Reducing daily stress: Breaking a habit

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Converging evidence that subliminal evaluative conditioning does not affect self-esteem or cardiovascular activity

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ABSTRACT

Background

Self-esteem moderates the relationship between stress and (cardiovascular) health, with low self-esteem potentially exacerbating the impact of stressors. Boosting self-esteem may therefore help to buffer against stress.

Objectives

Subliminal evaluative conditioning (SEC), which subliminally couples self-words with positive words, has previously been successfully used to boost self-esteem, but the existing studies are in need of replication. In this article, we aimed to replicate and extend previous SEC studies.

Methods

The first 2 experiments simultaneously examined whether SEC increased self-esteem (Experiment 1, n = 84) and reduced cardiovascular reactivity to a stressor in high worriers (Experiment 2, n = 77). On the basis of these results, the 3rd experiment was set up to examine whether an adjusted personalized SEC task increased self-esteem and reduced cardiac activity in high worriers (n = 81).

Results

Across the 3 experiments, no effects were found of SEC on implicit or explicit self-esteem or affect or on cardiovascular (re)activity compared to a control condition in which the self was coupled with neutral words.

Conclusions

The results do not support the use of the subliminal intervention in its current format. As stress is highly prevalent, future studies should focus on developing other cost-effective and evidence-based interventions.

INTRODUCTION

It is widely known that there is a negative relation between stress and health (e.g., [22]). This might be particularly relevant in people with low self-esteem as self-esteem is negatively associated with worrying [94], anxiety [231], and depression [231]. Moreover, a prospective study by Trzesniewski et al. [232] showed that low self-esteem in adolescence is a predictor for lower mental and physical health in adulthood even after controlling for relevant co-varying variables. Increasing self-esteem can therefore be important and might provide a buffer against stress. In the present study, we specifically focused on the effect of *implicit* self-esteem on psychological outcomes and physiological activity.

Implicit Self-Esteem

Current self-esteem interventions primarily target explicit processes, that is, explicit self-esteem that encompasses people's explicit beliefs or knowledge about themselves. Yet people may not always be aware of their self-esteem, and it is believed that attitudes towards oneself can affect behavior and stress responses at the implicit level [233]. According to different authors (e.g., [234, 235]), explicit and implicit processes originate from different information processing systems that operate simultaneously. From this perspective, explicit processes are based in the reflective system known for its rule-based processing that requires cognitive capacity. In this system, a response (e.g., a behavior) results from a conscious decision process. Implicit processes are based in the impulsive system, which consist of networks of associations. Perceptual input or processes in the reflective system can activate these associations, and the activation then spreads to related elements, concepts, or behaviors. In contrast to the reflective system, the impulsive system is fast and does not depend on cognitive effort. Moreover, the impulsive system is recognized to have a low threshold for incoming information [235]. Considering that self-esteem may also be represented as an implicit (or automatic or unconscious) concept, it might be appropriate to modify this implicit process.

Study Rationale

Stress research has only scarcely focused on the importance of implicit processes for health. Yet Brosschot, Verkuil, and Thayer [38] proposed that unreported processes (i.e., unconscious perseverative cognition or worry) play an important role in explaining prolonged physiological effects due to stress. That is, implicit mental representations of threats to oneself (such as implicit worries or implicit low self-esteem) are hypothesized to prolong the stress response beyond the presence of the actual stressor. These prolonged physiological effects in turn lead to wear and tear effects on the body [28, 236].

A lot of research has been done on explicit worry and self-esteem, and its relation to increased physiological activation and its delayed recovery (e.g., [39, 237-239]). However, no research has looked whether implicit worry or self-esteem affects physiological activity. Therefore, the present study with three experiments focused on the effect of implicit self-esteem on physiological activity. Specifically, we aimed to experimentally *manipulate* implicit self-esteem as this allowed us to make statements about directionality and causality. Below we introduce the three experiments in which we aimed to increase implicit self-esteem, which represents the automatic or unconscious associations with the self-concept [80]. In Experiment 1, we attempted to replicate a previous study on subliminal evaluative conditioning (SEC) to increase implicit self-esteem [78]. In Experiments 2 and 3, we subsequently examined the effect of this self-esteem manipulation on physiological activity. This allowed us to examine if boosting implicit mental representations related to self-esteem indeed affect physiological activity, as hypothesized by Brosschot et al. [38].

Subliminal Evaluative Conditioning

SEC has been successfully used to increase implicit self-esteem [78]. Hereby, the self is repeatedly coupled with positive affective words and both stimuli are presented subliminally. With this, the self is assumed to acquire the value of the positive words. Using this procedure, Dijksterhuis [78] found higher implicit self-esteem in the experimental condition compared to the control condition (i.e., the self is coupled with neutral words). Grumm, Nestler, and Collani [79] reported similar effects in a larger sample, but no effect was found on explicit state self-esteem. A nearly identical SEC procedure was used by Jraidi and Frasson [240] and resulted in higher implicit self-esteem, learning performance, positive emotions, and delta-low-theta activity, which is indicative of higher concentration. Furthermore, Svaldi, Zimmermann, and Naumann [241] showed that SEC using slightly longer presentation times for stimuli and more trials resulted in higher implicit self-esteem. Using the same paradigm, Riketta and Dauenheimer [242] found higher levels of explicit self-esteem when self-referent words were coupled to positive words compared to negative words. Yet only explicit measures were studied, and these results might not directly translate to implicit outcomes. Importantly, these studies show that SEC has an effect size between medium and large. These initial findings seem promising, but the conclusions are limited due to issues of reliability concerning the assessment of implicit self-esteem. Specifically, previous studies measured implicit self-esteem with either (a) a shortened and unvalidated version of the Implicit Association Test (IAT) [243] or with (b) the Initials Preference Task that has insufficient psychometric properties [220]. There is therefore need for studies that assess whether implicit self-esteem can indeed be enhanced using SEC. We set out to test this and additionally examined if enhancing implicit self-esteem reduces cardiovascular (re)activity.

