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Reappraisal (but not distraction) is going to make you sweat: Physiological evidence for self-control effort

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ABSTRACT

Previous studies of emotion regulation suggested that *reappraisal* (construing an emotional event in non-emotional terms) has no cognitive or physiological consequences, but in all these studies, reappraisal was instructed ahead of an emotional situation. The authors' recent work, using behavioral indices, showed that inhibitory self-control resources are challenged when reappraisal starts late during an emotional situation relative to late instruction of *distraction* (diverting attention through producing neutral thoughts). The present study provides converging physiological evidence in showing that instructing to use reappraisal but not distraction late in a sadness inducing film involved increased skin conductance and decreased finger temperature. Both of these results are indicative of increased sympathetic activation that has been previously found to accompany inhibitory self-control effort.

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1. Introduction

Emotion regulation is an important cognitive skill that has substantial implications to one's interpersonal conduct, well being, coping and appropriate functioning in general (see Gross, 1998a, for a review). For this reason, people may be struggling with the question which emotion regulatory strategy would prove most useful in each context. However, providing an answer to such question may not be simple since the same strategy that was proven effective in one context may not be effective in another context.

In the present study we created one such context that poses a substantial challenge to the effectiveness of regulation strategies and as such is likely to involve physiological effort. Specifically, in the following sections we show that previous studies have established that reappraisal—construing an emotional situation in non-emotional terms—has no physiological or cognitive costs (see Gross, 2002; Richards, 2004, for reviews). However, in a recent behavioral study, we showed (Sheppes and Meiran, in press) that initiating reappraisal late during a sadness mood induction increased the regulatory challenge, and resulted in the expenditure of inhibitory self-control resources relative to late distraction (diverting attention away from an emotional situation via producing neutral thoughts. e.g. Nolen-Hoeksema, 1991). In the present study, we sought to provide converging physiological evidence for the increased inhibitory self-control effort that we found for late initiated reappraisal but not for distraction.

1.1. Does reappraisal consume inhibitory self-control resources?

Two lines of evidence have established that reappraisal does not involve an expenditure of inhibitory self-control resources as reflected in behavioral and physiological measures. First, several behavioral studies were inspired by the ego depletion theory, which views self-control as a limited resource which gets depleted when one tries to *inhibit* competing behaviors, urges or desires (see Muraven and Baumeister, 2000, for review). According to this theory, the exertion of self-control appears to depend on a limited resource. Just as a muscle gets tired after performing an effortful action, an initial act of an inhibitory self-control task causes impairments (ego depletion) in the performance of a subsequent self-control task. Applying this logic, it was shown that initiating reappraisal did not result in ego depletion (e.g., Baumeister et al., 2007; Vohs and Schmeichel, 2003).

Second, another study showed that as opposed to the increased inhibitory-related sympathetic activation found in suppression of facial expressions, reappraisal showed a physiological response profile that was not different from that of a control condition (Gross, 1998b).

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The basic argument for reappraisal's lack of inhibitory self-control cost is based on Gross's (1998a) process model of emotion regulation. In that model, reappraisal is considered an antecedent focused emotion regulation strategy, which is initiated early, before emotional response tendencies are fully activated. Such an early initiation diverts the emotional trajectory before the emotional response is fully blown, and hence does not tax self-control resources.

Note that in all of these studies, reappraisal was indeed instructed very early during the emotion generative process (at the mood induction onset), making the inhibitory self-control challenge minimal. Indeed, we agree that in this case, reappraisal is what Gross (1998a, 2001) defines as "an antecedent focused strategy", changing the emotional trajectory early on and consequently at a minimum cost.

