 3, panel A).

Similarly, couples' relationship satisfaction also moderated their level of negative

reciprocity during the Appreciation discussion ($\beta = -0.40, p = .026$).¹ Couples with both partners in the Cookie condition who were less satisfied in their relationship (below -0.77 *SD* less than the mean) showed more negative reciprocity during the discussion (see Figure 3, panel B).

HF-HRV Main Effects, Moderation, and Mediation

Participants with higher baseline HF-HRV acted more positively during the Appreciation discussion ($\beta = 0.21, p = .009$). In addition, among participants who inserted pins in the Voodoo Doll task, those whose partners had higher baseline HF-HRV inserted more pins, contrary to our hypotheses ($\beta = 0.28, p = .032$). Besides these effects, participants' and their partners' baseline HF-HRV was not associated with any other dependent variable in this study ($ps \geq .061$). Similarly, participants' and their partners' baseline HF-HRV did not moderate the effect of the food condition on these dependent variables ($ps \geq .084$). Change in participants' HF-HRV (relative to baseline) during the Disagreement and Appreciation discussion did not mediate the effect of the food condition on these dependent variables. (All 95% CIs for the indirect path contained 0.)

Discussion

Although self-control may moderate the tenor of couples' interactions, past studies have relied on retrospective self-reports, hypothetical scenarios and false-feedback provocations (*e.g.* Finkel and Campbell, 2001; Finkel et al., 2009). To address this issue, we tested how facing a self-control challenge affected the quality and consequences of couples' *behavior*. Across a range of outcomes, the self-control challenge of the Cookie condition worsened partners' interactions and their feelings about their each other. Participants and their partners who were in the Cookie condition (a) showed greater decreases in positive affect during the Disagreement discussion, (b) felt less positively about each other afterward, and (c) showed less positive reciprocity during the Appreciation discussion.

¹These data were highly right-skewed, because most couples showed little negative reciprocity. To correct for this, we transformed this variable before analysis, taking its reciprocal square-root. (This transformation is given by the following function, with Y indicating the negative reciprocity variable: $f(Y) = -1/Y^{1/2}$.) To ease interpretation, we standardized the transformed variable to have a mean of zero and a standard deviation of one.

We predicted that the effects of the Cookie condition would be weaker for couples who were highly satisfied and committed in their relationships. This was true for the effect of the Cookie condition on (a) participants' positive mood during the Disagreement discussion; (b) their positive feelings for their partner after the Disagreement discussion; (c) their aggressive feelings toward their partner after the Disagreement discussion; and (d) among participants who inserted pins during the Voodoo Doll task after the Disagreement discussion, the number of pins they inserted; (e) participants' negativity during the Appreciation discussion; and (f) their negative reciprocity during the Appreciation discussion. Some of these effects were moderated by participants' own reports of relationship quality, and others by participants' partners' reports. Nevertheless, in every case but one, the effects of the Cookie condition were stronger among those with lower relationship quality. Only one result was inconsistent with our hypothesized moderation effect: among participants who inserted pins, those in the *Radish* condition with less satisfied partners inserted *more* pins. However, because this result was not hypothesized *a priori*, it should be interpreted with caution.

These results suggest that relationship quality can mitigate the negative impact of a self-control challenge on couples' interactions. Only one other study has tested this hypothesis, and it did not observe moderation (Finkel & Campbell, 2001). However that study did not observe participant's behavior, but relied instead on their retrospective self-reports of behavior, responses to personality inventories, and hypothetical vignettes of relationship conflict, which may account for this difference in findings.

Contrary to our hypotheses, we did not observe an effect of the food condition on several of our dependent variables, whether as main effects, or as effects moderated by relationship quality. This was the case for (a) participants' change in negative affect during the disagreement discussion, as well as (b) their positivity, (c) unconstructiveness, (d) vulnerability and support, (e) and mutual avoidance during both discussions. These null findings may be due to the fact that couples in this study were mostly in the early stages of their relationships (on average they had been together less than two years), and their discussions during our laboratory tasks may not have been serious enough to elicit effects on these variables.

We hypothesized that participants with higher baseline HF-HRV would have less negative interactions, and more positive and less aggressive feelings between partner (main effects). However, this was only true for one dependent variable: Participants with higher baseline HF-HRV acted more positively during the Appreciation discussion. To our knowledge this is the first study to observe an association between baseline HF-HRV and a behavioral indicator of more effective self-regulation in a highly social situation, such as a discussion with one's partner. However, because this pattern only emerged for one of our dependent variables, it should be interpreted cautiously. We also observed one main effect of baseline HF-HRV in the opposite direction of our hypotheses. Among participants who inserted pins in the Voodoo Doll task, those whose partners had higher baseline HF-HRV inserted more pins. Because this effect was not hypothesized *a priori*, it should also be interpreted with caution.

We also hypothesized that the effect of the Cookie condition would be weaker among participants with higher baseline HF-HRV (moderation effects). However, this was not the case for any of our dependent variables. Finally, we predicted that changes in HF-HRV during the Disagreement discussion (relative to baseline) would mediate the effects of the Cookie condition. However, analyses indicated that this was also not the case for any of our dependent variables. Although we used multiple imputation, our high rates of missing heart-rate data may still have limited our statistical power to test our HF-HRV hypotheses. However, few studies have examined associations between HF-HRV and self-regulation in social situations, and past results are mixed (Butler et al., 2006; T. W. Smith et al., 2011). Moreover, these past studies differ from the present work in terms of the relationships they examined (strangers and married couples), their experimental design (they did not involve a self-control challenge), and their analysis of HF-HRV (they did not examine the mediation hypotheses that this study tested).

Strengths and Limitations

In contrast to past studies of self-control and couples' interactions, which relied on self-reports or false-feedback provocations, this study examined couples' *behavior*. In addition to self-report measures of affect, attitudes and intentions, we used observer ratings of couples'

interactions together, and a behavioral measure of aggression. Moreover, we assigned participants to food conditions individually, which enabled us to test actor and partner effects. Finally, our experimental manipulation, resisting tempting food, is a common experience in the US and globally. Indeed, a representative survey using random-digit dialing indicated that in the US 29% of men and 44% of women were trying to lose weight, and a meta-analysis of 34 representative samples from 7 countries found that on average 42% of adults had tried to lose weight in the past year (Serdula et al., 1999; Santos, Sniehotta, Marques, Carraga, & Teixeira, 2017).

Despite these strengths, several limitations qualify the results of this study. Although our sample was relatively diverse in terms of ethnicity, it included only college students who had been in a relationship for less than two years, on average. The effects we observed may operate differently among couples in other life stages, and from other socioeconomic backgrounds. In addition, participants' level of trait emotional eating differed between the food conditions. These ratings of trait emotional eating were also systematically related to participants' level of positive mood during both discussions, and to their aggressive impulses and likelihood of inserting pins after the Disagreement discussion. To address this, we controlled for ratings of emotional eating in all of our substantive analyses. We did not examine trait emotional eating as a moderator, because we had no *a priori* hypotheses. However, future research using food as a self-control challenge should consider examining this individual difference as a potential moderator. Finally, we prompted couples to discuss points of disagreement and appreciation in their relationship, because such discussions were unlikely to emerge spontaneously during our experiment. However, couples reported that the topics they chose for the the Disagreement discussion were important to them, and that the experience felt similar to their private discussions.

Implications

This study provides experimental evidence that facing a self-control challenge can worsen couples' interactions, and their feelings afterwards. Indeed, the couples in this study were highly satisfied in their relationships, and the self-control challenge we employed was relatively minor and lasted only three minutes. Nevertheless, it led partners to act less positively and more

negatively, and to feel worse about each other afterward. Moreover, these detrimental effects lasted into the Appreciation discussion at the end of the study, roughly 40 minutes after the manipulation. Our findings are consistent with the essential premise of both the Strength and motivational theories of depletion: Sustaining self-control is challenging. However, positive expectations, or rewarding experiences can mitigate the effects of depletion (*e.g.*, Derrick, 2013; Job, Dweck, and Walton, 2010). These strategies may be especially relevant for couples' with lower relationship quality, who were more strongly affected by the self-control challenge in this study. Our findings suggest that self-control depletion is one mechanism by which external demands and stressors affect couples' relationship quality (Neff & Karney, 2017). Self-control challenges are common, and they may undermine the positivity of couples' relationships and leave them at greater risk of conflict and aggression.

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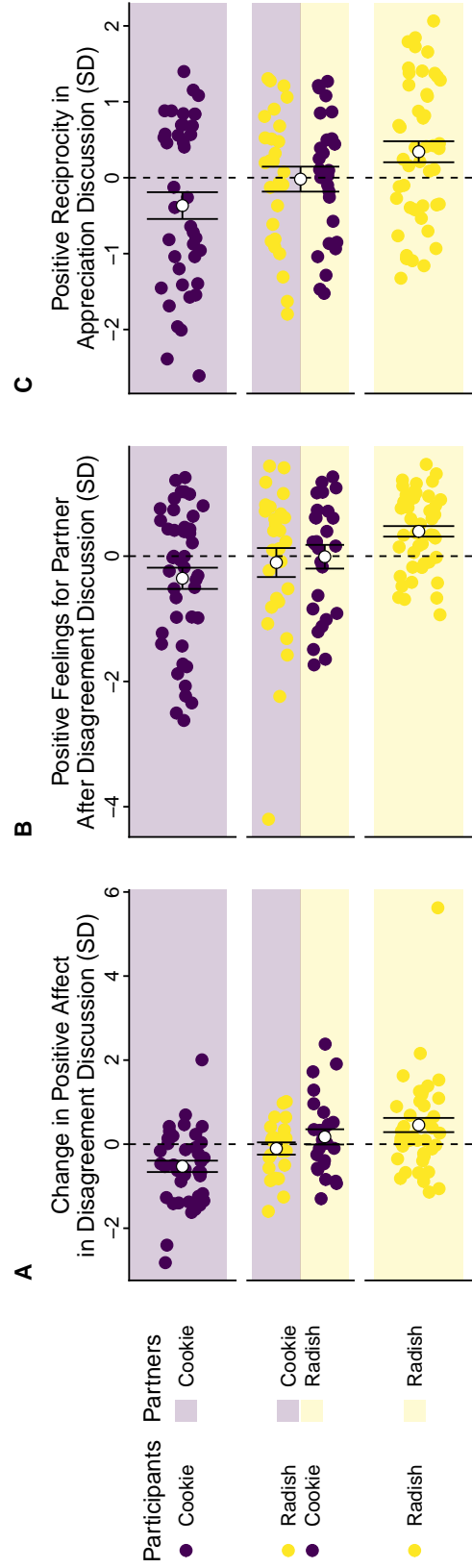


Figure 1. (A) Change in positive affect during the Disagreement Discussion, (B) positive feelings for partner after the Disagreement Discussion, and (C) positive reciprocity during the Appreciation Discussion by participants' and partners' food conditions. A: Participants in the Cookie condition (dark points) and those whose partners were in the Cookie condition (darker shading) showed a larger decrease in positive affect during the discussion. B: Participants whose partners were in the Cookie condition (darker shading) reported lower positive feelings for their partner. C: Couples with more participants in the Cookie condition showed less positive reciprocity during the disagreement discussion. White points indicate marginal means with standard error bars. All DVs are centered with zero as their grand means. The middle portion of Panel C shows only one white point indicating the marginal mean, because positive reciprocity was a couple-level outcome.

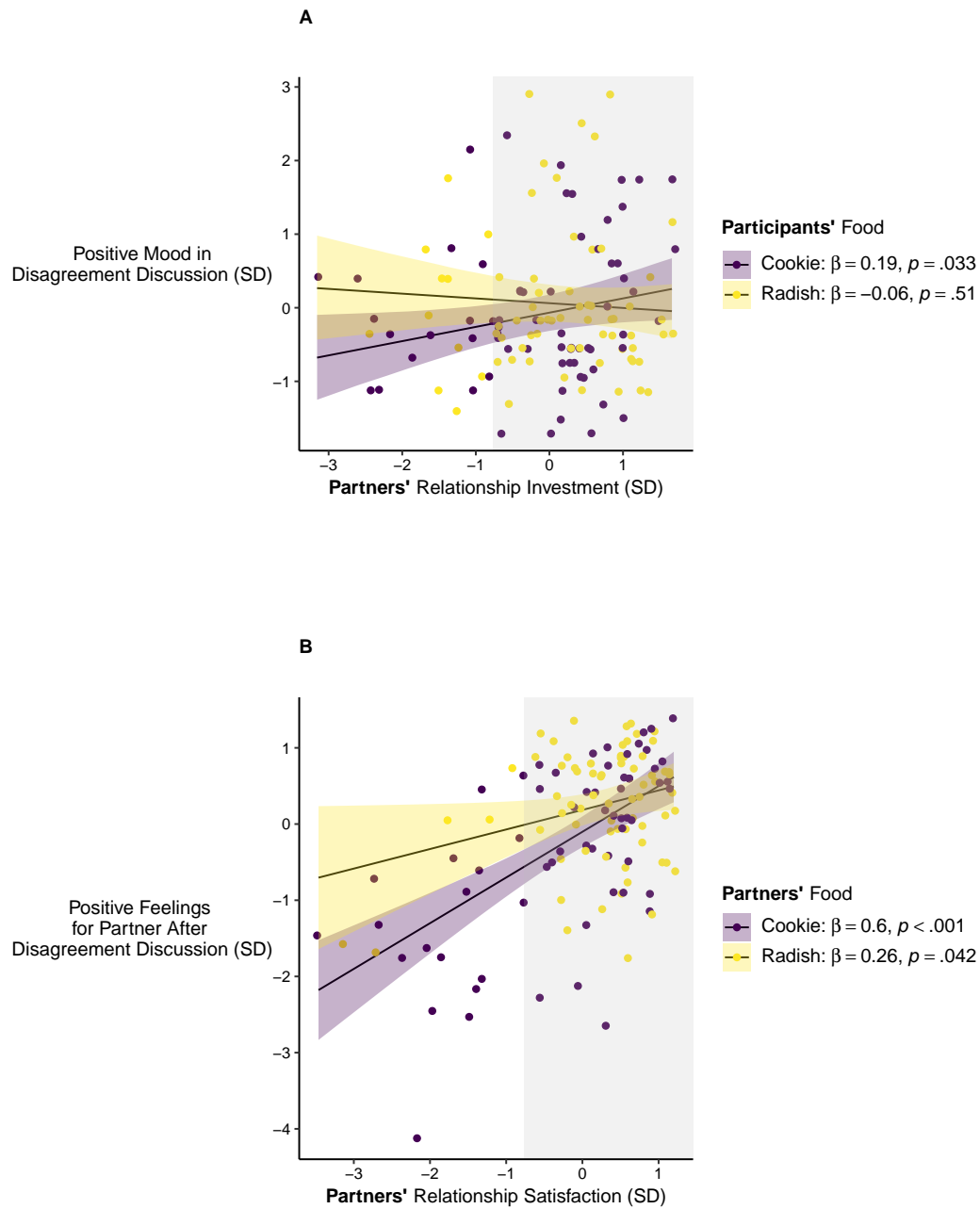


Figure 2. Shaded rectangles indicate the range of the x-axis for which the effect of the food condition was not statistically significant. Simple slopes are noted in the legend. A: Participants in the Cookie condition with less invested partners showed less positive mood during the Disagreement discussion. D: Participants with partners the Cookie condition whose partners were less satisfied in their relationship reported less positive feelings for their partner after the Disagreement discussion. Continuous variables are centered with zero as their grand means.