Overview of Three Experiments

Our study's objective was to examine the effect of SEC on implicit self-esteem (Experiments 1 to 3) and physiological activity (Experiments 2 and 3). Overall, we hypothesized that when the self was subliminally coupled to positive words, this would increase implicit self-esteem and reduce cardiovascular (re)activity. The first two experiments were carried out simultaneously to study whether the original SEC was capable of increasing self-esteem (Experiment 1) and whether it was capable of dampening the negative physiological consequences of a stressor in at risk individuals, that is, high worrying participants (Experiment 2). On the basis of the results of Experiments 1 and 2, Experiment 3 was set up to study the effectiveness of an adjusted SEC task for increasing self-esteem and decreasing cardiovascular activity, again in high-worrying participants.

EXPERIMENT 1

We aimed to examine whether implicit self-esteem could be increased using SEC. Previous studies have found large effects using this procedure [78, 79], and we intended to replicate this effect using a more reliable assessment of implicit self-esteem. On the basis of previous research, it was hypothesized that individuals in the experimental condition (EC) would have higher self-esteem (both implicit and explicit) directly after coupling the self with the positive words compared to the control condition (CC). In order to gain insight into the duration of the potential effects of SEC, a follow-up measurement of implicit self-esteem and affect (2 hr after the SEC) was added to the protocol. Although long-term effects of SEC are unknown, other subliminal priming paradigms have shown that effects can be maintained after several minutes (i.e., between 15 and 43 min) and even 4 days [57, 244]. Therefore, it was hypothesized that implicit self-esteem and positive affect (both implicit and explicit) were higher, and negative affect (both implicit and explicit) were lower in the EC compared to the CC 2 hr after the manipulation. We checked for baseline differences of trait self-esteem, trait worry, and intermediately perceived stress and worry. Moreover, we explored whether the hypothesized effects were influenced (moderated) by trait self-esteem and worry.

Method

Participants. Participants were recruited at Leiden University, and the study was approved by the internal review board (nr. CEP 3033663498). No specific inclusion or exclusion criteria were used. To estimate the required sample size, the effect size of Dijksterhuis [78] and Grumm et al. [79] were averaged (resulting in a d = 1.15) and used in a power analysis [212]. Per condition, 11 participants were required to detect an effect with the alpha set at .05 (80% power). To detect smaller effects, we aimed to include 80 participants. Eighty-four participants completed the experiment; 76 females and 8 males with a mean age of 19.83 (SD = 2.26).

Materials.

Self-esteem manipulation. Subliminal evaluative condition, as used by Dijksterhuis [78], was used to manipulate implicit self-esteem. The sequence of the trials was as follows: (a) a row of 10 X's was shown for 500 ms, (b) *Ik* was displayed (Dutch for 'I') for 17 ms, (c) a positive word (in the EC) or a neutral word (in the CC) was displayed for 17 ms, and (d) this was followed by a random letter string. Participants decided whether the letter string started with a vowel or consonant. Fifteen different positive and neutral words were used (see Appendix 1). All words were presented twice, resulting in 30 trials, and five practice trials were used.

Implicit self-esteem. The IAT was used to measure implicit self-esteem [243]). The task was presented as a categorization task. In each trial, a word—that belonged to a specific category—was randomly presented in the middle of the screen. The different category names were displayed in the top-left and right of the screen. Participants were instructed to determine to which category the word belonged and to press the corresponding key as quickly as possible.

The task consisted of five blocks composed of either 20 or 60 trials. Blocks 3 and 5 are the critical blocks. In these blocks, two categories are presented on the left and two on the right side of the screen (see Appendix 1 for details). The task was administered twice using different words (see Appendix 1). The proposed scoring algorithm by Greenwald, Nosek, and Banaji [219] was used to calculate the IAT score.

Awareness check. An awareness check was included to determine whether participants consciously perceived the SEC stimuli. On the basis of the signal detection theory [245], a d' measure and its 95% confidence interval was calculated using the true hits and correct rejections of 42 discrimination trials. To obtain good accuracy scores, corrections were made of 1/(2 N) and 1-1/(2 N) with N = 42. If the confidence interval included zero, it was assumed that the participants did not consciously perceive the shown prime words. On the basis of this criterion, no participants were excluded from the analyses.

Questionnaires. Explicit state self-esteem was assessed using the 20-item State Self-Esteem Scale (SSES) [246]. Cronbach's alpha was considered high (.86). Affect was measured implicitly as well as explicitly. *Implicit affect* was measured using the Implicit Positive and Negative Affect Test (IPANAT) [191]. In this test, participants are shown nonsense words (e.g., VIKES) and they have to indicate to what extent those words express an emotion (e.g., sad). Five nonsense words were shown, and each word was coupled with 12 emotional adjectives (i.e., three adjectives per primary emotion [anxiety, anger, sadness, and happiness]). Resulting in 74 items and from this positive and negative implicit affect scores were calculated. As a measure of *explicit affect*, participants were asked to what extent they were currently experiencing the 12 emotional adjectives. Cronbach's alpha for positive and negative affect was adequate for both implicit and explicit affect (between .72 and .90). Trait self-esteem was assessed with the 10-item Rosenberg Self-Esteem Scale (RSES) [247]. The 16-item Penn State Worry Questionnaire (PSWQ) [94] was used to measure trait worry. Both instruments had high Cronbach's alpha (respectively .88 and .94).