However, in a previous work, we showed that not all forms of reappraisal come free of charge. Specifically, we introduced a new form of emotion regulation defined as online regulation—the attempt to change an emotion which starts and continuously operates *during* an emotional situation (Sheppes and Meiran, 2007). In that study, we tested distraction and reappraisal in two manners. When we tested both strategies as antecedent (initiated at the mood induction onset) we replicated previous findings in showing that reappraisal and distraction were equally effective. However, initiating both strategies late (during the mood induction presumably after the emotion response has sufficiently evolved) revealed that reappraisal was less effective than distraction in down regulating the sad emotion.

In a following study, designed to test the behavioral origin of this effect, we adopted a classical ego depletion procedure. We found that initiating reappraisal late (relative to late distraction), resulted in an expenditure of self-control resources, as reflected in a subsequent increased Stroop interference effect (a task involving inhibition, Sheppes and Meiran, in press). We suggested that initiating reappraisal late in an emotional situation may pose a high inhibitory self-control challenge, because it requires overcoming a strong tendency of identifying with the emotional content which had a chance to be well established prior to the late strategy initiation.

Accordingly, applying reappraisal late involves using self-control resources as one has to stop and override the strong previous interpretation when transforming it to a neutral interpretation. By contrast, we showed that late distraction does not involve consuming self-control resources since it entails diverting attention away from the emotional situation and its contents by producing independent neutral contents. This feature of distraction was observed in memory decrements of the emotional situation once distraction was initiated; indicating reduced encoding of the emotional situation (Sheppes and Meiran, 2007, in press).

Notice that this inhibitory self-control effort that we found for reappraisal is relatively indirect because we examined the delayed effects of self-control effort (the depletion of self-control resources as seen in subsequent Stroop performance), but did not yet show evidence for self-control challenge as it occurs online. One of the most straightforward ways to examine online processes as they evolve is via physiological measures.

Several researchers argued that the cognitive effort that accompanies self-control demand in general and inhibition/suppression in particular is reflected in increased sympathetic activation, specifically in an increase in skin conductance level (SCL) and also to less extent in a decrease in finger temperature (FT). Below we provide a short review of this topic.

1.2. Inhibition, self-control effort and their relation to increased sympathetic activation

One of the early demonstrations of the relation between SCL and inhibitory self-control effort was obtained by Elliott et al. (1970). These authors found the increase in SCL to be a reliable measure that positively correlated with increased inhibitory demand in the Stroop task. Two other studies have shown that SCL increased both when participants refrained from telling the truth in a guilty knowledge test (Pennebaker and Chew, 1985), and when participants avoided talking about personal and traumatic events (Pennebaker et al., 1987).

SCL was also measured in studies that examined the inhibitory processes occurring during the suppression of emotional thoughts (e.g., Wegner and Gold, 1995; Wegner et al., 1990). For example, Wegner and Gold (1995) investigated the effects of suppression of thoughts concerning a significant past romantic relationship. Participants had to either express or suppress thoughts regarding a desired past relationship (a high emotional difficult condition) or a no longer desired past relationship (a low emotional easy condition). Results for the expression and suppression groups in the desired relationship condition showed that those who were instructed to suppress their thought had indeed thought less about the desired past relationship but showed increased SCL relative to the group who were instructed to express their thoughts and feelings. Note that there were no SCL differences between express and suppress groups in the non-desired past relationship condition indicating that only taxing suppression results in SCL increase.

In addition, behavioral studies provide converging support for the interpretation that SCL rise observed in thought suppression may denote the expenditure of inhibitory self-control resources. Specifically, it was repeatedly shown that initiating thought suppression consumes self-control resources and leads to ego depletion (see Muraven and Baumeister, 2000, for a review).

Last, several studies measured the physiological profile of expressive suppression, defined as inhibiting ongoing emotion-expressive facial behavior (Gross, 1998b, 2002; Gross and Levenson, 1993, 1997). It was hypothesized that because suppression involves behavioral inhibition it should result in increased sympathetic activation as reflected in the physiological response. The results supported the hypothesis in showing higher SCL and lower FT in films inducing disgust (Gross, 1998b; Gross and Levenson, 1993) and sadness (Gross and Levenson, 1997).