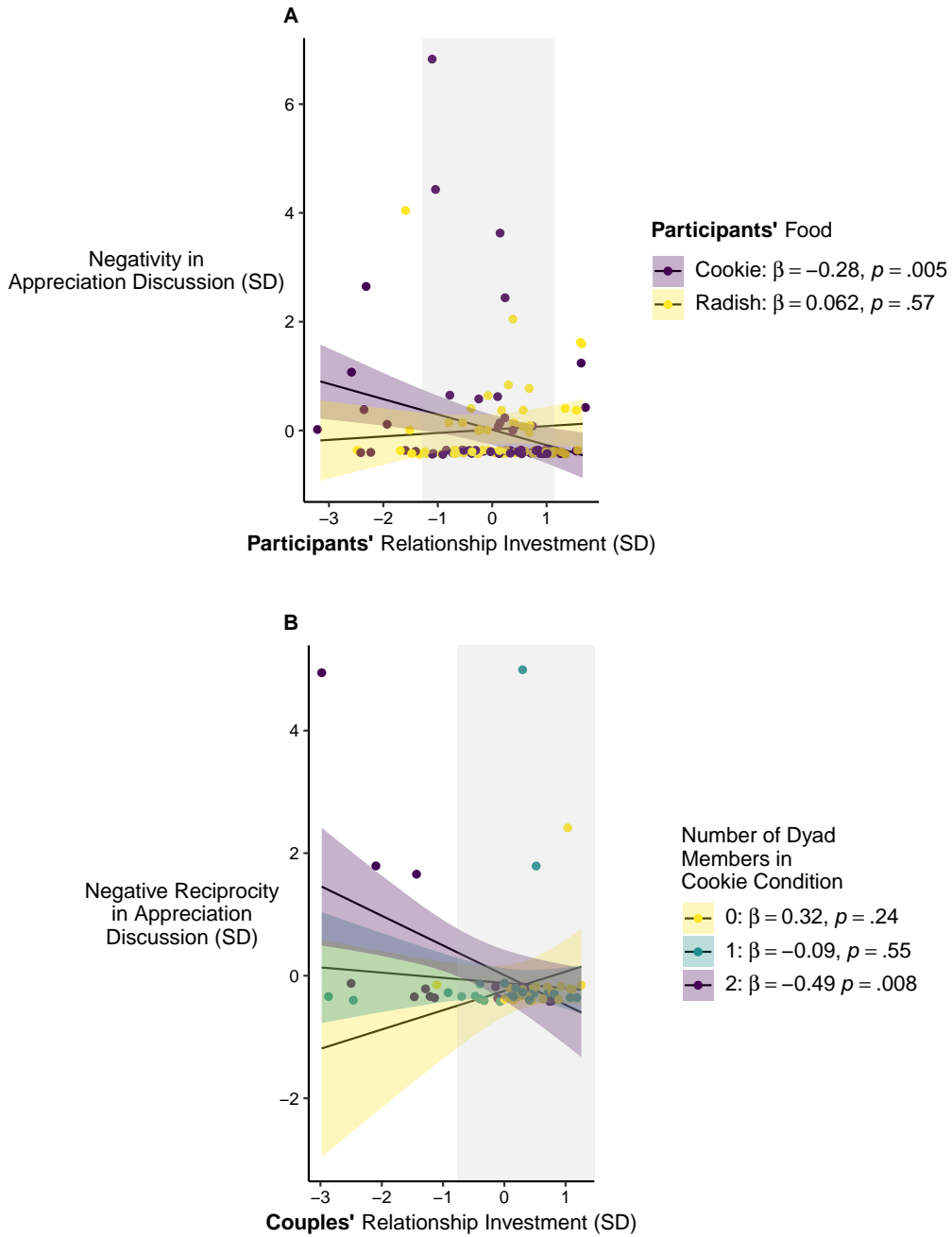


Figure 3. A: Participants in the Cookie condition who were less invested in their relationship acted more negatively during the Appreciation discussion. This pattern reversed for highly invested participants. Shaded bands show 95% confidence intervals. B: Similarly, during the Appreciation discussion, the Cookie condition led less satisfied couples to show more negative reciprocity. The shaded rectangles indicates the range of the x-axis for which the effects of the food condition was not statistically significant. Continuous variables are centered with zero as their grand means.

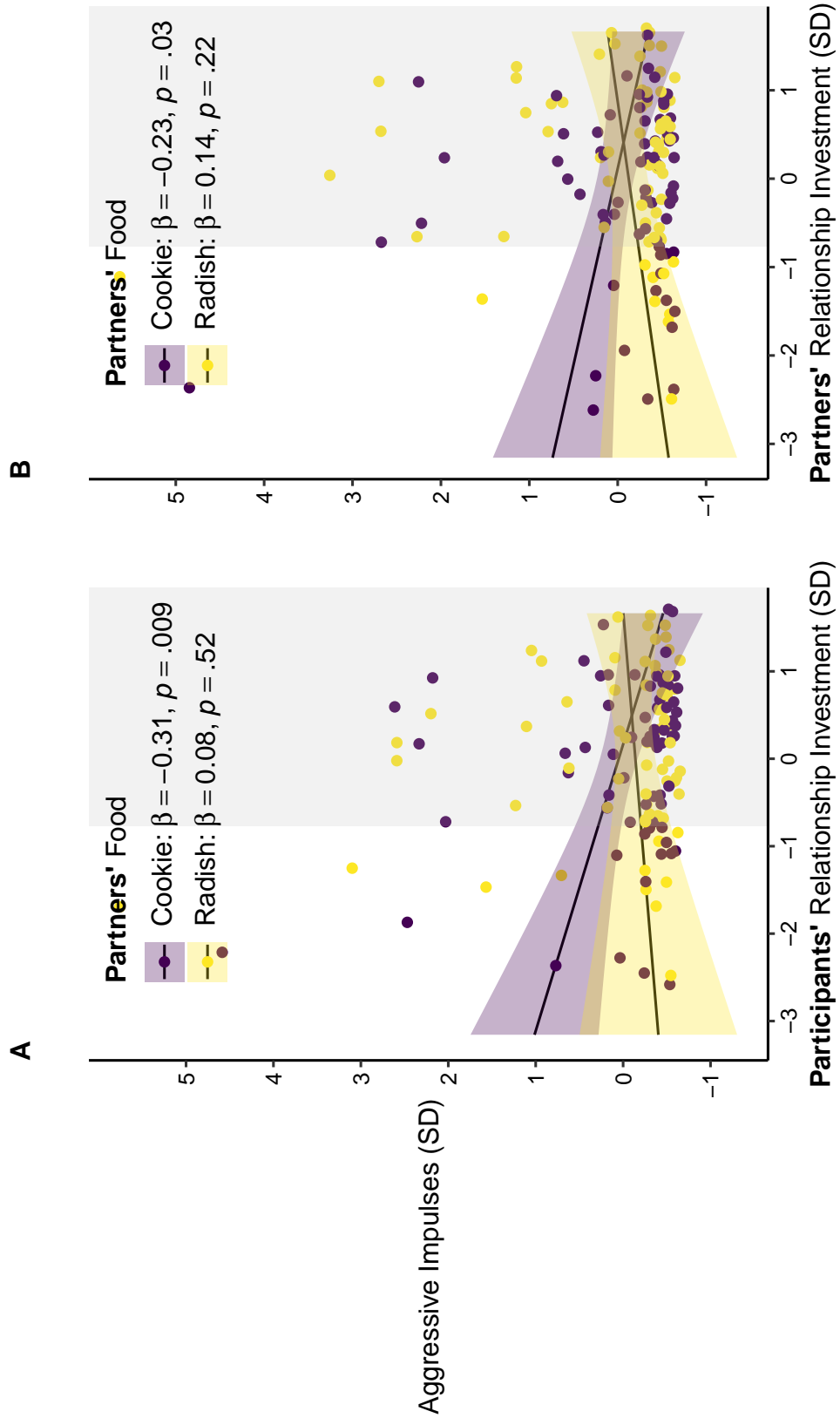


Figure 4. A: Participants whose partners were in the Cookie condition and who were less invested in the relationship reported greater aggressive impulses toward their partner after the Disagreement discussion. B: Participants whose partners were in the Cookie condition and whose partners were less invested showed a similar pattern. Shaded rectangles indicate the range of the x-axis for which the effect of the food condition was not statistically significant. Shaded bands show 95% confidence intervals. Continuous variables are centered with zero as their grand mean.

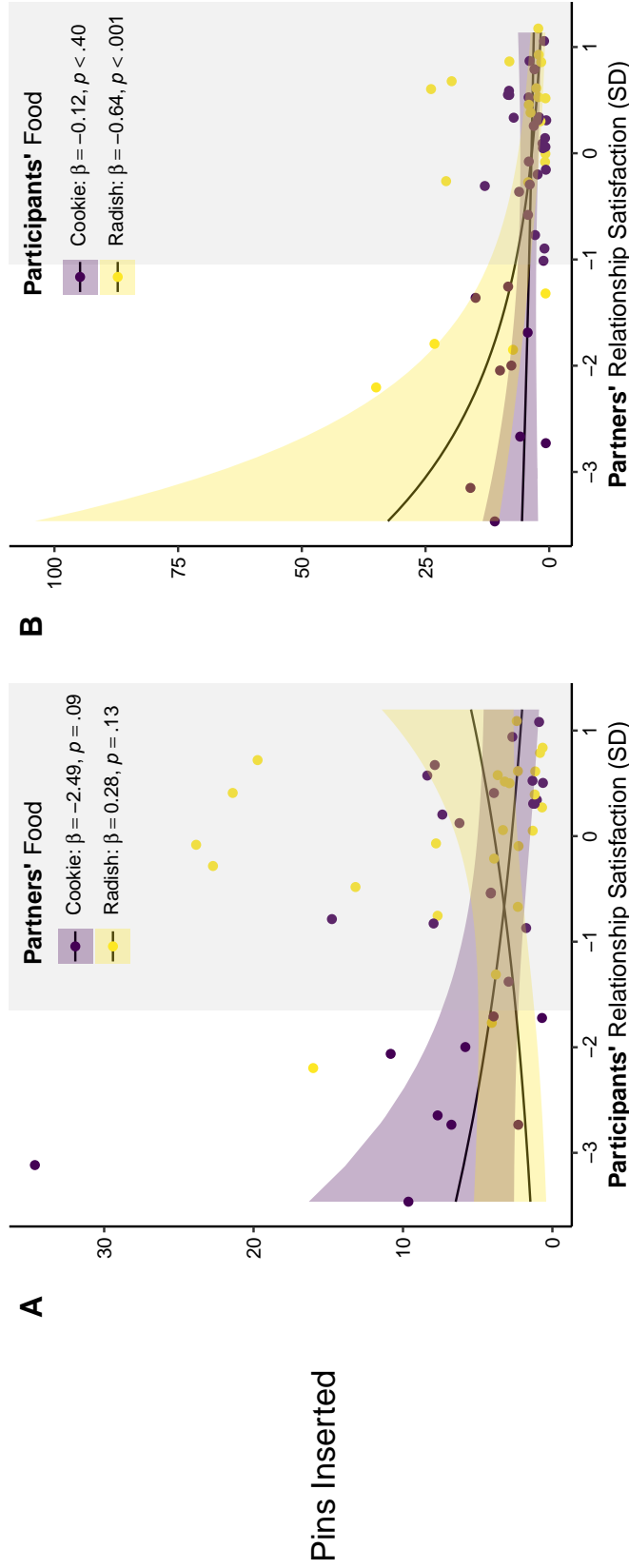


Figure 5. A: Among participants who inserted pins, those who were less satisfied in their relationship and whose partners were in the Cookie condition inserted more pins. B: Among participants who inserted pins, those who were in the Radish condition and whose partners were less satisfied in their relationships inserted more pins. Shaded rectangles indicate the range of the x-axis for which the effect of the food condition was not statistically significant. Shaded bands show 95% confidence intervals. Relationship satisfaction variables are centered with zero as their grand means.