Participants also indicated whether they had encountered any periods of stress or worry in the 2 hr between the first and second session. If so, participants registered the frequency and length of these periods of worry or stress. Plus the severity of these stressful events on a 5-point scale with 1 = 'not at all' and 5 = 'very much.'

Procedure. At the start of the experiment, all participants were consented. After answering demographic questions, participants were randomly allocated to the EC or CC. Participant and experimenter were blind to the allocated condition. Due to a programming error in the randomization scheme, more participants were allocated to the EC than to the CC (50/84, 60%). The SEC paradigm was followed by the IAT and SSES. A baseline measure of both the IAT and SSES was omitted, because it would risk giving away the true focus of the experiment (i.e., self-esteem). After completing the SSES, participants were informed that they could leave and were to return within 2 hr for the second part of the experiment. In part two of the experiment, participants answered questions concerning worry or stress episodes in the past 2 hr. Next, the second IAT, IPANAT, explicit affect measure, and the awareness check were completed. Participants were thanked and debriefed. Participants were told that we had aimed to increase (implicit) positive affect; however, participants were not yet told that the true aim was to increase (implicit) self-esteem. This knowledge could have influenced the trait self-esteem questionnaire that had to be filled in a week later. This questionnaire was completed a week after the experiment for two reasons. First, including the questionnaire at the start of the experiment could have given away the true aim of the experiment. Second, if the questionnaire was presented directly at the end of the experiment, the self-esteem manipulation may have influenced the scoring and we believed it was unlikely that the potential effects of the SEC lasted for a week. Additionally, the PSWQ had to be filled in. After completing the two questionnaires online, participants were informed about the true aim of the experiment. Participants received money or course credit for participating.

Statistical analyses. Independent sample *t* tests were done to check whether the two conditions differed in trait self-esteem and worry (which were measured a week after completing the experiment). Furthermore, Bayes factors (of *t* tests) were estimated to determine whether the self-esteem manipulation differentially affected self-esteem and affect in the EC and CC (using Bayes factor package in R [version 0.99.484]). Bayes factors were used, because this type of hypothesis testing is more robust and is not biased in favor of rejecting the null-hypothesis compared to traditional hypothesis testing [248]. Given the expected direction for implicit and explicit self-esteem directly after the SEC paradigm, these analyses were tested one-sided. All other outcomes were tested two-sided. The classification system of Jeffreys [249] and Lee and Wagenmakers [250] was used to categorize the strength of the estimated Bayes factors.

Results

Descriptive statistics. For one participant, data of the second IAT and IPANAT were missing, and one participant failed to complete the trait worry and self-esteem questionnaire. Of the 84 participants, 34 were in the CC and 50 in the EC. The two conditions did not differ on descriptive variables including trait self-esteem and trait worry (see Table 1). Across the two conditions, the average trait self-esteem score was 10.05 (SD = 4.46) and the average trait worry was 51.17 (SD = 13.40). The number of stressful events and worry episodes that participants encountered between Parts 1 and 2 of the experiment did not differ between conditions. Across both conditions, 12 participants reported experiencing a stressful episode, with a mean frequency of 2.08 (SD = 1.50), a mean duration of 34.36 min (SD = 39.49), and a mean severity score of 1.45 (SD = 0.69). Thirty-seven participants reported experiencing at least one worry episode. The mean frequency of those episodes was 1.78 (SD = 0.98), and the mean duration in minutes was 18.62 (SD = 26.72).

TABLE 1 Baseline characteristics, biobehavioral, and outcomes variables per condition in Experiments 1 - 3

	Experiment 1		Experiment 2		Experiment 3	
	EC (n = 34)	CC (n = 50)	EC (n = 39 | 37)[a]	CC (n = 38 | 33)[a]	EC (n = 41 | 35 | 33)[b]	CC (n = 39 | 29 |32)[b]
Baseline variables						
Gender[c]	88%	94%	90%	82%	90%	85%
Age	19.82 (2.16)	19.85 (2.44)	20.41 (2.27)	20.16 (1.73)	20.32 (2.39)	20.49 (2.06)
Trait SE	9.49 (4.33)[d]	10.85 (4.59)[d]	9.90 (3.96)[d]	10.59 (4.17)[d]	12.10 (3.58)[d]	11.33 (4.96)[d]
Trait worry	50.53 (13.62)[d]	52.09 (13.23)[d]	55.05 (7.62)	54.97 (7.91)	53.54 (6.15)	55.21 (8.16)
SBP	—	—	119.18 (20.14)	120.66 (16.50)	121.92 (18.82)	127.81 (16.84)
DBP	—	—	59.91 (12.91)	61.02 (11.91)	69.58 (10.40)	71.45 (11.64)
HR[e]	—	—	78.49 (13.06)	76.85 (10.86)	76.43 (10.37)	78.72 (9.81)
RMSSD	—	—	—	—	37.05 (18.31)	36.16 (25.68)
Biobehavioral variables						
Coffee today	—	—	0.33 (0.66)	0.34 (0.67)	0.44 (0.78)	0.36 (0.81)
Cigarette today	—	—	1.33 (1.53)	1.17 (0.98)	0.15 (0.57)	0.00 (0.00)
Alcohol today[f]	—	—	0	0	0	0
Drugs today[f]	—	—	0	0	0	0
Medication use[f]	—	—	8	9	5	7
Current psychological treatment[f]	1	0	2	4	4	4
Outcome variables						
Implicit SE	0.55 (0.50)	0.36 (0.60)	0.62 (0.44)	0.51 (0.43)	0.69 (0.43)	0.69 (0.45)
Implicit SE, delayed effect	0.40 (0.48)	0.44 (0.42)	—	—	—	—
Explicit state SE	69.80 (4.89)	67.62 (5.86)	69.36 (10.56)	66.59 (10.82)	65.93 (9.04)	65.41 (11.18)
Implicit PA	3.02 (0.62)	2.99 (0.52)	2.92 (0.78)	2.97 (0.68)	3.21 (0.69)	3.09 (0.60)
Implicit NA	2.86 (0.53)	2.86 (0.53)	2.89 (0.67)	3.06 (0.43)	3.09 (0.44)	3.02 (0.48)