Converging behavioral support for the interpretation that increased sympathetic activation may relate to the expenditure of inhibitory self-control resources in suppression comes from Inzlicht and Gutsell (2007) who have directly shown that expressive suppression depletes self-control resources. Specifically, suppressing one's emotions resulted in subsequent increased Stroop effect relative to a control condition. Last, note again that just like Wegner and Gold (1995),Gross and Levenson (1997) did not find an increase in sympathetic activation when participants suppressed their ongoing facial behavior to a non-emotional neutral film. This last finding indicates that increased sympathetic arousal in suppression is only observed when the inhibitory demand is strong.

1.3. The present study

In the present study, we set out to provide physiological evidence for the differential inhibitory self-control demands associated with online cognitive reappraisal and online distraction. We examined this issue under conditions that presumably challenge inhibitory self-control abilities. To that end, we measured physiological responses associated with the autonomic system while participants were watching a sadness inducing film. According to the online emotion regulation paradigm, participants were randomly assigned to conditions by receiving subtitles containing the core instructions at a late point during this film. This procedure enabled us to measure the strategies' response profiles before and after the strategy initiation. Reappraisal's profile was compared to a control condition in which participants were allowing their feelings to rise, and to late distraction which has not been shown to involve the expenditure of inhibitory self-control resources. Moreover, by showing that online distraction

does not result in increased sympathetic activation we could demonstrate the specificity of the effect to reappraisal rather than to online emotion regulation attempt in general.

Our main hypothesis was that once late reappraisal is initiated (after the emotion-related response tendencies are sufficiently evolved), it would involve inhibitory self-control costs, reflected in an increase in SCL relative to a pre-regulation period, as compared to distraction and control conditions. In addition, some studies (e.g., Gross, 2002; Richards and Gross, 1999) have also looked into the decrease in FT serving as an index of greater vasoconstriction and hence greater sympathetic activation. We therefore incorporated a measurement of FT into our design and predicted that reappraisal would show a decrease in FT once it is initiated relative to distraction and control conditions.

Last as mentioned above, in our previous studies we found that when reappraisal was given a sufficiently long time to operate, it was as effective as distraction in reducing subjective negative experience (see Sheppes and Meiran, 2007 Experiment 2, in press). Because we incorporated the same late initiation condition in the present study, we predicted that both strategies would be effective in reducing subjective negative experience relative to a control condition. Obtaining this result was important to rule out an alternative explanation according to which the increase in sympathetic activation in reappraisal denotes an improvement in negative mood rather than an inhibitory effort.

2. Method

2.1. Participants and procedure

Forty five undergraduate female students (mean age 22.9, SD = 1.03; seven left handed) participated in the experiment for course credit or monetary compensation[1] (30 NIS; approximately US$7). Only women were selected for this study because it was previously shown that they tend to be more emotionally expressive than men (Kring and Gordon, 1998). Because a (Hebrew) film was used, all participants were native Hebrew speakers. The experiment was administered individually and participants were randomly assigned to conditions. After signing a consent form, participants were attached to physiological sensors. Three minutes of resting baseline (pre-instruction baseline) were administered in which participants were asked to relax, while a Windows XP 3D Flower-Box screen saver was displayed. Immediately after, participants received verbal instructions regarding the film viewing. All participants were first told: "Try to watch the film carefully, and if any feelings would arise allow them without blocking yourself from the film or from your experience". Participants were further told that at some point during the film, one of two subtitles containing core instructions would appear (control—which entails to keep watching the film in the same manner as before subtitles, or one of the strategies).[2] They were also told that in fact only one type of subtitles would appear and would remain valid thereafter. This procedure, which was previously proven useful (Sheppes and Meiran, 2007 Experiments 2 and 3; in press), was used so that participants would not know ahead of time which strategy would be instructed and so that they would therefore allow their feelings prior to the subtitles appearance. During this phase of the experiment, the participants were also asked how they planned to implement the strategy if asked to, in order to ensure their accurate comprehension of the instructions. The distraction condition involved asking participants to "Keep on viewing the film but try at the same time to think about something else that is not related to the film content and that is emotionally neutral". The reappraisal condition involved asking participants "Try to adopt a neutral, analytical and objective attitude toward the film contents". Following the instruction part, participants were given a second two minute relaxing phase (post-instruction baseline). Then, participants watched a 403s film clip taken from the TV documentary "The Real Story" about Holocaust survivors hospitalized in a mental institution after being abandoned by their families and society. It was previously shown that this film mainly induces sadness (Sheppes and Meiran, 2007, in press). One hundred ninety seconds from the film onset, the subtitles (containing the instructions related to one of the three conditions) appeared at the bottom of the screen and remained there throughout the remainder of the film clip. Therefore, the film clip was divided to two parts: Pre-manipulation period (the first 189s from the film's onset) and a Regulation period (190s from the film's onset until the film's termination). After watching the film, participants were given a mood check, followed by an amusing story they had to read in order to improve their mood upon leaving the experiment. Finally, participants were debriefed also to ensure that they correctly applied the instructions of their condition, and thanked.