Table 1
Intraclass correlations (ICC) of behavior ratings

Individual ratings	ICC		Couple ratings	ICC
	Women	Men		
Attention and support	.89	.94	Negative Reciprocity	.93
Disapproval	.97	.96	Positive Reciprocity	.92
Dominance	.97	.97	Vulnerability empathy support	.92
Negativity	.96	.94	Mutual avoidance	.89
Positive mood	.94	.94		
Positivity	.94	.96		
Unconstructive	.93	.95		

Note: ICCs (1, k) indicate the level of absolute agreement, treating the average rating as the unit of analysis. For this analysis, ratings were averaged across the two discussion tasks.

Table 2
Group differences by food condition.

	Conditions							
	All		Cookie		Radish		Difference	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	β	<i>p</i>
Food								
Hungry	3.73	0.96	3.86	0.96	3.61	0.95	0.28	0.09
Want	2.86	1.43	3.69	1.20	2.04	1.14	1.15	<.01
Difficult	2.01	1.10	2.43	1.12	1.58	0.89	0.80	<.01
Discussion								
Similar discussion	1.98	1.10	1.93	1.05	2.03	1.15	-0.03	0.87
Feel similarly	2.27	1.16	2.21	1.17	2.32	1.15	-0.10	0.55
Feel strongly	2.01	1.02	1.97	0.98	2.05	1.07	-0.05	0.77
Important topic	1.80	1.01	1.74	0.95	1.86	1.08	-0.15	0.37
Relationship								
Duration (years)	1.72	1.92	2.24	2.38	1.20	1.11	0.04	0.07
Satisfaction	5.15	0.70	4.97	0.79	5.33	0.57	-0.21	0.14
Investment	5.58	1.45	5.42	1.54	5.75	1.34	-0.06	0.70
Trait self-control	3.20	0.68	3.11	0.60	3.28	0.75	-0.27	0.11
Trait aggression	2.00	0.67	1.97	0.70	2.03	0.65	-0.10	0.54
Trait eating								
Restrained	2.45	1.01	2.60	1.01	2.29	1.00	0.31	0.07
External	3.46	0.60	3.53	0.55	3.39	0.64	0.23	0.18
Emotional	2.41	0.89	2.62	0.94	2.18	0.78	0.50	<.01

Note: Effect sizes are standardized, with the Radish condition as the reference group. Significant differences are shown with β in bold.

Table 3

Associations between trait emotional eating and dependent variables

Variable	Difference		Variable	Difference	
	β	p		β	p
Disagreement Discussion Ratings			Appreciation Discussion Ratings		
Positivity	-0.03	0.60	Positivity	-0.02	0.73
Negativity	0.12	0.10	Negativity	-0.05	0.36
Unconstructiveness	-0.09	0.28	Unconstructiveness	0.06	0.45
Positive mood	0.11	0.06	Positive mood	0.12	0.04
Mutual avoidance	0.25	0.21	Mutual avoidance	0.28	0.14
Negative reciprocity	0.11	0.56	Negative reciprocity	0.00	0.77
Positive reciprocity	0.00	0.99	Positive reciprocity	-0.01	0.96
Vulnerability and support	-0.04	0.82	Vulnerability and support	0.06	0.59
After Disagreement Discussion					
Change in positive affect	0.02	0.85			
Change in negative affect	0.17	0.05			
Aggressive impulses	0.17	0.03			
Pin insertion likelihood	0.54	0.00			
Pin insertion count	-0.04	0.73			
Positive feelings for partner	0.03	0.72			

Note: Effect sizes are standardized, except for the pin insertion variables, which are shown in log-odds and raw count. Significant differences are shown with β in bold.

Study 2

Thinking of Supportive Relationships and Regulating Negative Emotion

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Abstract

Theory and evidence suggest that supportive relationships can buffer people's negative emotional reactions, and could even enhance their emotion regulation. However, studies in this literature have not directly examined participants' negative emotional reactions, nor have they assessed whether supportive relationships impact emotion regulation. To address this issue, the present study separately tested whether thinking of a supportive relationship (or an acquaintance, in the control condition) affected participants' negative emotional responses, and their emotion regulation. We also measured participants' high-frequency heart rate variability (HF-HRV), to test theories that this biological marker may index self-regulation. Although we had a large sample ($N = 206$) and excellent statistical power, we found no evidence that prompting participants to think of a supportive relationship affected their emotional responses, or self-regulation. In addition, we did not observe associations between HF-HRV and self-regulation.

Recent theories suggest that supportive relationships can buffer people's negative emotional reactions, and could even enhance their emotion regulation (Coan, 2011; Beckes & Coan, 2011). Indeed, studies indicate that merely thinking of supportive relationships can attenuate people's self-reported experiences of stress (Jakubiak & Feeney, 2016), anxiety (Smith, Ruiz, & Uchino, 2004), and pain (Eisenberger et al., 2011; Jakubiak & Feeney, 2016; Younger, Aron, Parke, Chatterjee, & Mackey, 2010). However, while past studies have focused specifically on stress, pain, and threat, they have not directly examined participants' broader reports of negative emotion. Moreover, past studies have not assessed whether supportive relationships impact emotion regulation. It is not clear whether the benefits observed in previous studies reflect dampened emotional *reactivity*, enhanced emotion *regulation*, or both. To address this issue, the present study separately tested how thinking of supportive others affects participants' negative emotional responses, and their emotion regulation.

Interpersonal Influences on Emotion Regulation

Much emotion regulation occurs in social contexts (Gross & Thompson, 2007), and emotions serve important social functions (Niedenthal & Brauer, 2012; Frijda & Mesquita, 1994). Indeed, theories of emotion regulation acknowledge the importance of social context and have long considered how people can affect each other's emotion regulation (Thompson, 1994; Gross, 1998b; Zaki & Williams, 2013). The dominant framework for understanding emotion regulation is the Process Model (Gross, 1998b), which highlights 5 stages at which emotion regulation occurs: (a) situation selection, (b) situation modification, (c) attentional focus, (d) appraisal, (e) and response modulation. The present study examines how thinking of others influences people's ability to regulate their emotions by shifting appraisal.

Reappraisal: an Effective Approach to Emotion Regulation

People can change their appraisal of a situation to alter its emotional impact (Gross, 1998b; Lazarus & Alfert, 1964). Reappraising negative situations effectively reduces people's negative emotional reactions, while still allowing them to engage with a situation (Gross, 1998a). In contrast, other antecedent focused emotion regulation strategies require disengagement (e.g.,

choosing to avoid a negative situation or distracting oneself from attending to it). And unlike emotional suppression, reappraisal does not affect people's autonomic response, social functioning, or memory of events (Richards, Butler, & Gross, 2003; Butler et al., 2003; Gross, 1998a; Richards & Gross, 2000). Indeed, several studies have found that emotional suppression led to poorer functioning, while reappraisal did not. For instance, emotional suppression worsened participants' memory of events and conversations (Richards & Gross, 2000; Richards et al., 2003), led people to be more distracted, less responsive, and less fluent in their conversations (Butler et al., 2003), and increased sympathetic nervous system reactivity (indicated by finger pulse amplitude, skin temperature, and skin conductance level; Gross, 1998a). In contrast, reappraisal did not produce any of these negative effects.

People can use different tactics to reappraise emotional situations. For instance, they can try to create psychological distance from a situation, viewing it from a more detached perspective or imagining that it is happening to someone with whom they are not very close (McRae, Ciesielski, & Gross, 2012). They can also try to reinterpret the situation by generating a more positive narrative. The present study focuses on *reinterpretation*, because it is commonly used and effective at reducing negative emotion (McRae et al., 2012). It also allows relatively strong engagement with the situation compared to other reappraisal tactics like distancing.

Social Resources Reduce Sensitivity to Negative Stimuli

Thinking about close others may shift people's appraisals, reducing their sensitivity to negative stimuli. Social Baseline theory proposes that because the presence of others increases joint resources and distributes risk and effort over greater numbers, people may view their environment as less challenging when reminded of their close relationships (Coan & Sbarra, 2015; Beckes & Coan, 2011). For instance, participants perceived a hill as less steep when they were with a friend, compared to when alone (Schnall, Harber, Stefanucci, & Proffitt, 2008). Indeed, even thinking about a friend led participants to view the hill as less steep, compared to thinking of a familiar stranger (e.g., a store clerk) or a hostile relationship (Schnall et al., 2008). These studies build on other findings which indicate that people's perceptions of effort shift in response

to their available resources. For instance, people also view hills as steeper and distances as longer when fatigued, sleepy, or less physically fit (Proffitt, Stefanucci, Banton, & Epstein, 2003; Schnall, Zadra, & Proffitt, 2010). Being with a friend, or simply thinking of them, may serve as a social resource and similarly lead people to perceive their environment as less challenging (Schnall et al., 2008; Beckes & Coan, 2011).

Thinking of close others may also improve appraisals of threat and distress (Coan, 2011). Several studies indicate that viewing pictures of one's romantic partner reduces sensitivity to pain (Eisenberger et al., 2011; Master et al., 2009; Younger et al., 2010). In these studies, a hot object was held to participants' forearms as a painful stimulus. Compared to control pictures of objects, strangers (Eisenberger et al., 2011; Master et al., 2009), or acquaintances (Younger et al., 2010), viewing their partner's picture reduced participants' pain-related neural activation and self-reported ratings of pain. Similarly, recalling a partner's supportive touch lowered participants' ratings of pain and stress during a cold-pressor task (Jakubiak & Feeney, 2016). And thinking about a supportive other also improved participants' stress appraisals of a public speaking task (Smith et al., 2004).

Together, these studies suggest that thinking of close others can attenuate distress, perhaps by reminding people of their social resources, and making them feel that they are not alone in facing their challenges. Indeed, the women viewing photos of their partner showed increased activation of a neural region associated with safety signaling (the ventromedial prefrontal cortex; Eisenberger et al., 2011). And those who showed the strongest activations of this region also showed the greatest reductions in pain-related neural activity and self-reported pain ratings. However, these studies have focused specifically on experiences of pain and threat, but have not examined participants reports of negative emotion more broadly, or tested changes in emotion regulation.

Social Resources Might Enhance Emotion Regulation

The reductions in threat and distress conferred by supportive relationships have been observed without corresponding increases in the activation of brain regions associated with

effortful self-regulation, such as the lateral and medial prefrontal cortex (Coan, Schaefer, & Davidson, 2006; Eisenberger, Taylor, Gable, Hilmert, & Lieberman, 2007). These findings suggests that such benefits may emerge without increased efforts to self-regulate (Coan, 2011, 2010). For instance, women in one study showed less threat-related neural activation while they anticipated a painful electric shock if they held their husband's hand (Coan et al., 2006). Threat-related activation was reduced in the ventral anterior cingulate cortex, an area implicated in emotional responses and bodily arousal; the posterior cingulate, supramarginal gyrus, and postcentral gyrus, which are implicated in visceral and musculoskeletal responses; and the superior colliculus, which is implicated in emotion-related homeostatic function. In another study, participants who reported more frequent interactions with supportive others (in daily diaries) showed less distress-related neural activation when they experienced social exclusion (Eisenberger et al., 2007). These participants showed reduced activation of the dorsal anterior cingulate cortex, an area associated with the distress of social rejection; and Brodmann Area 8, an area associated with maternal separation in rhesus monkeys. In both studies, these decreases in threat- and distress-related activation were not accompanied by increased activity in brain regions implicated in effortful self-regulation. Indeed, the attenuated threat-response when women held their husband's hand was accompanied by *reduced* activity in the right dorsolateral prefrontal cortex (Coan et al., 2006).

Several mechanisms have been proposed to account for these reductions in threat and distress in the absence of increased activation of prefrontal emotion-regulation areas. These hypothesized mechanisms include endogenous opioid, oxytocin, and dopamine activity (Coan, Kasle, Jackson, Schaefer, & Davidson, 2013). For instance, supportive relationships may increase opioid levels, which in turn may reduce stress reactivity (Eisenberger et al., 2007). Indeed, the dorsal anterior cingulate cortex, an area implicated in experiences of pain and stress, has a high density of opioid receptors. It is possible that supportive relationships lower the sensitivity of this region by increasing levels of opioids (Eisenberger et al., 2007).

Supportive relationships may also decrease threat reactivity through increases in oxytocin (Coan et al., 2013). Oxytocin levels increase following trusting or supportive

interactions (Grewen, Girdler, Amico, & Light, 2005; Zak, Kurzban, & Matzner, 2005; Seltzer, Ziegler, & Pollak, 2010; Kéri & Kiss, 2011), and higher levels of oxytocin may reduce threat sensitivity. For instance, intranasal oxytocin administration reduced men's stress appraisal of a speech task (Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003); reduced amygdala activation in response to fearful stimuli (Kirsch et al., 2005); increased parasympathetic and decreased sympathetic activity (Norman et al., 2011); and reduced salivary cortisol after experiencing social rejection (Linnen, Ellenbogen, Cardoso, & Jooper, 2012) or discussing a point of conflict with one's romantic partner (Ditzen et al., 2009).

Finally, preliminary evidence suggests that dopaminergic reward processing may be another mechanism by which supportive relationships reduce sensitivity to threat (Younger et al., 2010). For example, one study examined the effect of viewing a romantic partner's picture on participants' reports of pain. Participants reported less pain when viewing their partner's photo, and this reduction in pain was accompanied by increased activation of regions implicated in reward processing the bilateral caudate head, nucleus accumbens, amygdala, lateral orbitofrontal cortex, and dorsolateral cortex; Younger et al., 2010.

Although it is not clear *how* supportive relationships attenuate sensitivity to threat and distress, these benefits appear to emerge without accompanying increases in the activity of regions associated with emotion regulation (Coan, 2011, 2010). This suggests that supportive relationships may reduce people's sensitivity to threat, and lead people to experience less distress even without effortful regulation. These effects may thus represent the *modulation* of emotion, rather than the *regulation* of emotion, because they appear to involve a direct reduction in distress and negative affect, rather than an increase in the effectiveness of people's effortful regulation of these experiences (Zaki & Williams, 2013; Beckes & Coan, 2011). However, if these benefits emerge without additionally taxing people's regulatory capacities, such emotion modulation might leave people with greater cognitive resources to deploy more active emotion-regulation strategies. This may be particularly helpful for cognitive emotion-regulation strategies such as reappraisal. However, no study has yet examined this possibility.