	Experiment 1		Experiment 2		Experiment 3	
	EC (n = 34)	CC (n = 50)	EC (n = 39 | 37)[a]	CC (n = 38 | 33)[a]	EC (n = 41 | 35 | 33)[b]	CC (n = 39 | 29 |32)[b]
Explicit PA	4.20 (0.79)	4.16 (0.90)	3.94 (0.85)	3.68 (0.89)	3.98 (0.88)	4.13 (0.82)
Explicit NA	1.67 (0.53)	1.72 (0.66)	1.89 (0.53)	2.12 (0.76)	1.74 (0.50)	1.70 (0.50)

Note. CC = control condition; DBP = diastolic blood pressure; EC = experimental condition; HR = heart rate; NA = negative affect; PA = positive affect; SBP = systolic blood pressure; SE = self-esteem; RMSSD = root mean square of successive differences.

[a] The first sample size reflects the number of participants included in the analyses of the psychological outcomes and the second sample size reflects the number of participants included in the physiological data analyses.

[b] The first sample size reflects the number of participants included in the analyses of the psychological outcomes, the second sample size reflects the number of participants included in the analyses of the blood pressure data and the third sample size reflects the number of participants in the analyses of the heart rate and heart rate variability data.

[c] Gender is represented by the percentage of women.

[d] It is considered a baseline variable, but the variable was actually measured a week after completing the experiment as inclusion of this measure at baseline would have risked giving away the true nature of the experiment.

[e] Heart rate is calculated from the blood pressure data in Experiment 2 and is measured using an electrocardiogram in Experiment 3.

[f] Indicated with the number of positive responses.

Direct effects. Contrary to the hypotheses, the estimated Bayes factor for implicit self-esteem indicated strong evidence that the data favored the null-hypothesis. Specifically, the data are 0.09 more likely under the alternative hypothesis than under the null-hypothesis ($t(82) = -1.63$). Moreover, the level of explicit state self-esteem did not differ between the two conditions. Again, the Bayes factor provided strong evidence for the null-hypothesis, with $t(82) = -1.85$, JZS $BF_{10} = 0.09$. In other words, SEC did not increase implicit or explicit self-esteem (see Table 1 for the means and SD's per condition). Exploratory analyses showed no moderation of the condition effect by trait worry or trait self-esteem.

Delayed effects. Bayes factor estimates for the second IAT found moderate evidence for the null-hypothesis, meaning that the conditions did not differ on implicit self-esteem 2 hr after the manipulation ($t(82) = 0.35$, JZS $BF_{10} = 0.24$). Furthermore, the estimated Bayes factors for both positive and negative implicit affect were in favor of the null-hypothesis (resp. $t(80) = -0.24$, JZS $BF_{10} = .24$ and $t(80) = -0.01$, JSZ $BF_{10} = 0.23$). Similar results were also found for explicit positive and negative affect (resp. $t(80) = -0.19$, JZS $BF_{10} = 0.24$ and $t(80) = 0.38$, JZS $BF_{10} = 0.25$). Summing up, there was no effect on implicit self-esteem and affect (both implicit and explicit) 2 hr after the SEC manipulation (see Table 1 for the means and SD's per condition).

EXPERIMENT 2

Previous research has shown that there is a negative association between self-esteem and cardiovascular functioning. Hughes [239], for instance, found higher systolic and diastolic blood pressure (resp. SBP and DBP) in reaction to negative feedback compared to positive feedback, and this effect was stronger for those with low compared to high self-esteem. Furthermore, Elfering and Grebner [251] showed that—in response to public speaking challenges—the habituation in blood pressure was faster in individuals with higher trait self-esteem. Moreover, Greenberg et al. [238] found that individuals with higher self-esteem had lower physiological arousal (i.e., skin conductance) in response to stress. Notable is the finding by Rector and Roger [252] that individuals who received a manipulation to increase state self-esteem had a lower heart rate (HR) in response to a stressful social performance task compared to those who received a neutral manipulation. In line with these laboratory studies, Smith, Birmingham, and Uchino [253] found a positive association between ambulatory measured social evaluative threat and blood pressure. In a related study, Levy et al. [57] subliminally primed older individuals with words related to either positive or negative age stereotypes (e.g., wise, insightful or Alzheimer and decline) and cardiovascular activity was continuously measured during a stressful task. Results showed that positive priming directly decreased blood pressure and skin conductance and attenuated the responses during the stressful task. That is, it appeared to protect against stress-related physiological reactivity whilst negative priming had the opposite effect. These studies suggest that high self-esteem may act as a buffer against the negative physiological effects of a stressor. Considering this, it will be interesting to see if increasing implicit self-esteem using SEC can provide a buffer against stress and results in a reduced cardiovascular reaction to a stressor.