2.2. Apparatus

2.2.1. Mood check

This was a 9-point visual analogue Likert scale (1 = not at all; 9 = to a great deal) in which participants rated their sadness and general mood and some filler questions regarding happiness, surprise, disgust, fear, frustration anger, and anxiety.

2.2.2. Physiological measures

A Biopac System MP100 technology was used to record physiological signals at a rate of 1000Hz. Skin Conductance Levels (SCLs), were derived from a signal using a constant voltage of 0.5 between the SCL100 electrodes that were attached to the middle phalanges of the first and second fingers of the non-dominant hand. Finger temperature (FT in Celsius) was assessed using an SKT100 thermometer attached to the surface of the distal phalanx of the third finger of the non-dominant hand. Note, that all participants were also connected to electrodes that assessed their heart reactivity.[3] For all measures, we applied the mean change from the pre-instruction baseline score, using the AcqKnowledge software (Biopac Systems, Goleta, CA).

2.3. Statistical analyses

The separate statistical analyses conducted on each physiological measure (i.e., SCL, FT) were divided to preliminary and core analyses. Preliminary analyses were conducted on the period preceding the film clip which included two baselines: (a) a resting pre-instruction baseline and (b) a post-instruction baseline (immediately prior to the film clip). To check for group differences, we conducted two separate one-way analyses of variance (ANOVAs, (1) on the raw scores of the pre-instruction baseline (2) on post-instruction baseline change scores from pre-instruction baseline) with Condition (Reappraisal, Distraction, Control) serving as a between participants variable.

Core analyses evaluated differences between groups that are due to the experimental manipulation which occurred during the film clip. For the dependent measure we used the mean change score relative to

[1] One participant (from the control group) was excluded from all analyses due to equipment failure. In addition, groups did not differ in age or in handedness.

[2] In plain words, participants in the reappraisal condition received reappraisal and control instructions, participants in the distraction condition received distraction and control instructions and half of the participants in the control condition received reappraisal and control instructions and the other half received distraction and control instructions.

[3] There were no meaningful results concerning this measure and it is not discussed any further.

Table 1
Means and standard deviations in parenthesis of all physiological measures

	Skin conductance level (μmho)			Finger temperature (°C)		
	Reappraisal	Distraction	Control	Reappraisal	Distraction	Control
Pre-instruction baseline	14.06 (2.09)	14.24 (2.09)	15.03 (2.16)	31.06 (0.94)	32.56 (0.94)	31.44 (0.97)
Post-instruction baseline	1.97(0.80)	0.75(0.80)	0.62(0.82)	0.45(0.34)	0.27(0.34)	0.02(0.35)
Beginning period	2.47(0.91)	1.28(0.91)	1.88(0.95)	0.34(0.4)	0.10(0.4)	−0.28(0.42)
Pre-regulation period	−0.28(1.01)	0.26(1.01)	−0.21(1.04)	0.25(0.43)	−0.01(0.43)	−0.24(0.44)
Regulation period	0.69(1.18)	−0.40(1.18)	−0.67(1.22)	0.05(0.49)	0.17(0.49)	−0.06(0.51)
(Regulation)–(pre-regulation)	0.97(0.56)	−0.66(0.56)	−0.47(0.58)	−0.20(0.15)	0.18(0.15)	0.18(0.15)