Heart Rate Variability as an Index of Self-Control

Recent theories suggest that parasympathetic activity may index self-regulation, because the neural circuits supporting parasympathetic activity and self-regulation are co-localized in the brain (Porges, 2001; Thayer & Lane, 2009). Heart rate variability is the beat-to-beat variation in heart rate. Because this variation reflects parasympathetic activity, heart rate variability may index of self-regulation. Specifically, variability in the high-frequency band of this signal, called *high-frequency heart rate variability* (HF-HRV), is linked to parasympathetic activity and self-regulation. According to these theories, higher resting levels of HF-HRV may indicate a greater capacity for self-regulation, and temporary increases in HF-HRV may reflect efforts to self-regulate.

Although an emerging literature supports these theories, most past studies have focused on processes within individuals, largely removed from social context (*e.g.*, Zahn et al., 2016; Johnsen et al., 2003; Fabes and Eisenberg, 1997; Segerstrom and Nes, 2007; Reynard, Gevirtz, Berlow, Brown, and Boutelle, 2011; Geisler and Kubiak, 2009; Geisler, Vennwald, Kubiak, and Weber, 2010; Geisler, Kubiak, Siewert, and Weber, 2013). We identified three studies that have observed associations between baseline HF-HRV and potential indices of self-regulation in social context (Fabes, Eisenberg, & Eisenbud, 1993; Smith et al., 2011; Butler, Wilhelm, & Gross, 2006). In one study, children with higher baseline HF-HRV showed less distress and more sympathy in reaction to a film about a distressed child (Fabes et al., 1993). However, this study used only a 38 s baseline heart-recording for their measure of HF-HRV, which is too short to provide reliable values (Malik et al., 1996, pp. 364). Another study found that married couples with higher baseline HF-HRV reported better relationship quality (Smith et al., 2011).

A third study tested associations between women's baseline HF-HRV and their emotional reactions during a conversation about an upsetting film (Butler et al., 2006). Women were randomly assigned to regulate their emotions during the conversation, or to respond naturally. Women with higher baseline HF-HRV experienced more negative and less positive emotion during the discussions (reflected in self-reports, and observer ratings of their behavior). Furthermore, this effect did not differ by emotion-regulation condition. The authors of this study

suggested that higher baseline HF-HRV corresponded to greater emotional flexibility. However, we believe that theories of HF-HRV as an index of self-regulation predict that link between baseline HF-HRV and negative emotion should differ by condition. If higher baseline HF-HRV reflects greater capacity for self-regulation, then when participants are asked to down-regulate their negative emotions, those with higher baseline HF-HRV should show *less* negative emotion (*i.e.*, more effective regulation).

Two of these studies also supported the prediction that HF-HRV reflects self-regulatory effort. In the study of married couples, wives showed decreased HF-HRV after a negative discussion task, which the study's authors thought might reflect their self-regulatory fatigue (Smith et al., 2011). Similarly, in the study in which women discussed an upsetting film, those who were asked to down-regulate their negative emotion showed increased HF-HRV (Butler et al., 2006). Although the literature examining HF-HRV as a marker of self-regulation is growing, studies examining these associations in social context are few and contradictory. The present study examined associations between HF-HRV and self-regulation, in order to test this biological marker.

The Present Study

Although past work has examined how supportive relationships can buffer people's experiences of stress, pain, and threat, these studies have not directly examined participants' reports of negative emotion, or the effectiveness of their emotion regulation (Jakubiak & Feeney, 2016; Smith et al., 2004; Eisenberger et al., 2011; Younger et al., 2010). To address this issue, we tested how thinking of supportive others impacts people's negative emotional responses, and emotion regulation. Participants were randomly assigned to reflect on their relationship with someone they felt close to and supported by (the *Close* condition), or to reflect on their relationship with an acquaintance (the *Acquaintance* condition). Afterwards, all participants completed an emotion-regulation task, which assessed how strongly participants reacted to upsetting photos, and how effectively they regulated their negative emotions using reappraisal. At the end of the study, participants were given a bowl of candy to eat from while answering

questionnaires, ostensibly as part of a tasting task. The amount of candy consumed served as a measure of self-control, indicating their success at resisting this tempting, unhealthy food.

We hypothesized that, compared to the Acquaintance condition, the Close condition would lead to less negative emotional reactions. (We measured this by comparing participants' emotion ratings after viewing neutral and upsetting photos.) We also expected to replicate the basic finding that reappraisal is effective in reducing negative emotion. (We measured this by comparing participants' emotional ratings after reappraising the content of upsetting photos, or simply viewing them.) In addition, we hypothesized that the Close condition would amplify these benefits, and lead to more effective emotion regulation. We also hypothesized that the Close condition would lead participants to better sustain their self-regulation, reflected in more sustained emotion regulation during the emotion task, and less candy consumed afterwards.

Additionally, we hypothesized that reappraisal would be more effective among participants with higher baseline HF-HRV (a moderation effect). Finally, we hypothesized that changes in HF-HRV during the emotion regulation task (relative to baseline) would mediate the benefits of reappraisal, such that higher HF-HRV during the trials would account for decreases in negative emotion.

Method

Participants

Participants were 206 undergraduate students who were recruited through the psychology department subject pool for a Relationships and Emotions study. Participants were compensated with research credit. Table 4 shows participants' ethnicity and their parents' highest level of education. Participants were primarily Asian (41%), non-Latino White (23%), Multi-racial (18%), and Latin American (13%). Their mean age was 20.39 years old ($SD = 2.95$ years).

Procedure

Heart baseline measures. After participants gave informed consent, the research assistant placed electrodes on the participants' wrists and collarbone for electrocardiography. Participants then completed 2 baseline measures of heart activity, each lasting for 2 minutes.

1. *Paced Breathing*: Participants matched their breathing to the fixed rhythm of a rising and falling tone. This task controls for the influence of individual differences in breathing rate on heart activity and provides more reliable measurement of resting heart-rate variability than when participants are breathing freely (Pinna et al., 2007; Berntson et al., 1997).
2. *Photo viewing*: Participants then sat quietly, while they viewed 8 photos for 15 seconds each. We selected photos which were previously rated as mildly positive and evoking low arousal. To increase their engagement with this task, participants rated how much they like each photo. This baseline was chosen to match the nature of the Emotion task.

Emotion task practice. The Emotion task consisted of three different types of trials: (a) Responding naturally to neutral photos (*Look Neutral*), (b) Responding naturally to emotional photos (*Look Negative*), (c) Reappraising emotional photos (*Reappraise*). Emotional photos depicted people experiencing conflict, violence, fear, or sadness. Neutral photos depicted people in unemotional situations. Figure 6 shows the sequence for each trial.

The experimenter first described the emotion regulation task to the participants. Each trial began with an instruction cue (2 s), either *Look*, to indicate that participants should respond naturally to the next picture or *Decrease*, to indicate that participants should try to reduce their emotional response to the picture by reappraising the scene to generate a more positive narrative. These instructions have been used in past emotion-regulation studies (Ochsner & Gross, 2008; Denny & Ochsner, 2014). After the instruction cue, participants viewed an image (6 s), followed by an inter-stimulus interval (1 s), a response scale to rate their level of negative emotion (3 s), and an inter-trial interval (3 s).

The research assistant then practiced the format of the trials with the participant, pausing at each step. Participants practiced a trial in which they responded naturally to a photo.

The research assistant gave the participant the following instructions:

If you see the word ‘Look’, I’d like you to just look at the picture and let yourself respond to it. Let yourself feel whatever emotions you have while looking at the picture. If you feel good or bad, just let yourself feel that way.

During the practice trial, participants described their reaction to the photo out loud. Participants then practiced a trial in which they were asked to reappraise a photo. The research assistant gave the participant the following instructions:

If you see the word ‘Decrease’, I’d like you to try to minimize how badly you feel by changing how you think about the picture. Try to change the meaning of the emotional event in the picture to minimize how badly you feel. You can try to reinterpret the picture to imagine that the scene in the picture is not as bad as it first seemed, that the situation will soon improve, or that help is on the way.

To ensure that participants understood the reappraisal strategy, participants also described their reappraisal out loud. These instructions are adapted from those used in past emotion-regulation studies (Ochsner & Gross, 2008; Denny & Ochsner, 2014). Participants then completed three additional practice trials silently. We wrote the Emotion task in *Python* using the *PsychoPy* package (Peirce, 2009; Van Rossum & Drake Jr, 1995). Trials were completed on a laptop computer.

Relationship prompt. After the practice period, participants were randomly assigned to the Support and Acquaintance conditions. Participants in the Close condition were prompted to write about someone they felt close to and supported by. They were given the following prompt (differences between conditions shown in bold):

Before we begin the emotion task, I’d like you to answer a few questions about your relationship with another person— **someone you are close to, who has been supportive and helpful to you in important ways.** Can you please think of someone who fits this description? Think of a specific person **who you are**

currently close to, who you can rely on or turn to when you need help, advice, or encouragement.

1. Briefly describe what you value or appreciate most about this person.
2. Briefly describe what this person values or appreciates most about you.
3. Describe what this person does for you that is supportive or helpful.
4. Describe how you feel when you see this person, after being away from them for a few hours or days.

In the control condition, participants were given the following prompt:

Before we begin the emotion task, I'd like you to answer a few questions about your relationship with another person– **someone you are polite and friendly with, but who you would not count as a friend.** Can you please think of someone who fits this description? Think of a specific person **who you know well enough to say hello to, but not well enough to think of them as a friend.**

1. Briefly describe how you know this person and what they seem like to you.
2. Describe what you think this person thinks about you, what you seem like to them.
3. Describe what this person does when you see them... What do they usually talk about?
4. When you see this person after not seeing them in a while, how do you feel? ... What do you say?

These questions are adapted from Smith et al. (2004). As in past work, participants were paced to spend 30 s answering each question (2 minutes total), and afterwards, to spend 15 s reviewing each of their responses (1 minute total) (Smith et al., 2004).

Emotion task. Participants then completed the emotion regulation task. The task consisted of 4 blocks of 12 trials, with a 30 s break in between each block. In total, the task took 13.5 minutes. The quantity and pacing of trials and blocks was similar to those used in previous studies. (*e.g.*, Denny and Ochsner, 2014, used three blocks of 18 trials each, with short breaks in between blocks.) Within each block, participants completed 4 consecutive trials of each of the 3 conditions. The order of conditions in the blocks was randomized with the constraint that conditions did not repeat consecutively between blocks. After each trial, participants indicated their level of negative emotion on a 5-point Likert scale from *Not at all badly* to *Very badly*, with the heading *How badly do you feel?*

Candy and questionnaires. After the emotion regulation task participants were given a bowl of candy they could eat from while answering questionnaires. This was ostensibly part of a tasting task, in which participants rated the flavor of the candy. After rating the candy, participants completed the rest of the study questionnaires, and the research assistant left the candy with the participant for 6 minutes in total. Participants were then be thanked and debriefed. They were also given the contact information for student psychological services, where they could find counseling if the photos they viewed during the study raised issues for them.

Materials

Picture Stimuli. Emotional and neutral photos were chosen from public online sources and the International Affective Picture System (Lang, Bradley, & Cuthbert, 2008). Emotional photos depicted people experiencing conflict, violence, fear, or sadness. We used 36 emotional photos in total. Four were used for the practice reappraisal trials, and the remaining 32 were randomized (separately for each participant) to 16 Look Negative trials and 16 Reappraise trials. We used 16 neutral photos for the 16 Look Neutral trials. Neutral photos depicted people in unemotional situations. All photos were rated by a separate online sample of 50 participants for their arousal and valence, on a Likert scale from 1 to 9. Negative photos were rated as high in negativity ($M = 7.71$, $SD = 0.45$) and high in arousal ($M = 7.44$, $SD = 0.37$). Neutral photos were rated as low in negativity ($M = 1.32$, $SD = 0.049$), and low in arousal

($M = 2.85$, $SD = 0.74$).

Measures

Relationship questions. Participants in the Close condition answered a series of question to describe their relationship with this person. They indicated whether they chosen to write about a friend, family member, romantic partner, or another kind of relationship. They also specified whether they live with this person and, if so, how long they had lived together. For family, participants were also asked to specify the family relationship (e.g., brother, mother). For romantic partners, participants were asked to specify the length of the relationship, whether they were seeing each other exclusively, married, or engaged, if they had previously separated and gotten back together, and how frequently they sleep together in the same bed. For spouses, participants specified how long they had been married. All participants also indicated how long they had known the person they chose, whether this person lives in Los Angeles, and how often they have spoken together in the past three months. Tables 5 and 6 show the characteristics of the people and relationships that participants chose to write about.

Inclusion of the other in the self. Participants completed the *Inclusion of the Other in the Self* scale (Aron, Aron, & Smollan, 1992). They chose the picture that best represented their relationship with the person they wrote about, from a series seven Venn-diagram circles with different amounts of overlap.

Task effort. After the Emotion task, participants answered the following 4 questions about how difficult they found the task: (a) How much effort did you put in to the task? (b) How difficult did you find the task? (c) How tired do you feel after doing the task? (d) Did you feel frustrated while you were doing the task? Responses were given on 7-point Likert scales from *No effort* to *A lot of effort*, *Very easy* to *Very difficult*, and *Not at all* to *Very much*. We analyzed these questions separately, because they showed low internal consistency ($\alpha = .53$).

Relational-interdependent self-construal. Participants indicated the extent to which their close relationships form an important part of their identity, by responding to the following 3 items from the *Relational-Interdependent Self-Construal* scale (Cross, Bacon, & Morris, 2000). (a) My close relationships are an important reflection of who I am. (b) When I

feel very close to someone, it often feels to me like that person is an important part of who I am. (c) In general, my close relationships are an important part of my self-image. These items were chosen because they had the highest item-total correlations in the original scale validation paper. Responses were given on 7-point Likert scale, from *Strongly disagree* to *Strongly agree*. These items showed good internal consistency ($\alpha = .90$).