To date, no study has investigated whether SEC can provide a buffer against physiological stress. The aim of this experiment—which was conducted simultaneously with Experiment 1—was to examine whether SEC had an effect on self-esteem and cardiovascular (re)activity to a stressor. On the basis of previous literature, an increase in implicit and explicit self-esteem was expected in the EC compared to the CC. With regard to the cardiovascular activity, we expected (a) a decrease in blood pressure and HR during the SEC compared to baseline (as a direct effect) and (b) a decrease in blood pressure and HR reactivity in response to a stressor in the EC compared to the CC.

Method

Participants. The study was approved by the internal review board of Leiden University (CEP nr. 8812891384) and students were included if they (a) had not participated in Experiment 1 and (b) had a minimum score of 45 or higher on the PSWQ. This cut-off score can be used to screen for generalized anxiety disorder [104] and ensured that participants were high worriers (and thus at a greater risk for CVD and low self-esteem, making it a clinically interesting sample). Participants were selected based on their level of worry and not self-esteem, because we did not want to give away the focus of the study by using a self-esteem questionnaire. Sample size was based on the power analysis reported in Experiment 1. Seventy-seven individuals participated, including 11 males. The mean age was 20.29 (SD = 2.01).

Materials. The SEC paradigm and questionnaires were identical to Experiment 1. In contrast to Experiment 1, all measures were completed directly after the SEC paradigm and no follow-up measures were conducted. Blood pressure was measured continuously throughout the experiment using the Finometer MIDI (Finapres Medical Systems BV, the Netherlands) by placing a cuff around the middle finger of the nondominant hand. SBP and DBP were computed using a customized script in Matlab (version R2012b). Pulse in beats per minute was calculated from the blood pressure data, because it can be used as an indicator of HR. To obtain a baseline measure of physiological activity, a 10-min nature documentary was shown. The first 9 min were used to recover from previous activity, and the final minute was used to calculate a baseline measure of SBP, DBP, and HR.

Procedure. People who were interested in participating could complete the PSWQ online to determine whether their worry level was sufficiently high (i.e., 45 or higher). If this was the case, a laboratory appointment was scheduled. During the laboratory appointment, participants were consented, and they were connected to the apparatus used to measure physiological activity during the entire experiment. Next, participants answered demographic and biobehavioral questions after which the 10-min nature documentary was shown. The SEC paradigm automatically started at the end of the movie, and participants were randomized into either the EC or CC. Afterwards, the experimenter entered the room and started the stress induction, which was a speech preparation based on Field and Powell [254]. Participants were told that they had to give a speech at the end of the experiment that reflected their opinion on the unrest in Syria (which was an important and recurring news item at the time of the experiment). Participants were told that the speech had to be given in front of a camera, and that they would be judged by the experimenter on their social and communication skills. Other psychologists from the department would also view the recording at a later moment and perform similar ratings. At this point, the experimenter setup a camera next to the computer and indicated that the camera would start recording at the start of the speech. Two anticipation periods were included; these periods could be used for preparation and making notes. The first one lasted 2 min and was scheduled directly after the stress induction instructions. This was followed by the IAT, IPANAT, explicit affect measure, awareness check, and the second anticipation period (lasting 1 min). After this, participants were informed that no speech had to be given and, similar to Experiment 1, they received the first debriefing. A week later, participants completed the RSES online, and they received the second (true) debriefing. Participants were rewarded money or course credit.

Statistical analyses. The analyses of the psychological outcome measures were similar to Experiment 1; however, all analyses were tested two-sided (because the effect of SEC on stress induction had not been previously studied). For the physiological outcomes—SBP, DBP, and HR—mean levels per minute were calculated for the manipulation, the anticipation 1 and 2 phases. To ensure the reliability of the physiological data, averages were only analyzed when less than 35% of the data in that minute was used to calibrate the blood pressure signal by the Finometer.

Multilevel analyses were used to examine whether there was a direct effect of SEC on cardiac activity (i.e., SBP, DBP, and HR). For each of the physiological outcomes, a multilevel model was built including the predictor time (i.e., 0 = last minute of baseline, 1 to 3 = 3 min of the manipulation phase), condition (i.e., 0 = CC, 1 = EC) and Time X Condition. The interaction allowed us to examine whether cardiac activity during the manipulation decreased as a result of SEC. Furthermore, to examine whether SEC affected cardiac reactivity to stressors, three additional models were built with similar predictors. However now, the predictor time included not only the baseline and the manipulation phase (3 min) but also the first anticipatory stressor phase (2 min) and the second anticipatory stressor phase (1 min).

Besides focusing on the hypothesis that the self-esteem manipulation would affect cardiovascular reactivity, we explored whether trait self-esteem was associated with cardiovascular reactivity to the stressor. Enhanced reactivity to the stressor might be expected in people with low self-esteem, if self-esteem is indeed related to somatic health. To do so, multilevel analyses were used with cardiovascular responses to the speech preparation as outcome (i.e., anticipatory stressor phases) and trait self-esteem as predictor. The models were controlled for baseline levels of physiological activity.

Results

Descriptive statistics. Of the 77 participants, 38 were in the CC and 39 were in the EC. The conditions did not differ on the descriptive or biobehavioral variables, vor on trait worry or trait self-esteem (see Table 1).

One participant stopped with the experiment after the IAT. For this participant, only part of the data were available and no physiological data were saved. Physiological data of seven participants were not included (although their exclusion did not change the results). Therefore, the physiological data of 70 participants were analyzed. The baseline levels of SBP, DBP, and HR did not significantly differ between conditions (Table 1).