Note that the Pre-instruction baseline scores are in raw values. All other measures are change scores from the pre-instruction baseline. The (regulation period)–(pre-regulation period) row corresponds to the main analyses reported.

the pre-instruction baseline (c.f. Gross, 1998b; Gross and Levenson, 1997). In these analyses we concentrated on the physiological difference between the regulation period relative to a pre-regulation period. For the regulation period we computed the mean sympathetic activation during the experimental manipulation (190s from the film onset until the film's termination). For the pre-regulation period we decided to compute the mean sympathetic activation during the clip period that had just proceeded the regulation period (i.e. 130–189s from the film's onset).

Note that the majority of researchers have used quite similar approaches to that applied here (e.g., Gross and Levenson, 1997). That is, these studies have compared some reference point (usually a short baseline) to the average period of the manipulation (the average of the total film duration). In this sense, our use of the total regulation period (which is the manipulation in the current study) resembles that of most previous research in this area of research. Second, our decision to focus on the last minute preceding the regulation period as our reference point (pre-regulation period) has both theoretical and technical grounds (see also Wegner and Gold, 1995, who used a similar approach). Theoretically, the aim of the present study was to check the physiological profile of regulation strategies as they are initiated online (after response tendencies were substantially evolved). As such, we wanted to check for physiological changes during the regulation period relative to the film period in which the negative emotion had already established. Technically, the pre-regulation period was chosen to be based on the last pre-manipulation minute because we noticed that the film's onset (0–129s from the film's onset; henceforth beginning period) involved a relatively high sympathetic increase in all groups (see Table 1 which summarizes the means and standard errors for all physiological measures). We suspect that this increase denotes either the introduction of a novel and demanding stimulus or the anxiety and surprise associated with the initiation of the film contents. For this reason, the last minute of the pre-manipulation period represents a point in the film where participants were already relatively accustomed to the film clip and its contents. Indeed, the actual physiological values of this last minute in all groups most closely approached the baseline values (see Table 1).

Therefore, the core analysis involved a two-way mixed ANOVA design on change scores from baseline (separate analyses for SCL and FT) with Time (Pre-Regulation Period, Regulation Period) as a within subject variable and Condition (Reappraisal, Distraction, Control) treated as a between subjects variable. Our main prediction, that reappraisal would show a sympathetic increase, was tested using a focused interaction contrast pitting the regulation period against the pre-regulation period for reappraisal against distraction and control participants.

Last, for the mood check analysis, we computed a one-way ANOVA on the averaged (reversed) general mood and sadness scores (Negative Experience, see Sheppes and Meiran, 2007, in press), with Condition (Reappraisal, Distraction, Control) serving as a between participant variable. The main prediction was evaluated by performing a focused contrast pitting distraction and reappraisal to control.

3. Results

3.1. Mood check

As predicted, distraction (M=5.93, SD=0.38) and reappraisal (M=5.53, SD=0.38) conditions were associated with lower levels of negative experience relative to the control condition (M=7.11, SD=0.39) $F(1, 41)=8.47$, $p<0.01$ with no significant differences between distraction and reappraisal $F(1, 41)<1$.

3.2. SCL

3.2.1. Preliminary analyses

We did not find any meaningful SCL differences between groups during the pre-instruction and post-instruction baselines (both Fs<1). These results are important since they show that our random assignment of participants to groups has been successful, and that the instruction procedure (which was somewhat different between reappraisal and distraction) did not create changes between groups prior to the mood induction.