Rejection sensitivity. Participants responded to 6 hypothetical scenarios from the *Rejection Sensitivity Questionnaire* (Downey & Feldman, 1996). For each scenario, participants indicated how concerned they would be about facing social rejection and the degree to which they would expect rejection. e.g.:

Your boyfriend/girlfriend has plans to go out with friends tonight, but you really want to spend the evening with him/her, and you tell him/her so. How concerned or anxious would you be over whether or not your boyfriend/girlfriend would decide to stay in? [...] I would expect that the person would willingly choose to stay in.

We selected scenarios which focused on rejection from parents, friends, and romantic partners. For each of these relationships, we chose the two scenarios with the highest factor loadings in the original scale validation paper. Responses were given on a 6-point Likert scale, from *Very unconcerned* to *Very concerned*, or *Very unlikely* to *Very likely*. The scale authors suggest scoring each scenario by multiplying participants expected likelihood of rejection with their anxiety about being rejected (Downey & Feldman, 1996). Together, these scored scenarios showed poor internal consistency ($\alpha = .55$). To address this, we conducted an exploratory factor analysis. (We report details of the factor analysis in the Supplemental Materials.) This yielded a *Friend* factor (with both scenarios about friends), a *Parent* factor (with both scenarios about parents), and the remaining two scenarios about one's partner, as single items.

Hostility. Participants completed these 4 items from the hostility sub-scale of the *Aggression Questionnaire* (Buss & Perry, 1992): (a) At times I feel I get a raw deal out of life. (b) Other people always seem to get the breaks. (c) I wonder why sometimes I feel so bitter about things. (d) I sometimes feel that people are laughing at me behind my back. These items were chosen because they had the highest factor loadings in the original scale validation paper.

Responses were given on a 5-point Likert scale, from *Extremely uncharacteristic of me* to *Extremely characteristic of me*. These items showed reasonable internal consistency ($\alpha = .75$).

Support and conflict. Participants in the Close condition also answered questions about experiences of support and conflict with the person they chose. Participants will answered questions from the *Social Support Inventory* (Dunkel-Schetter, Feinstein, & Call, 1986). Participants responded to 6 items to indicate how satisfied they were with the support provided by the person they chose, over the past three months. Participants indicated their satisfaction with informational support (i.e., advice; one item), tangible support (i.e. assistance; one item), and emotional support (i.e. caring; four items). Responses were given on 5-point Likert scales from *Very dissatisfied* to *Very satisfied*. These items showed good internal consistency ($\alpha = .93$).

Participants also responded to five questions which assessed their experience of conflict with the person they chose. Participants indicated how often, in the last three months, they had felt criticized, let down, irritated, or burdened by the person they chose, and how often that person has been angry with them. Responses were given on 5-point Likert scales from *Never* to *Very often*. These items showed good internal consistency ($\alpha = .87$).

All participants also completed the *Social Relationships Inventory* (Uchino, Holt-Lunstad, Uno, & Flinders, 2001). Participants indicated how important the person they chose is to them and how helpful, upsetting, and unpredictable this person is when the participant needs support. Responses were given on a 6-point Likert scale, from *Not at all* to *Extremely*.

Subjective social status. Participants completed the MacArthur Scale of Subjective Socioeconomic Status (Adler, Epel, Castellazzo, & Ickovics, 2000). Participants marked their standing on a drawing of a 10-rung ladder to indicate where they felt they ranked in society in terms of money, education and jobs. Specifically, participants were given the following prompt:

At the top of the ladder are the people who are the best off — those who have the most money, the most education and the most respected jobs. At the bottom are the people who are the worst off — who have the least money, least education and the least respected jobs or no job. The higher up you are on this ladder, the closer you

are to the people at the very top; the lower you are, the closer you are to the people at the bottom. Where would you place yourself on this ladder?

Social desirability. Participants also completed a short-form of the *Social Desirability Scale* (Crowne & Marlowe, 1960; Reynolds, 1982). Participants indicated their agreement with 13 statements. (e.g., I never hesitate to go out of my way to help someone in trouble. I have never intensely disliked anyone.) Responses were given as *True* or *False*. These items showed reasonable internal consistency ($\alpha = .69$).

Heart rate variability. Participants' heart activity was recorded using spot electrodes in a modified lead II configuration with a BIOPAC MP150 amplifier, recording at 2000 *hz* using the BIOPAC AcqKnowledge software (BIOPAC Systems, Goleta, CA). We checked and edited recordings for artifacts using the algorithm of Berntson, Quigley, Jang, and Boysen (1990) with the MindWare HRV software (MindWare Technologies Ltd., Gahanna, OH). We also used this software to calculate HF-HRV values using spectral analysis of the linearly-detrended inter-beat interval time-series with a Hamming window, and the high frequency range defined as 0.12 -0.40 *hz*.

Data Analysis

Mixed models. We used linear mixed models to account for the nesting of emotion ratings in participants. We tested whether random intercepts and slopes for participants were warranted, using likelihood ratio tests to compare models with and without random intercepts, and with and without random slopes. These tests indicated that random intercepts and slopes were warranted for the substantive predictors in all of our emotion-rating models.

Auto-correlated errors. We used models with auto-regressive errors to account for the serial correlation in participants' emotion ratings. We chose an auto-regressive (AR) structure, because this was consistent with our expectation that participants' emotion ratings would be serially correlated, and that the strength of these associations would weaken over time. (As opposed to, for example, a moving-average error structure in which lagged associations are present only for a fixed window.)

We compared models without auto-regressive errors and models with AR orders of 1 (an auto-regressive parameter for the most recent time-step) through to 20 (different auto-regressive parameters for each of the 20 most recent time-steps.) We report our results from AR(1) models, because (a) the AR(1) models showed significant improvements in fit compared to models without auto-regressive errors (as indicated by likelihood-ratio tests); (b) the AR(1) models are more parsimonious than those with higher AR orders; (c) models with higher AR orders did not result in meaningfully different estimates for our substantive parameters of interest, which were stable to two decimal places when comparing the AR(1) through AR(7) models; (d) methodologists note that fitting a reasonable approximation of the correlation structure is sufficient when researchers are interested in substantive questions that do not center on the serial correlation of the data (e.g., Zuur, Ieno, Walker, Saveliev, and Smith, 2009, pp.147).

Linear contrasts. We used a dummy codes to estimate the effect of the Close condition (coded 0 for Acquaintance and 1 for Close), participants' emotional reactivity to the negative photos (with trials coded 0 for Look Neutral and 1 for Look Negative), and participants' emotion regulation (with trials coded 0 for Look Negative trials and 1 for Reappraise trials). We used separate models to test participants' reactivity and regulation, and for each model we subset the data to include only trials relevant to a given contrast. For example, to test whether the Close condition improved emotion regulation, we subset the data to include only emotion ratings from Reappraise and Look Negative trials, and fit the following model.

Level 1:

$$Y_{ij} = \beta_{0j} + \beta_{1j}t_{ij} + e_{ij}.$$

Level 2:

$$\beta_{0j} = \gamma_{00} + u_{0j} + \gamma_{01}s_j,$$

$$\beta_{1j} = \gamma_{10} + u_{1j} + \gamma_{11}s_j.$$

Written as a single equation, this gives:

$$Y_{ij} = \gamma_{00} + u_{0j} + \gamma_{10}t_{ij} + u_{1j}t_{ij} + \gamma_{01}s_j + \gamma_{11}s_jt_{ij} + e_{ij}.$$

For this model, we subset the data to include only emotion ratings from Look Negative and Reappraise trials. The emotion rating Y on trial i for participant j was estimated by an

intercept, γ_{00} ; the participant's deviation from that intercept, u_{0j} ; the effect, γ_{10} , of the trial type t (coded 0 for Look Negative trials and 1 for Reappraise trials); participant variability in that effect, u_{1j} ; the effect, γ_{01} , of the participant's support condition s (coded 0 for Acquaintance and 1 for Close); the effect, γ_{11} , of their interaction; and the error term, e_{ij} .

Sustained regulation. We tested whether the Close condition lead participants to better sustain their emotion regulation by modeling the three-way interaction between trial-number (how long participants had been doing the Emotion task), Close condition (coded 0 for Acquaintance and 1 for Close) and the trial-type contrast (coded 0 for Look Negative trials and 1 for Reappraise trials). We also tested whether the Close condition lead participants to eat less candy after the Emotion task, by fitting an ordinary-least-squares regression of the amount of candy eaten on the dummy code for the Close condition.

HF-HRV. We tested whether baseline HF-HRV was associated with more effective reappraisal (a moderation effect). This analysis paralleled that described above, but with the addition of participants' baseline HF-HRV and its interaction with the trial-type dummy code. We used the paced-breathing task as the baseline measure of HF-HRV for this analysis, because it provides a more reliable measurement of resting heart-rate variability than when participants are breathing freely (Pinna et al., 2007; Berntson et al., 1997). We also tested whether participants' change in HF-HRV during the discussion tasks (relative to baseline) mediated the benefits of reappraisal. For this analysis, we computed the difference between each participants' HF-HRV during the Emotion task, and their HF-HRV during the the photo viewing baseline. We chose this baseline measure because it is the most similar to the conditions of the Emotion task. We tested this hypothesis using the quasi-Bayesian estimation method of the R package *mediation*, and used 10,000 simulations for each model (Tingley, Yamamoto, Hirose, Keele, & Imai, 2014). Because this package does not support models with auto-correlated errors, we aggregated each participants emotion ratings and HF-HRV change values by trial type. This produced three averaged emotion ratings and three average HF-HRV change values per participant, which corresponded to the three trial types. We then ran our mediation analysis using multilevel models of these aggregated ratings, with random intercepts for participants. We

used the packages *lme4*, *lmerTest*, and *nlme* to fit our models in *R* (R Core Team, 2016; Bates, Mächler, Bolker, & Walker, 2015; Kuznetsova, Brockhoff, & Christensen, 2015; Pinheiro, Bates, DebRoy, Sarkar, & R Core Team, 2018).

Missing data. For the Emotion task, we used data from participants whose responses were at least 90% complete. With this criteria, 97% of participants had usable Emotion data. For the HRV analyses, we used data from participants whose heart recordings from that section were at least 90% complete and free of artifacts. With these criteria, 93% of participants had usable data for the paced breathing baseline task (used for our moderation hypotheses). For measures of HRV change (used for our mediation hypotheses), 90% of participants had usable data to calculate their HRV change during the Emotion task. (Missing HRV data was due to technical difficulties with the heart-recording equipment). We fit all our models using restricted maximum likelihood estimation.

Statistical power. Past studies prompting participants to think of a supportive relationship showed effects sizes of $d = 0.44$ on reductions in anxiety during a stressful speech task (Smith et al., 2004), $d = 0.72$ on pain ratings (Younger et al., 2010), and $d = 0.89$ on perceptions of hill slant (Schnall et al., 2008). The effect on reductions in anxiety during a speech task was the most similar finding to the present study. Indeed, we used exactly the same wording and pacing from that study in our prompts asking participants to think about someone they were close to (or an acquaintance, in the control condition). Based on this past work, we selected a target sample size of $N = 140$, which gave power = .84 to detect effects of $d = 0.50$. We collected 206 participants in total.

Results

Preliminary Analyses

Manipulation check. Table 7 show group differences by condition in participants' experience of the Emotion task, and their reports of support, conflict, and closeness with the person that they wrote about. The two conditions did not differ in their perceptions of the Emotion task. Compared to participants in the Acquaintance condition, those in the Close

condition reported that the person they wrote about was more important to them, $t(202) = 25.60, p < .001$, and that they felt greater overlap between this person and themselves, $t(204) = 15.40, p < .001$. They reported more experiences of conflict, $t(204) = 5.50, p < .001$, and support, $t(204) = 14.34, p < .001$, with this person. They also reported that when they needed support, they found this person both more helpful, $t(204) = 15.98, p < .001$ and more upsetting, $t(203) = 2.00, p = .048$. These differences were roughly 2.5 - 10 times greater for ratings of support and the importance of the relationship, than for differences in conflict and how upsetting this person was in support situations. These differences suggest that our manipulation successfully prompted participants in the Close condition to think about someone they felt close with and supported by, and prompted participants in the Acquaintance condition to think of someone they knew only incidentally.

Group equivalence. Table 8 show group differences by condition in participants' trait levels of hostility, interdependent self-construal, social desirability, subjective social status, and rejection sensitivity. Participants in the Close condition showed more socially desirability, $t(204) = 2.31, p = .02$, and reported higher subjective social status, $t(203.91) = 2.12, p = .035$. They also reported lower rejection sensitivity in the scenarios involving their friends, $t(202) = -3.81, p < .001$, and a fight with their partner, $t(203) = -2.72, p = .007$. Consequently, we report models which controlled for socially desirable responding, (For comparison, we also ran models without these controls, which did not produce substantively different results.) subjective social status and these rejection sensitivity measures. The two rejection-sensitivity variables were correlated $r = .32$. All other correlations between these potential confounds ranged from $r = .08$ to $r = .19$. The associations between these potential confounds and our variables of interest are shown in Table 9.

Emotion Task

Participants in the Close and Acquaintance conditions did not differ in their emotional reactivity ($\beta = 0.11, p = .10$). (See Figure 7, panel A.) In addition, although reappraisal effectively lowered participants' negative affect in response to the emotional photos ($\beta = -0.79$,

$p < .001$), the strength of this effect did not differ between participants in the Close and Acquaintance conditions ($\beta = -0.08, p = .31$). (See Figure 7, panel B.) Moreover, participants in the Support condition did not show better sustained emotion regulation than those in the Acquaintance condition, ($\beta < 0.001, p = .88$), nor did they eat less candy after the Emotion task ($\beta = 1.48, p = .54$).