Psychological outcomes. The estimated Bayes factor for implicit self-esteem indicated anecdotal evidence—formerly known as 'barely worth mentioning'—for the null-hypothesis, with $t(75) = -1.06$ and JZS $BF_{10} = 0.38$. The same was true for explicit self-esteem, with $t(74) = -1.13$ and JZS $BF_{10} = 0.41$. Moreover, exploratory analyses indicated that there was no moderation of condition by trait worry or trait self-esteem. Furthermore, moderate to anecdotal evidence for the null-hypothesis was found for implicit positive and negative affect, and explicit positive and negative affect (implicit positive affect: $t(74) = 0.33$, JZS $BF_{10} = 0.25$; implicit negative affect: $t(74) = 1.26$, JSZ $BF_{10} = 0.47$; explicit positive affect: $t(74) = -1.33$, JZS $BF_{10} = 0.51$ and explicit negative affect: $t(74) = 1.54$, JZS $BF_{10} = 0.66$). All in all, implicit and explicit self-esteem and affect did not differ between conditions as a result of SEC (see Table 1 for means and

SD's per condition).

Physiological outcomes. To examine whether SEC directly affected cardiac activity during the manipulation phase, multilevel models were built for SBP, DBP, and HR (see Table 2). The nonsignificant interaction effects show that SBP, DBP, and HR did not differ significantly over time between conditions (resp. B = −0.46 with *p* = .818, B = −0.12 with *p* = .923 and B = −0.02 with *p* = .990). This indicates that SEC did not affect cardiac activity during the manipulation phase.

The multilevel models for SBP, DBP, and HR showed an increase in physiological activity over time for all participants, resp. B = 4.14 with *p* < .001, B = 2.13 with *p* < .001, and B = 1.84 with *p* < .001 (see Table 2). Specifically, physiological activity increased at the start of the stressor (anticipatory stressor phase 1) and remained high during the second anticipatory stressor phase (see Figure 1). However, contrary to our hypothesis, the Time x Condition interaction was not significant for any of the physiological outcomes. This indicates that participants in the EC did not have a lower cardiovascular response in reaction to the stressor compared to the CC.

Moreover, the multilevel models showed that trait self-esteem was negatively associated with increased SBP and DBP in response to the stressor (resp. B = −0.89, *p* < .001 and B = −0.31, *p* = .003). Trait self-esteem was not significantly associated with the HR response to the stressor (B = −0.25, *p* = .074). Considering that SEC was not effective, we also explored whether cardiovascular reactivity in response to the stressor varied as a function of state self-esteem and implicit self-esteem. However, cardiovascular reactivity to the stressor was not associated with state self-esteem (SBP: B = 0.06, *p* = .462; DBP: B = 0.04, *p* = .318; HR: B = 0.06, *p* = .276) or implicit self-esteem (SBP: B = 0.30, *p* = .877; DBP: B = 1.54, *p* = .115; HR: B = 1.35, *p* = .301).

TABLE 2 Results of the multilevel models predicting cardiac activity in Experiments 2 and 3

	Systolic blood pressure			Diastolic blood pressure			Heart rate[a]			Log-transformed RMSSD		
Predictor	B (SE)	*t*	*p*	B (SE)	*t*	*p*	B (SE)	*t*	*p*	B (SE)	*t*	*p*
Experiment 2												
Effect of SEC during manipulation phase												
Intercept	123.12 (2.70)	45.55		61.49 (1.74)	35.39		77.81 (1.88)	41.30				
Time	2.53 (1.46)	1.73	.084	1.30 (0.94)	1.39	.166	-0.11 (1.02)	-0.11	.915			
Condition	-2.50 (3.71)	-0.67	.501	-1.56 (2.38)	-0.65	.514	1.85 (2.58)	0.72	.474			
Time X Condition	-0.46 (1.99)	-0.23	.818	-0.12 (1.28)	-0.10	.923	-0.02 (1.39)	-0.01	.990			
Effect of SEC during manipulation phase and anticipatory stressor phases												
Intercept	121.98 (2.23)	54.60		60.87 (1.35)	45.15		75.60 (1.57)	48.01				
Time	4.14 (0.62)	6.70	.000**	2.13 (0.37)	5.72	.000**	1.84 (0.43)	4.23	.000**			
Condition	-2.90 (3.07)	-0.94	.345	-1.99 (1.85)	-1.08	.282	2.29 (2.16)	1.06	.290			
Time X Condition	-0.16 (0.85)	-0.19	.852	0.24 (0.51)	0.46	.644	-0.33 (0.60)	-0.55	.584			
Experiment 3												
Intercept	130.56 (2.84)	45.92		72.57 (1.74)	41.80		80.62 (1.61)	50.10		1.46 (0.03)	45.53	
Time	3.73 (1.52)	2.45	.015*	1.42 (0.93)	1.53	.128	0.07 (0.86)	0.08	.938	0.03 (0.02)	2.00	.047*
Condition	-6.51 (3.84)	-1.69	.092	-2.19 (2.35)	-0.93	.352	-2.90 (2.26)	-1.28	.201	0.04 (0.04)	0.88	.378
Time X Condition	-1.65 (2.05)	-0.80	.424	-0.46 (1.25)	-0.37	.712	0.09 (1.21)	0.07	.943	-0.03 (0.02)	-1.09	.277

Note. B = coefficient; RMSSD = root mean square of successive differences; SE = standard error of the coefficient.