3.2.2. Core analyses

Our main prediction was that reappraisal would show an increase in SCL during the regulation period relative to the pre-regulation period as compared to distraction and control. Indeed the contrast analysis supported our prediction, $F(1, 41)=5.0$, $p<0.04$. In another focused contrast, we found that Distraction and Control did not differ from one another $F(1, 41)<1$ and both actually showed a decrease in SCLs during the regulation period relative to the pre-regulation period (see Fig. 1). Furthermore, the aforementioned difference between

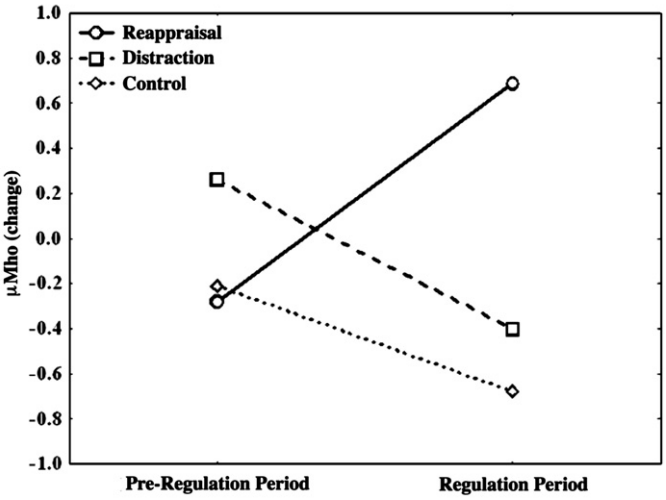

Fig. 1. Mean SCL change scores from baseline of the pre-regulation and regulation periods for the three instructional groups.

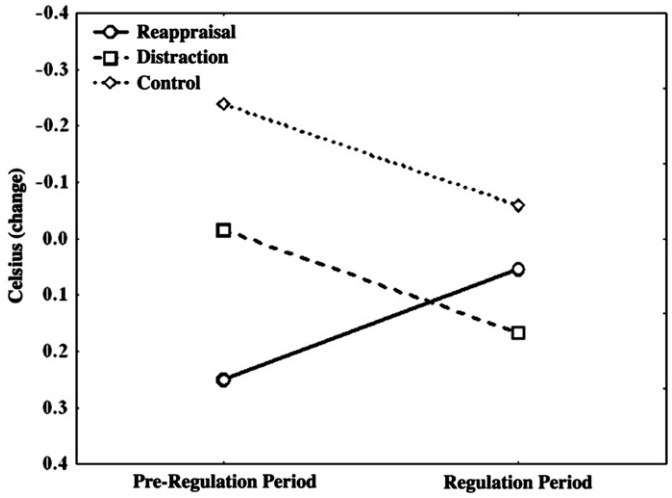

Fig. 2. Mean FT change scores from baseline of the pre-regulation and regulation periods for the three instructional groups. Note that the ordinate's scale is such that increased sympathetic activation is upward.

Reappraisal and the other groups remained significant even when we directly compared reappraisal to distraction $F(1, 41)=4.3$, $p<0.05$. Note that there were no significant SCL differences between reappraisal, distraction, and control groups during the pre-regulation period[4] (all Fs<1).

3.3. FT

3.3.1. Preliminary analyses

Similar to the SCL preliminary analyses, we did not find any meaningful FT differences between groups during the pre-instruction and post-instruction baselines (both Fs<1).

3.3.2. Core analyses

Our main prediction was that reappraisal would show a decrease in FTs during the regulation period relative to the pre-regulation period as compared to distraction and control. The contrast analysis supported our prediction, $F(1, 41)=4.17$, $p<0.05$. A similar focused contrast indicated no significant differences between Distraction and Control, $F(1, 41)<1$ and both actually showed an increase in FTs during the regulation period relative to the pre-regulation period (see Fig. 2). Furthermore, the difference between Reappraisal and distraction was marginally significant even when these conditions were directly compared in a focused contrast, $F(1, 41)=3.18$, $p=0.08$[5].