Heart Rate Variability

Participants with higher baseline HF-HRV did not show more effective emotion regulation ($\beta = -0.01, p = .82$). As an exploratory analysis, we also tested whether higher baseline HF-HRV was associated with less emotional reactivity. However, we observed no such association, ($\beta = -0.06, p = .28$). Furthermore, participants' change in HF-HRV during the emotion task did not mediate the effect of reappraisal on their emotion ratings (average causal mediated effect $\beta = 0.001, p = .78$).

Discussion

Recent theories suggest that supportive relationships can buffer people's negative emotional reactions and could enhance their emotion regulation (Coan, 2011; Beckes & Coan, 2011). However, past studies on the effects of supportive relationships have not directly examined participants' broader reports of negative emotion, nor have they assessed whether supportive relationships impact emotion regulation. To address these issues, the present study separately tested whether thinking of a supportive relationship affected participants' negative emotional responses, and their emotion regulation. We hypothesized that the Close condition would lead to less negative emotional reactions. However we found no difference in participants' reactions between the Close and Acquaintance conditions. In addition, although we replicated the basic finding that reappraisal is effective at reducing negative emotion, we found no evidence that thinking of a supportive relationship enhanced this effect, contrary to our hypotheses. Also contrary to our hypotheses, thinking of a supportive relationship did not lead participants to better sustain their self-regulation, as reflected in the effectiveness of their reappraisal throughout the Emotion task, and the amount of candy they ate afterwards.

These null findings suggest that our manipulation to activate participants' thoughts about a supportive relationship was not strong enough to shift their experience of the Emotion task, or that the Emotion task was not demanding enough for thinking of supportive relationships to confer a measurable benefit. We modeled our manipulation directly on one used in a similar study, which observed a moderate reduction in participants' reports of anxiety during a stressful speech task (Smith et al., 2004). However, the speech task used in that study was a much stronger emotional stimulus than the Emotion task we employed in the present study. In that study, participants were video recorded and evaluated while they gave a speech that they had only a few minutes to prepare. Indeed, many of the other studies which have observed benefits of thinking of supportive relationships also employed more intense stimuli, such as a painfully hot object, or a cold-pressor task (Eisenberger et al., 2011; Younger et al., 2010; Jakubiak & Feeney, 2016). It is possible that the benefits of thinking of supportive relationships only emerge during more intense emotional situations.

We also hypothesized that participants with higher baseline HF-HRV would show more effective reappraisal (a moderation effect). However, we observed no difference in the effectiveness of reappraisal by participants' baseline HF-HRV. Finally, we hypothesized that changes in HF-HRV during the emotion regulation task (relative to baseline) would mediate the benefits of reappraisal, such that higher HF-HRV during the Emotion task would account for decreases in negative emotion. However, we did not observe such a mediation effect. Although an emerging literature documents links between HF-HRV and self-regulation, few studies have observed these associations in the context of social relationships, and past results are mixed (Butler et al., 2006; Smith et al., 2011). These past studies did not examine the HF-HRV mediation hypothesis that this study tested. In addition, these past studies involved interacting with another person. In contrast, the present study only prompted participants to think about their relationship with another person. The relatively weaker activation of social ties used in the present study may explain these differences in findings.

Strengths and Limitations

To our knowledge, this is the first study to separately test whether thinking of a supportive relationship affects participants' negative emotional responses, and their emotion regulation. We directly tested the effectiveness of participants' emotion regulation by contrasting trials in which they were asked to respond naturally to upsetting photos, and trials in which they were asked to reappraise them. We also recorded participants' HF-HRV and tested associations between self-regulation and this biological marker. Moreover, we allowed participants in the Close condition to freely choose someone they felt supported by, which resulted in a diverse set of different relationships (shown in Table 5). We had a large sample and excellent statistical power. In addition, to prompt participants to think of supportive relationships (or an acquaintance, in the control condition), we used a manipulation to that had shown a moderate effect on participants' anxiety in a previous study (Smith et al., 2004).

Despite these strengths, several limitations qualify the results of this study. Although our sample was relatively diverse in terms of ethnicity, it included only college students. The effects we examined may operate differently for people in other life stages, and from other socioeconomic backgrounds. In addition, participants' social desirability, subjective social status and reports of rejection sensitivity differed between the Close and Acquaintance conditions. Participants with higher social desirability also showed greater decreases in their emotion ratings between Look Negative and Reappraise trials. To address this, we controlled for these potential confounds in all our substantive analyses.

Implications

Although we observed a preponderance of null results, the findings of this study can inform future work. We did not observe an effect of thinking about a supportive relationship on participants' emotional reactions, or on the effectiveness of their emotion regulation. These null results suggest that our manipulation was not strong enough to shift their experience of the Emotion task, or that the Emotion task was not demanding enough for thinking of supportive relationships to confer a measurable benefit. Future research should assess stronger means of

activating supportive relationships, for instance by studying participants while someone they feel supported by is physically present. Future research should also consider more intense emotional stimuli, for example viewing an upsetting film (*e.g.*, Butler et al., 2006). In addition, this study contributes to a small literature examining links between HF-HRV and self-regulation in social contexts. Although the present study did not involve the physical presence of someone the participants were close to, we prompted participants to think about their relationships, and we used only photos depicting social situations as stimuli for the emotion task. Our null findings were not consistent with the HF-HRV moderation and mediation effects predicted by current theories (Thayer & Lane, 2009; Porges, 2001). More work is needed to assess whether social context may affect the links between self-regulation and HF-HRV.

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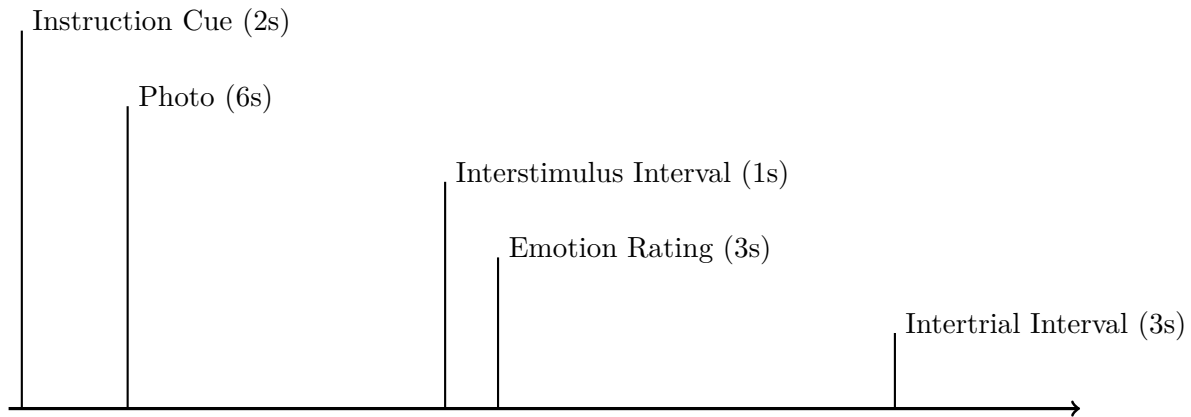


Figure 6. An illustration of the trial structure for Study 2.

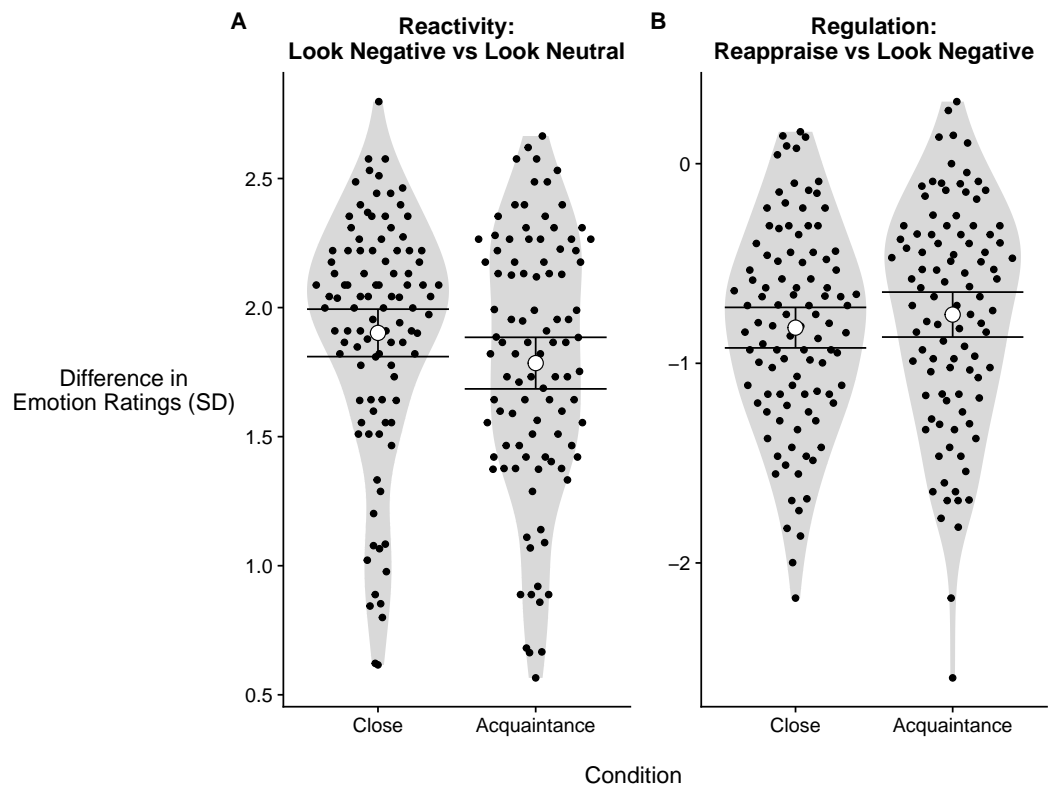


Figure 7. A: Participants in the Close and Acquaintance conditions did not differ in their emotional reactivity to the upsetting photos. This was measured by contrasting their emotion rating on Look Negative and Look Neutral trials. B: Participants also did not differ in the effectiveness of their emotion regulation to the upsetting photos. This was measured by contrasting their emotion rating on Reappraise and Look Negative trials. The y-axis represents participants' average differences in emotion ratings corresponding to their emotional reactivity and the effectiveness of their emotion regulation, in standard-deviation units. White points indicate marginal means of these differences. Error bars show the 95% confidence intervals.

Table 4
Participant demographic characteristics

	<i>N</i>	%
Ethnicity		
Asian	85	41.26
White	47	22.82
Multi	37	17.96
Latin American	27	13.11
Black or African American	6	2.91
Middle Eastern	3	1.46
Native American or Alaskan Native Asian Indian	1	0.49
Father's education		
Some high school	34	16.50
High school Diploma	27	13.11
Some college	38	18.45
Bachelor's Degree	49	23.79
Graduate or Professional Degree	56	27.18
Mother's education		
Some high school	29	14.08
High school Diploma	33	16.02
Some college	37	17.96
Bachelor's Degree	70	33.98
Graduate or Professional Degree	37	17.96

Table 5
Relationship characteristics by relationship type and condition

	<i>N</i>	<i>Cohabit</i>		<i>Months Known</i>		<i>Past Sep.</i>	
		<i>No</i>	<i>Yes</i>	<i>M</i>	<i>SD</i>	<i>No</i>	<i>Yes</i>
Total	206	169	36	64.69	86.19	28	5
Acquaintance	103	93	9	20.14	34.01		
Close	103	76	27	108.81	98.81	28	5
Friend	37	30	7	61.38	52.31		
Partner	33	28	5	44.15	32.44	28	5
See only one another	31	27	4	43.52	33.36	27	4
Engaged	1	1	0	60.00		0	1
Married	1	0	1	48.00		1	0
Family	32	18	14	233.50	65.88		
Mother	13	4	9	218.15	61.69		
Sister	7	5	2	231.14	22.03		
Father	5	4	1	287.00	68.17		
Other	4	4	0	216.50	126.43		
Brother	3	1	2	239.00	19.29		
Other	1	0	1	7.00			

Note: Relationship counts reflect participants from the Close Condition only. Past Sep. indicates couples had previously separated and gotten back together.

Table 6
Others' characteristics by condition

Relationship	<i>N</i>	Gender		In LA		UCLA Student			Social Status	
		Man	Woman	No	Yes	No	Grad.	Yes	<i>M</i>	<i>SD</i>
Total	206	82	124	64	142	85	11	110	6.69	1.55
Acquaintance	103	41	62	14	89	24	2	77	6.57	1.50
Close	103	41	62	50	53	61	9	33	6.81	1.60

Note: Grad. indicates that the person had already graduate from UCLA.

Table 7
Group differences by condition, part 1 of 2

	Condition							
	All		Acquaintance		Close		Difference	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>d</i>	<i>p</i>
Task								
Difficult	2.74	1.55	2.74	1.50	2.75	1.59	0.01	.96
Effort	5.11	1.26	5.10	1.26	5.12	1.25	0.02	.91
Frustrated	2.26	1.32	2.17	1.26	2.35	1.37	0.14	.32
Tired	4.55	1.67	4.61	1.63	4.50	1.70	-0.07	.62
Relationship								
Important	4.02	1.92	2.33	1.18	5.68	0.61	3.59	<.001
Conflict	1.80	0.65	1.56	0.60	2.03	0.62	0.77	<.001
Support	5.29	1.17	4.46	0.91	6.12	0.74	2.00	<.001
IOS	3.10	1.83	1.76	0.98	4.44	1.47	2.15	<.001
Support Situations								
Helpful	4.09	1.70	2.83	1.42	5.35	0.74	2.23	<.001
Upsetting	1.77	1.02	1.63	1.12	1.91	0.88	0.28	.047
Unpredictable	2.13	1.22	2.24	1.29	2.01	1.14	-0.19	.17

Note: Significant differences are shown with *d* in bold. IOS indicates responses to the *Inclusion of the Other in the Self* scale (Aron, Aron, & Smollan, 1992). The Support Situations heading indicates responses to questions from the *Social Relationships Inventory* asking about participants' experiences when they need support (Uchino, Holt-Lunstad, Uno, & Flinders, 2001).