[a] In Experiment 2 heart rate is calculated from the blood pressure data and in Experiment 3 heart rate is measured using an electrocardiogram.

* = $p < .05$.

** = $p < .01$.

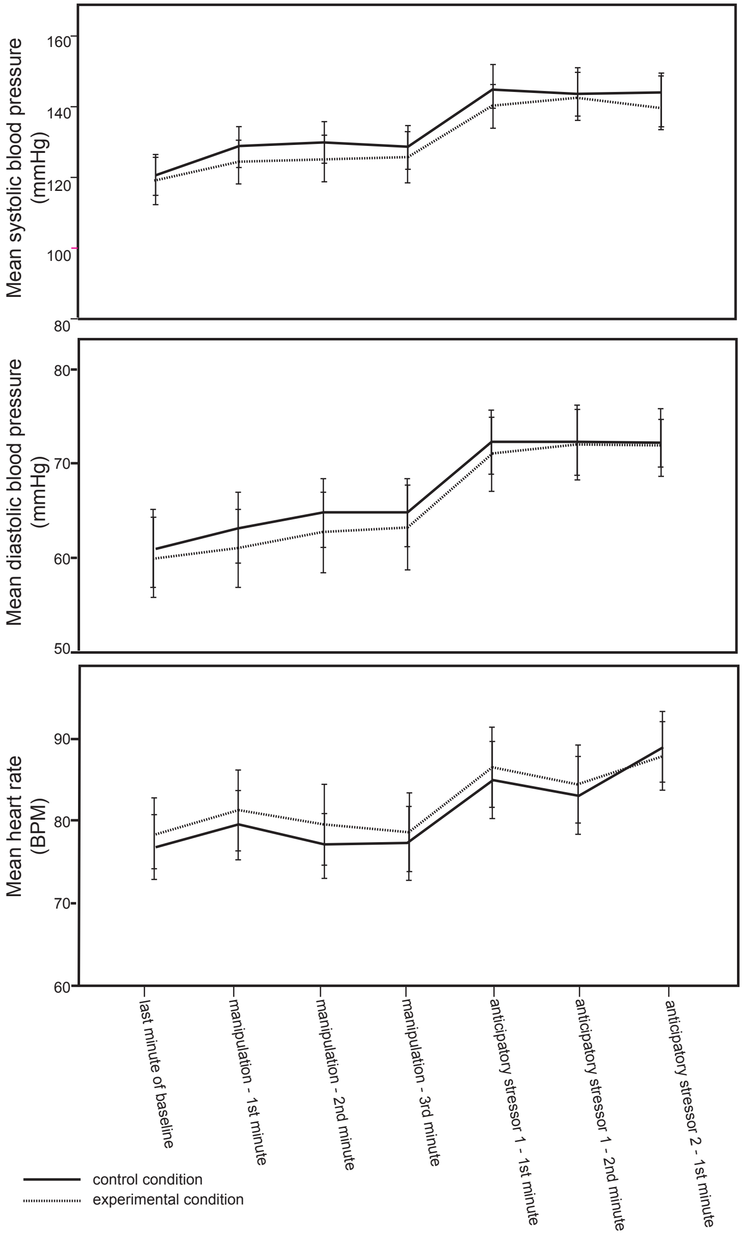

Figure 1 Line graphs representing the mean systolic and diastolic blood pressure, and heart rate in beats per minute (BPM) per condition during baseline, the self-esteem manipulation, and during the anticipatory stressor periods (Experiment 2). Error bars represent ± 2 SE.

EXPERIMENT 3

The findings of Experiment 1 and 2 suggest that SEC, in its current format, is ineffective in increasing self-esteem, decreasing cardiovascular activity and cardiovascular reactivity in response to a stressor. Therefore, the aim of the third experiment was to use an adjusted, ‘personalized’ and therefore more ‘intense’ version of SEC. In addition, a personalized and therefore more ‘sensitive’ version of the IAT was used. Together they were expected to result in a larger effect. The performed adjustments were based on changes that have been made to the original IAT by Olson and Fazio [255]. Specifically, Olson and Fazio personalized the IAT by replacing the more general category labels *pleasant* and *good* with respectively *I like* and *I don’t like*. The personalized IAT thereby focuses more on personal attitudes versus generally held attitudes. Multiple experiments have indeed shown that this personalization reduced the extrapersonal associations. That is, associations that are available in memory but are irrelevant to one’s own evaluation (e.g., other people’s attitude about what is considered pleasant) [255-257]. Additionally, the personalized IAT had a stronger relation to behavioral intentions and behavior, and was better able to detect attitude change compared to the original IAT. In a like manner, we personalized the SEC labels (i.e., change ‘I’ to ‘I am’), which was expected to result in a larger positive effect on self-esteem. To explain, in a personalized SEC task the positive words directly target the person (i.e., ‘I am’) instead of targeting the *self* (i.e., ‘I’), which might represent a more generally held view of the self, for example, how one *should see* oneself.

It was investigated whether the personalized SEC increased implicit self-esteem, as measured by the personalized self-esteem IAT, and directly decreased cardiovascular activity. In order to study the effect on cardiovascular activity more accurately, the cardiovascular reactivity to a stressor was not included in the current experiment, because the inclusion of a stressor might mask potential (small) effects of SEC on cardiovascular activity. Considering that—as mentioned above—a subliminal positive priming paradigm has been shown to directly reduce blood pressure [57], we expected a decrease in cardiovascular activity as a direct result of SEC. Additionally, the effect of personalized SEC on explicit self-esteem and affect (both implicit and explicit) were explored during the experiment.