As can be seen in Fig. 2, there were some observable differences between groups during the pre-regulation period. However, these differences were found to be non-reliable, All Fs<1). Nevertheless, one could still argue that the differences that we found (during the regulation period relative to the pre-regulation period) between reappraisal, relative to distraction and control derive from Wilder's (1958) law of initial values. Applying this law for the present focus, it could be that because reappraisal showed the highest initial value, it had the highest tendency to drop during the regulation period. However, this conclusion is unwarranted, because according to the same law, the control group who showed the lowest initial value should have showed the smallest drop during the manipulation. In fact Control showed an increase that was of the same magnitude as that of Distraction which had higher initial values. Importantly, the FT results provide partial converging evidence to the SCL results. Specifically, they show that late reappraisal relative to late distraction and control results in a decrease in FT levels, which indicates an increased sympathetic activation.

4. Discussion

In the present work we were able to show that by increasing the inhibitory challenge of regulation strategies, a physiological cost for reappraisal (but not for distraction) was revealed. Specifically, we showed that initiating reappraisal late, during an emotional triggering event (ETE), involved an increase in SCLs relative to distraction and control conditions. This physiological index of sympathetic activation has been repeatedly shown to denote an index of inhibitory self-control effort, in the realm of suppression of emotional thoughts (e.g., Muraven et al., 1998; Wegner and Gold, 1995; Wegner et al., 1990), and in emotion regulation during expressive suppression of facial expressions (e.g., Baumeister et al., 1998; Gross and Levenson, 1993, 1997). In addition, we found some converging evidence from the decrease of FT during late initiated reappraisal relative to distraction and control participants. This last result tended to be somewhat less strong than the SCL result. However, since it is compatible with some former research (e.g. Gross, 2002; Richards and Gross, 1999), and because it converges with the SCL results it strengthens our certainty that late reappraisal but not distraction involves an increased sympathetic activation. Last, we found that both reappraisal and distraction successfully reduced subjective levels of negative experience relative to a control condition.

The use of online regulation offers an important contribution to current theorizing, by illuminating different costs for regulation strategies. The results of the present study demonstrating reappraisal's (but not distraction's) increased physiological activation commensurate with our previous findings and indicate that for late reappraisal, the creation of an alternative neutral interpretation of the emotional contents requires the inhibition of a firmly established emotional interpretation which was formed during the long unregulated duration. By contrast, initiating distraction late does not seem to involve inhibition, rather it involves diverting attention from an emotional situation by loading working memory with independent neutral contents (Sheppes and Meiran, 2007, in press; see also Van Dillen and Koole, 2007).

The online regulation phenomenon and its related findings have important implications. Online regulation should not be treated as an "artificial creature" that is restricted to laboratory settings. Individuals tend to get angry, sad, surprised, happy, afraid, disgusted, to some extent before they try to start controlling these emotions. In these situations, one has to acknowledge the inhibitory self-control consequences that might follow the use of late reappraisal. According to the ego depletion theory, achieving a certain self-control goal relies on the amount of remaining resources from a previous self-control task (Muraven and Baumeister, 2000). For example, while self-control resources are crucial for many forms of impulse control (Baumeister et al., 2007), one may be more susceptible to break a diet after a heated conversation in which reappraisal started too late.

Admittedly, we cannot be certain that the increased sympathetic activation which we found for reappraisal indicates increased inhibitory self-control effort. As noted by others, the relation between physiological

[4] Further analyses were conducted in order to check for differences between groups during the beginning period (0–129s from the film's onset and prior to our pre-regulation period value) which could undermine our conclusions. A one-way ANOVA performed on the SCLs during the beginning of the film with Condition (Reappraisal, Distraction, Control) as a between subject variable did not reveal any differences between groups (all Fs<1). Furthermore, because the trends in means did show a difference between groups we re-conducted our core analysis while covarying the Beginning Period. All of the effects reported above remained significant and remarkably similar.