Table 8
Group differences by condition, part 2 of 2

Trait	Condition							
	All		Acquaintance		Close		Difference	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>d</i>	<i>p</i>
Hostility	2.77	0.80	2.80	0.81	2.74	0.79	-0.08	.59
Interdependence	5.77	1.15	5.83	1.22	5.72	1.09	-0.10	.49
Social Desirability	0.43	0.20	0.40	0.20	0.46	0.19	0.32	.02
Subjective Status	6.20	1.66	5.96	1.63	6.45	1.66	0.30	.04
Rejection Sensitivity								
Friend factor	9.95	4.94	11.23	4.87	8.67	4.69	-0.53	<.001
Parent factor	6.16	5.25	6.61	5.31	5.71	5.18	-0.17	.22
Partner fight	12.50	7.56	13.92	7.26	11.10	7.62	-0.38	.01
Partner stay	11.92	6.39	11.88	6.39	11.96	6.42	0.01	.93

Note: Significant differences are shown with *d* in bold. Interdependence indicates responses to the *Relational-Interdependent Self-Construal* scale (Cross, Bacon, & Morris, 2000).

Table 9

Bivariate associations between potential confounds and variables of interest

	Emotion				HF-HRV			
	Reactivity		Reappraisal		Baseline		Change	
Potential Confounds	β	p	β	p	β	p	β	p
Social Desirability	0.07	.09	-0.11	.03	<0.01	.96	-0.10	.20
Subjective Status	<0.01	.94	-0.02	.77	0.06	.40	0.05	.51
Rejection Sensitivity								
Friend factor	0.01	.80	0.03	.58	-0.02	.84	<0.01	.97
Partner fight	0.02	.57	0.01	.89	<0.01	.95	-0.05	.50

Note: Effect sizes are standardized and reflect bivariate associations. Significant differences are shown with β in bold. Reactivity indicates participants' average difference in emotion ratings between Look Neutral and Look Negative trials. Reappraisal indicates participants' average difference in emotion ratings between Look Negative and Reappraise trials. HF-HRV Baseline indicates participants' HF-HRV during the paced-breathing baseline. HF-HRV change indicates the difference between participants average difference in HF-HRV between the picture-viewing baseline and the Emotion task.

Conclusion

The two studies in this dissertation examined how self-regulation shapes the quality of people's relationships, and conversely, how people's relationships affect the way they self-regulate. Study 1 provided experimental evidence that facing a self-control challenge can worsen couples' interactions, and their feelings afterwards. These effects were reflected in observer ratings of couples' behavior, self-reports of affect and attitudes, and a behavioral measure of aggression. The couples in this study were highly satisfied in their relationships, and the self-control challenge we employed was brief and relatively minor. Nevertheless, it led partners to act less positively and more negatively, and to feel worse about each other afterward. Indeed, detrimental effects continued to the end of the study session, roughly 40 minutes after the manipulation. Moreover, many of these effects were stronger for couples with lower relationship quality. These results suggest that relationship quality can mitigate the negative impact of a self-control challenge on couples' interactions. In addition, the self-control challenge we used in this study, resisting tempting food, is a common experience in the US and globally (Serdula et al., 1999; Santos, Sniehotta, Marques, Carraça, & Teixeira, 2017). Self-control challenges are common, and they may undermine the positivity of couples' relationships and leave them at greater risk of conflict and aggression.

Study 2 tested whether thinking of a supportive relationship affected participants' negative emotional reactions, and their emotion regulation. Although we hypothesized that thinking of a supportive relationship would buffer participants' negative emotional reactions, improve their emotion regulation, and lead to better sustained self-regulation, we observed no effects on these dependent variables. These null findings suggest potential boundary conditions to the benefits of thinking about supportive relationships. Our manipulation to activate participants' thoughts about a supportive relationship may not have been strong enough to shift their experience of the Emotion task. Similarly, the Emotion task may not have been demanding enough for thinking of supportive relationships to confer a measurable benefit. Future research should assess stronger means of activating supportive relationships, for instance by studying participants while someone they feel supported by is physically present. Future research should

also consider more intense emotional stimuli, for example viewing an upsetting film (*e.g.*, Butler, Wilhelm, & Gross, 2006).

Both studies also tested associations between HF-HRV and self-regulation. We hypothesized that higher baseline HF-HRV would be associated with more effective reappraisal (moderation effects), and that changes in HF-HRV would mediate self-regulation effectiveness. However, with one exception, we did not observe such associations. In Study 1, participants with higher baseline HF-HRV acted more positively during the Appreciation discussion. However, because this pattern only emerged for one of our dependent variables, it should be interpreted with caution. Although an emerging literature documents links between HF-HRV and self-regulation, few studies have observed these associations in the context of social relationships, and past results are mixed (Butler et al., 2006; Smith et al., 2011). Moreover, these past studies differ from the present work in terms of the relationships they examined (strangers and married couples), their experimental design (they did not involve a self-control challenge and participants interacted with other people), and their analysis of HF-HRV (they did not examine the mediation hypotheses that this study tested). Our null findings were not consistent with the HF-HRV moderation and mediation effects predicted by current theories (Thayer & Lane, 2009; Porges, 2001). Nevertheless, our results contribute to the small literature examining links between HF-HRV and self-regulation in social contexts.

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Study 1 Supplemental Materials

Heart-Rate Baseline tasks

These tasks were chosen to account for the influences of breathing and speech on heart activity and enabled recordings of participants' heart activity while they kept fixed breathing rate, sat quietly, and spoke or listened to each other.

1. *Paced Breathing*: Participants matched their breathing to the fixed rhythm of a rising and falling tone. The tone had a period of 5 seconds, yielding a rate of 12 breaths per minute. This task controls for the influence of individual differences in breathing rate on heart activity and provides more reliable measurement of resting HF-HRV than when participants are breathing freely (Pinna et al., 2007; Berntson et al., 1997).
2. *Photo viewing*: Participants then completed three photo viewing tasks, one in which they sat quietly and viewed photos, one in which they described photos to their partner, and one in which they listened to their partner describing photos. Photos were selected from the International Affective Picture System (Lang, Bradley, & Cuthbert, 2008) with mildly positive valence ratings (slightly above the scale midpoint), and low arousal ratings. The photos were viewed on laptop computers.
 - (a) Participants sat quietly and viewed 8 photos, for 15 seconds each. To increase their engagement with this task, participants also rated how much they liked each photo.
 - (b) Participants then took turns describing pictures to each other. One partner was randomly assigned to go first, and described 4 photos for 30s each. The other partner sat quietly and listened.
 - (c) Participants then switched roles, and the other partner also described 4 photos while the first sat quietly and listened.

Disagreement Discussion

To provide a starting point for the discussion, participants first completed a questionnaire which listed several common areas of disagreement in relationships (*e.g.*, *Partner*

doesn't listen well, Chores around the house; adapted from Gottman, Markman, and Notarius, 1977). Each partner separately indicated how often they disagreed about each topic. The research assistant then asked each partner about their highest rated topic of disagreement: when they had last disagreed about the topic, what had happened, and how they felt. Before leaving the room, the research assistant asked the couple to spend the next four minutes discussing one partner's topic, before continuing to the other's, in randomly assigned order. The discussion lasted 8 minutes in total and the research assistant indicated over an intercom when it was time to change topics.

Appreciation Discussion

Again, to provide a starting point for the discussion, participants first completed a questionnaire in which they chose two qualities they appreciated about their partner from a list of positive attributes. The research assistant asked the partners to discuss each of their chosen attributes for two minutes. Partners alternated in discussing their chosen attributes, with one partner randomly assigned to begin. This discussion also lasted 8 minutes and the research assistant again indicated over the intercom when it was time to change topics.

Behavior Ratings and Factor Analysis

Ratings were made by a separate group of research assistants, who had not served as experimenters for the study. Raters were blind to participants' conditions and the study hypotheses. Ratings were made independently, and raters met regularly to discuss their ratings. Raters assessed each partner's *dominance*, *disapproval*, their level of *positive mood*, *attention and support* for their partner, how *unconstructive* they were during the discussion, and their level of *positivity* and *negativity* toward their partner. Raters also assessed each couple's level of *negative and positive reciprocity*, *vulnerability and support*, and *mutual avoidance*. The content of these rating codes was adapted for this study from the *Iowa Family Interaction Rating System* (Melby & Conger, 2001). Ratings were made using a naive rating system, in which raters provided an overall assessment of participants' behavior (Baucom, Baucom, & Christensen, 2012). These

ratings showed good inter-rater reliability, with $ICCs(1,k) > .89$. This indicates a high level of absolute agreement, treating the average rating as the unit of analysis (Shrout and Fleiss (1979)).

To consolidate our analysis of these ratings, we conducted an exploratory factor analysis. We performed this analysis on the individual-level ratings, so that the combined factors would remain individual-level (rather than couple-level) variables. (Only individual-level outcomes are appropriate for standard multi-level modeling techniques.) We averaged ratings across the two discussion tasks and conducted the analysis separately for men and women. The Kaiser-Meyer-Olkin measure of sampling adequacy (husbands, $KMO = .72$; wives, $KMO = .72$) and Bartlett's test of sphericity (husbands, $\chi^2(21) = 320.55$, $p < .001$; wives, $\chi^2(21) = 319.45$, $p < .001$) indicated that the use of the factor model was appropriate (Kaiser & Rice, 1974; Bartlett, 1950; Dziuban & Shirkey, 1974). An initial analysis indicated that ratings for unconstructiveness and positive mood loaded differently for women and men. We decided to exclude these ratings from the factor analysis, in order to obtain a common factor structure for both partners. A second analysis without these ratings yielded a two-factor structure that was identical for men and women. These two factors explained 87.9% of the variance for women, and 84.5% of the variance for men. We proceeded with the two-factor solution, because adding a third factor explained only an additional 2.6% of variance for women and 4.6% variance for men. We used ordinary least squares factoring with oblique (oblimin) rotation, which resulted in correlations of -0.21 for women and -0.13 for men. The magnitude of these correlations suggests that the oblique rotation should be interpreted (rather than using an orthogonal rotation). Table 10 shows the factor structure of the two-factor solution and the proportion of variance explained by each factor. Factors that loaded above 0.3 were considered to be sufficiently related to the factor (Floyd & Widaman, 1995). The first factor consisted of disapproval, dominance and negativity. We labeled this factor *Negativity*. The second factor consisted of attention and support and positivity. We labeled this factor *Positivity*. Both factors showed a high level of internal consistency (Negativity factor $\alpha s > .93$, Positivity factor $rs > .72$). The individual-level ratings of unconstructiveness and positive mood ratings loaded differently for women and men, so we excluded these ratings from the factor analysis, and analyzed them individually. We

conducted subsequent analyses of the behavioral ratings on the Negativity and Positivity factors, the individual-level ratings of unconstructiveness and positive mood, and the couple-level ratings of negative and positive reciprocity, vulnerability and support, and mutual avoidance.

Missing Data

To account for missing data in our measures of HF-HRV, affect change during the Disagreement discussion, and ratings of relationship satisfaction, we used multiple imputation for analyses with these variables. For each set of analyses, we generated 20 imputed data sets. (Graham, Olchowski, and Gilreath, 2007 recommend 20 sets of imputations for most analyses.) For each imputation model, we included auxiliary variables which were correlated with both the analysis variables and indicator variables signaling the missingness of the analysis variables (coded 1 for missing and 0 for complete). For mediation analyses with multiple imputation, we used the *MI Boot (pooled samples)* approach: We estimated the mediation model on each imputed data set, and then pooled these estimates to calculate a point estimate and confidence interval around the mediated effect (Schomaker & Heumann, 2018).

Example items

Disagreement discussion topics

The most frequently chosen topics were *time management* (13%), *uncertainty about the future* (13%), and *not spending enough time together* (12%). The other topics listed on the questionnaire were *alcohol or drug use*, *cheating*, *chores around the house*, *feel like partner doesn't listen well*, *frequency of sex*, *money*, *one person works too much*, *partner seems distant or not emotionally available*, *partner seems critical or demanding*, *problems with friends*, *problems with parents or family members*.

Appreciation discussion topics

The most frequently chosen qualities were *kind* (10%), *reliable* (8%), and *tenderhearted* (8%). The other qualities on the questionnaire were: *Accommodating*, *Approachable*, *Charitable*,

Cooperative, Courteous, Efficient, Friendly, Helpful, Inventive, Organized, Perseverant, Self-assured, Self-disciplined, Steady, Thorough, Well-mannered, Appreciative, Assertive, Cheerful, Considerate, Enthusiastic, Forgiving, Good-natured, Industrious, Outgoing, Pleasant, Respectful, Self-confident, Stable, Sympathetic.

Positive and negative emotions

Participants indicated the degree to which they felt 10 positive emotions (*e.g., interested, attentive, inspired*), and 10 negative emotions (*e.g., nervous, irritable, jittery*).

Aggressive impulses

The aggressive impulses questionnaire began with the following preface:

No matter how well a couple gets along, there are times when they disagree, get annoyed with the other person, want different things from each other, or just have spats or fights because they are in a bad mood, are tired, or for some other reason. Couples also have many different ways of trying to settle their differences. This is a list of things that might happen when you have differences. Please circle how likely it is that you would engage these behaviors toward your romantic partner based on how you currently feel.

Participants indicated how likely they were to engage in six different acts of aggression toward their partner (*e.g., Throw something at my partner that could hurt, Push or shove my partner, Grab my partner*).