[5] We also conducted analyses to check for FT differences between groups during the beginning period. The ANOVA was similar to that used in the corresponding SCL analysis (see Footnote 4). We did not find any differences between groups (all Fs<1.16 ns). When we repeated the core FT analysis while covarying the Beginning Period, all of the effects reported above, remained significant and essentially unchanged.

measures and their hypothesized psychological processes is anything but simple (see Cacciopo and Tassinary, 1990 for review). Obviously, the interpretation we offer should be treated cautiously. However, our current interpretation is based on four lines of supporting arguments and on ruling out at least one alternative explanation.

First, the convergence of the FT and SCL results provides a relatively strong support for the immediate conclusion regarding increased sympathetic activation.

Second, the present results should be considered together with our former supportive behavioral results (Sheppes and Meiran, 2007, in press) reviewed above, and with the associated theoretical analysis both of which predicted increased sympathetic activation for late reappraisal.

Third, our construal of increased sympathetic activation (via SCL and FT) as indicating inhibitory self-control effort agrees with the interpretation given by many other investigators (e.g., Gross, 1998b; Gross and Levenson, 1993, 1997; Richards and Gross, 1999; Wegner and Gold, 1995; Wegner et al., 1990).

Fourth, recent imaging data has offered that decreasing negative affect via reappraisal specifically recruits two inhibitory cerebral regions: the right pre-frontal cortex, and the anterior-cingulate cortex (e.g. Kalisch et al., 2005; Ochsner et al., 2004).

Last, we can rule out an alternative explanation that the SCL increase reflects a mood change. Our mood results (obtained immediately following the mood induction) indicated that reappraisal and distraction were associated with similar mood levels that were better than those seen in the control condition. Thus, our results showing increased SCL for reappraisal with lower similar levels for distraction and control do not commensurate with this account.

We acknowledge the limitations of the present work. First, the distraction and reappraisal groups received partially different instructions prior to the mood induction (i.e. their strategy and control conditions). This procedure was carried out in an effort not to over-confuse participants by providing instructions for all three conditions, but at the same time to conceal from participants the actual condition that appeared later during the film. Importantly, these group differences were non-significant in the present study. In addition, note that the control group also received the same instructions as both groups (see Footnote 2). This procedure is a clear advantage over previous research which used different instructions for the control group relative to the experimental groups, that resulted in significant SCL differences prior to the manipulation (see Gross, 1998a,b; Gross, Levenson, 1993).

Second, during the pre-film instructions participants were asked how they plan to implement the strategies and we cannot completely rule out the possibility that this aspect of the procedure has influenced the results. We chose this procedure based on our previous work (Sheppes and Meiran, 2007) in which we showed that ensuring comprehension of the instructions reduces to minimum participants' exclusion, leaves some ambiguity among participants regarding the actual condition that would appear (since participants are asked how they would implement both the control and the strategy conditions), and importantly for the present study, it likely lowers the effort associated with initiating the strategies online, which could have resulted in an increase in physiological activation.

Third, the present study included an online late condition, but did not contain an in-advance condition that was used in former research. Consequently, we can only conclude that late reappraisal is more effortful than late distraction and control. Note that Distraction's lack of increased sympathetic activation is important in ruling out that the sympathetic activation we found for late reappraisal derives simply due to performing any form of online regulation.

In conclusion, we demonstrated an important difference between two major cognitive emotion regulation strategies—distraction and reappraisal. Using a new methodology which according to our hypothesis makes emotion regulation more challenging we showed that initiating reappraisal but not distraction resulted in a physiological activity which presumably reflects the increased inhibitory self-control effort due to the need to change an already established emotion trajectory.

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