Positive feelings for partner

Participants indicated how they felt about their partner, answering 7 questions about how they felt about their relationship. (*e.g., How do you feel... About the degree to which you can trust your partner? About your partner as a friend to you? About your partner's ability to handle stress?*)

Relationship quality

Participants completed the Perceived Relationship Quality Components scale (Fletcher, Simpson, & Thomas, 2000). Participants indicated their levels satisfaction, commitment, intimacy, trust, passion, and love in their relationship, answering 3 questions about each. (*e.g.*, How satisfied are you with your relationship? How committed? How intimate is your relationship? How much do you trust your partner? How passionate is your relationship? Participants also completed the Investment subscale of the Investment Model Scale, indicating through 5 statements the degree to which they had invested in their relationship (Rusbult, Martz, & Agnew, 1998). (*e.g.*, I have put a great deal into our relationship that I would lose if the relationship were to end. My relationships with friends and family members would be complicated if my partner and I were to break up.)

Trait aggression

Participants completed a short form of the Aggression Questionnaire (Buss & Perry, 1992; Bryant & Smith, 2001). Participants answered 12 questions each indicating their generally inclination toward physical aggression, verbal aggression, anger and hostility. (*e.g.*, Given enough provocation, I may hit another person. I can't help getting into arguments when people disagree with me. I have trouble controlling my temper. I wonder why sometimes I feel so bitter about things.)

Trait self-control

Participants completed the Brief Self-Control Scale. Participants indicated through 13 statements how effectively they can exert self-control. (*e.g.*, I am lazy. I wish I had more self-discipline. Pleasure and fun sometimes keep me from getting work done.)

Trait eating behavior

Participants completed the Dutch Eating Behavior Questionnaire, which includes 33 questions about participants' habitual eating behavior. Ten questions focused on participants'

restrained eating. (*e.g.*, Do you try to eat less at mealtimes than you would like to eat? Do you watch what you eat? Do you deliberately eat less in order not to become heavier?) Thirteen questions asked about emotional eating. (*e.g.*, Do you have a desire to eat when you are depressed or discouraged? Do you have a desire to eat when you are irritated?) Ten questions asked about participants eating in response to external cues. (*e.g.*, If food smells and looks good, do you eat more than usual? If you have something delicious to eat, do you eat it straight away?)

Results without the Emotional Eating Covariate

Main Effects of Food Condition

Behavior ratings. Couples with more participants in the Cookie condition showed less positive reciprocity during the Appreciation discussion ($\beta = -0.35, p = .019$). Besides this effect, behavior ratings in both discussions were not significantly affected by participants' food condition, or partners' food condition ($ps \geq .18$).

Change in affect during the discussion. Participants in the cookie condition ($\beta = -0.45, p = .009$) and those whose partner was in the cookie condition ($\beta = -0.48, p < .007$) showed a larger decrease in positive affect during the Disagreement discussion. Participants' and their partners' food condition did not significantly affect participants' change in negative affect ($ps \geq .35$).

Positive feelings for partner. Participants in the cookie condition ($\beta = -0.16, p = .040$) and those whose partner was in the cookie condition ($\beta = -0.21, p = .007$) reported lower positive feelings for their partner after the Disagreement discussion.

Aggressive impulses against partner. Participants' and their partners' food condition did not significantly affect participants' self-reported aggressive impulses toward their partner ($ps \geq .12$).

Voodoo Doll. The odds of inserting pins were 2.75 times higher for participants in the Cookie condition ($\beta = 1.01, p = .005$). However, participants' and their partners' food condition did not significantly affect the number of pins participants inserted ($ps \geq .16$).

Moderation by Relationship Quality

Behavior ratings. Participants' partner's relationship investment significantly moderated the effect of participants' food condition on their negativity behavior during the Disagreement discussion ($\beta = -0.34, p = .021$). The region of significance indicated that the effect of partners' food condition was significant only for partners who were relatively low or high in their relationship investment. Participants in the Radish condition with less invested partners (below 3.11 *SD* less than the mean) acted less negatively toward their partner during the Disagreement discussion. However, this pattern reversed among participants with highly invested partners (more than 1.73 *SD* above the mean), who acted *more* negatively.

Similarly, couples' relationship satisfaction also moderated their level of negative reciprocity during the Appreciation discussion ($\beta = -0.43, p < .013$).² The region of significance indicated that the effect of couples' food condition on their negative reciprocity was only significant for couples who were relatively unsatisfied in their relationship. Couples with both partners in the Cookie condition showed more negative reciprocity during the Appreciation discussion. This effect was only significant for less satisfied couples (below 0.60 *SD* less than the mean).

Participants' partners' relationship satisfaction moderated the effect of participants' food condition on their level of positive mood during both the Disagreement discussion ($\beta = 0.24, p = .048$), and the Appreciation discussion ($\beta = 0.27, p = .025$). During the Disagreement discussion, participants in the Cookie condition with less satisfied partners (below .25 *SD* less than the mean) showed less positive mood. The same was true during the Appreciation discussion for participants in the Cookie condition with less satisfied partners (below 2 *SD* less than the mean).

Participants' relationship satisfaction also moderated the effect of their partners' food condition on their positive mood, however only during the Appreciation discussion ($\beta = -0.24, p = .033$). Participants with partners in the Radish condition showed more positive mood, during

²These data were highly right-skewed, because most couples showed little negative reciprocity. To correct for this, we transformed this variable before analysis, taking its reciprocal square-root. (This transformation is given by the following function, with Y indicating the negative reciprocity variable: $f(Y) = -1/Y^{1/2}$.) To ease interpretation, we standardized the transformed variable to have a mean of zero and a standard deviation of one.

the Appreciation discussion. However, this effect was only significant for participants who were relatively satisfied in their relationship (more than 0.66 *SD* above the mean). Besides the effects described above, relationship quality did not moderate the effect of the food condition on participants' behavior ratings ($ps \geq .06$).

Change in affect during the Disagreement discussion. Relationship quality did not moderate the effect of participants' and their partners' food condition on their change in positive ($ps \geq .27$) or negative affect ($ps \geq .09$) during the Disagreement discussion.

Positive feelings for partner. Participants' partners' relationship satisfaction also moderated the effect of participants' partners' food condition on participants' positive feelings for their partner after the Disagreement discussion ($\beta = 0.34, p = .035$). Participants with partners in the Cookie condition reported less positive feelings for their partner after the disagreement discussion. However, this effect was only significant for participants with relatively unsatisfied partners (below than -0.02 *SD* less than the mean). Besides this effect, relationship quality did not otherwise moderate the effect of food condition on participants' positive feelings for their partner after the Disagreement discussion ($ps \geq .073$).

Aggressive impulses. Participants' and their partners' relationship investment moderated the effect of their partners' food condition on their aggressive impulses ($\beta = -0.61, p = .0081$ for participants' investment; $\beta = -0.30, p = .011$ for partners' investment). Participants with partners in the Cookie condition reported more aggressive impulses after the Disagreement discussion. The region of significance indicated that this effect was only significant for participants who were relatively uninvested in the relationship (below 0.22 *SD* less than the mean), or whose partners were relatively uninvested (below 0.24 *SD* less than the mean). Besides these effects, relationship quality did not otherwise moderate the effect of food condition on participants' aggressive impulses after the Disagreement discussion ($ps \geq .071$).

Voodoo Doll. Relationship quality did not moderate the effect of participants' and their partners' food condition on their likelihood of inserting pins ($ps \geq .41$).

HF-HRV Main Effects, Moderation, and Mediation

Participants with higher baseline HF-HRV acted more positively during the Appreciation discussion ($\beta = 0.21, p = .008$). In addition, among participants who inserted pins in the Voodoo Doll task, those whose partners had higher baseline HF-HRV inserted more pins, contrary to our hypotheses ($\beta = 0.26, p = .035$). Besides these effects, participants' and their partners' baseline HF-HRV was not associated with any other dependent variable in this study ($ps \geq .06$). Similarly, participants' and their partners' baseline HF-HRV did not moderate the effect of the food condition on these dependent variables ($ps \geq .14$). And change in participants' HF-HRV during the Disagreement and Appreciation discussion did not mediate the effect of the food condition on these dependent variables. (All 95% CIs for the indirect path contained 0.)

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Table 10

Factor loadings from an exploratory factor analysis of behavior ratings

Variable	Women		Men	
	1	2	1	2
Disapproval	.98	-.20	1.00	-.15
Negativity	.94	-.24	.91	-.25
Dominance	.91	-.17	.81	.06
Attention and support	-.22	1.00	-.26	.82
Positivity	-.13	.72	-.05	.95
Variance explained (%)	55.0	32.9	51.1	33.4

Note: Numbers in bold indicate codes retained in the factor. Codes are presented by highest loadings for women. For this analysis, we averaged codes across the two discussion tasks. We used ordinarily least squares factoring with oblimin rotation.

Study 2 Supplemental Materials

Rejection Sensitivity Factor Analysis

Participants responded to 6 hypothetical scenarios from the *Rejection Sensitivity Questionnaire* (Downey & Feldman, 1996). These scenarios showed poor internal consistency ($\alpha = .55$). To address this, we conducted an exploratory factor analysis. The scenarios are shown below with the relationship in bold. (After each scenario we give a short title, which we will use to refer to these scenarios when describing the factor analysis.)

- Your **boyfriend/girlfriend** has plans to go out with friends tonight, but you really want to spend the evening with him/her, and you tell him/her so. (*Partner-Evening* scenario)
- You call your **boyfriend/girlfriend** after a bitter argument and tell him/her you want to see him/her. (*Partner-Argument* scenario)
- You ask your **parents** for extra money to cover living expenses. (*Parents-Money* scenario)
- After graduation, you can't find a job and ask your **parents** if you can live at home for a while. (*Parents-Home* scenario)
- You ask your **friend** to go on a vacation with you over Spring Break. (*Friend-Vacation* scenario)
- You ask a **friend** to do you a big favor. (*Friend-Favor* scenario)

The Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test of sphericity indicated that the use of the factor model was appropriate; $KMO = .63$; $\chi^2(21) = 20.73$, $p < .001$ (Kaiser & Rice, 1974; Bartlett, 1950; Dziuban & Shirkey, 1974). This analysis yielded a four-factor structure, which explained 41% of the total variance. We proceeded with the four-factor solution, because adding a fifth factor explained only an additional 6% of the total variance. We used ordinary least squares factoring with oblique (oblimin) rotation, which resulted in correlations of $r = .02$ to $r = .59$. The magnitude of these correlations suggests that the oblique rotation should be interpreted (rather than using an orthogonal rotation).

Table 13 shows the factor structure of the four-factor solution and the proportion of variance explained by each factor. Factors that loaded above 0.3 were considered to be sufficiently related to the factor (Floyd & Widaman, 1995). The first factor consisted of the two Friend scenarios. The second factor consisted of Partner-Argument scenario. The third factor consisted of the two Parent scenarios. Finally, the fourth factor consisted of the Partner-Evening scenario.

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Table 12

Factor loadings from an exploratory factor analysis of the rejection sensitivity items

Variable	1	2	3	4
Partner-Evening	−.01	.06	−.01	.69
Partner-Argument	.06	.72	.03	.07
Parents-Money	.21	−.20	.44	.11
Parents-Home	−.07	.11	.61	−.05
Friend-Vacation	.48	.01	−.04	.15
Friend-Favor	.57	.11	.02	−.08
Variance explained (%)	0.11	0.11	0.10	0.10

Note: Numbers in bold indicate codes retained in the factor. We used ordinarily least squares factoring with oblimin rotation.

Table 13
Correlation matrix of substantive variables in Study 2

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 Condition	—																	
2 Ladder	.15*	—																
3 Sociales	.16*	-.15*	—															
4 Interdepend	-.05	.07	-.01	—														
5 Hostility	-.04	-.17*	-.3***	-.02	—													
6 SRI-important	.87***	.16*	.15*	.06	-.02	—												
7 SRI-helpful	.75***	.19**	.12	.07	-.1	.83***	—											
8 SRI-upsetting	.14*	-.01	-.17*	-.12	.13	.16*	.05	—										
9 SRI-unpredictable	-.1	-.03	-.04	-.01	.2**	-.11	-.2**	.22**	—									
10 IOS	.73***	.12	.06	-.04	.04	.7***	.63***	.12	-.1	—								
11 Rejfa-Friend	-.26***	-.08	-.19**	-.16*	.25***	-.29***	-.31***	0	.18**	-.23***	—							
12 Rejfa-Parents	-.09	-.1	-.02	-.07	.07	-.05	-.05	.16*	.14*	-.08	.18**	—						
13 Rejfa-Partner-Fight	-.19**	-.08	-.09	-.01	.14*	-.21**	-.2**	-.08	.06	-.17*	.32***	.09	—					
14 Rejfa-Partner-Stay	.01	.03	-.08	.1	.19**	-.01	-.05	-.05	.13	-.01	.24***	.02	.39***	—				
15 Reap-v-Lneg	-.06	-.03	-.12	-.15*	.02	-.07	-.05	-.06	-.12	.03	.07	.07	.05	-.04	—			
16 Lneg-v-Lneu	.12	0	.16*	.23**	-.05	.17*	.19**	-.04	.03	.04	0	-.02	.06	.05	-.54***	—		
17 HRV-Baseline	-.01	.06	0	.05	-.07	.02	-.01	.06	-.03	-.04	-.02	-.13	0	.15*	-.01	-.06	—	
18 HRV-Change	-.12	.06	-.09	.06	-.02	-.07	-.11	.08	-.01	-.18*	-.01	.1	-.07	-.08	.05	.01	-.21**	—

Note: *** $p < .001$; ** $p < .01$; * $p < .05$. Ladder indicates subjective social status. Sociales indicates social desirability. Interdepend indicates interdependent self-construal. SRI indicates the Social Relationships Inventory. IOS indicates the Inclusion of the Other in the Self scale. Rejfa indicates factors from the rejection sensitivity factor analysis. Reap indicates Reappraisal trails. Lneg indicates Look Negative trials. Lneu indicates Look Neutral trials.