Method

Participants. The study was approved by the internal review board of Leiden University (CEP nr. 2989963000). High-worrying participants were selected using the same procedure and inclusion criteria as Experiment 2. However, participants were only included when they had not participated in either Experiment 1 or 2. A power analysis, using the averaged effect size of Dijksterhuis [78], Grumm et al. [79], and Experiment 1 and 2 (i.e., d = 0.73), indicated that 25 participants per condition was sufficient to find an effect (with α = .05 and 80% power). To allow for potential exclusion, a higher number (i.e., n = 81) of participants were included (88% female) with a mean age of 20.40 (SD = 2.22).

Materials. The materials were largely equivalent to Experiment 2; only the self-esteem manipulation (SEC) and measure of implicit self-esteem (IAT) were adjusted. The SEC was personalized by the following change: instead of displaying *Ik* (Dutch for 'I'), the words *Ik ben* (Dutch for 'I am') were shown. Furthermore, the personalized version of the self-esteem IAT was used [258]. This IAT has the same arrangement of blocks, but the positive and negative category labels were replaced by *I like* and *I don't like* (in Dutch respectively 'ik vind dit leuk' and 'ik vind dit niet leuk'). In line with Experiment 1 and 2, five words were used per category. This is in contrast with Olson et al. [258] who used 10 or 20 different words per category. However, Greenwald, McGhee, and Schwartz [217] found comparable effects for IAT's that used either five or 25 words per category. Lastly, error feedback was removed [255, 258].

SBP and DBP were measured using the same equipment as in Experiment 2. HR and heart rate variability (HRV) were measured by placing three electrodes on the upper body using the BIOPAC MP150 system [BIOPAC Systems Inc., USA]. HRV refers to the variability and periodic changes in HR (i.e., variation in inter-beat intervals) and is a measure of parasympathetic nervous system activity [35, 259]. The root mean square of successive differences (RMSSD) was used as an index of HRV. A customized script in Matlab (version R2012b) was used to compute SBP, DBP, HR, and RMSSD. The data was visually inspected to detect and exclude incorrectly identified R-peaks. Similar to Experiment 2, the final minute of the documentary was used as a baseline measure of cardiac activity.

Procedure. The procedure was similar to Experiment 2, except that this time only cardiac activity was measured and no reactivity to a stressor. The experiment began by signing the informed consent. Afterwards participants were connected to the apparatuses that measured cardiac activity throughout the experiment. The sequence of tasks was comparable to Experiment 2, but without the stress induction. After completing all the tasks, participants received a first debriefing (like Experiment 1 and 2). A week later, participants completed the RSES online and a second (true) debriefing was given. Participants received money or course credit for participating.

Statistical analyses. The psychological outcome measures were analyzed in the same way as in Experiment 2. For SBP, DBP, HR, and RMSSD mean scores were calculated for the manipulation phase. Again, the blood pressure data was only analyzed when less than 35% of the data in a minute was used to calibrate the blood pressure signal.

To examine whether SEC had a direct effect on cardiac activity in the absence of a stressor, multilevel models were built for each dependent variables (i.e., SBP, DBP, HR, and RMSSD). The models included the predictor time (i.e., 0 = final minute of baseline, 1 to 3 = 3 min of the manipulation phase), condition (i.e., 0 = CC, 1 = EC) and the interaction between time and condition. This enabled us to examine whether cardiac activity changed over time as a result of SEC and whether this change was different between conditions.

The RMSSD data was log-transformed. The untransformed means and standard deviations are reported in the Results. An additional Pearson correlation was done to explore whether HR calculated using the blood pressure data (as was done in Experiment 2) was positively associated with HR as measured with the electrocardiogram (i.e., considered the more standard measurement).

Results

Descriptive analyses. One participant stopped with the experiment while watching the documentary. Resulting in 80 participants, of whom 39 were allocated to the CC and 41 to the EC. The descriptive variables, biobehavioral variables, trait worry, and trait self-esteem did not differ between conditions (see Table 1).

Physiological data of 13 participants was excluded from the analyses (i.e., inclusion of these participants did not change the overall found results). Moreover, blood pressure data of three participants was excluded, and HR and RMSSD data of two participants was excluded. So the blood pressure analyses included data of 64 participants and the HR/RMSSD analyses included data of 65 participants. The baseline levels of SBP, DBP, HR, and log-transformed RMSSD did not significantly differ between conditions (see Table 1). In the final sample, there was a significant positive correlation between HR calculated using the blood pressure data and HR measured with an electrocardiogram ($r = .99$, $p < .001$).

Psychological outcomes. For implicit and explicit self-esteem, the estimated Bayes factors found moderate support for the null-hypothesis (resp. $t(78) = -0.08$, JSZ $BF_{10} = 0.23$ and $t(78) = -0.23$, JSZ $BF_{10} = 0.24$). Exploratory analyses again showed that there was no moderation of condition by trait worry or trait self-esteem. The results for implicit positive and negative affect and explicit positive and negative affect were comparable to the self-esteem results (implicit positive affect: $t(78) = -0.80$, JSZ BF_{10} = 0.31; implicit negative affect: $t(78) = -0.73$, JSZ $BF_{10} = 0.29$; explicit positive affect:

$t(78) = 0.76$, JSZ $BF_{10} = 0.30$ and explicit negative affect: $t(78) = -0.43$, JSZ $BF_{10} = 0.25$). In short, the levels of self-esteem and affect did not differ between the two conditions. The means and standard deviations per condition are displayed in Table 1.

Physiological outcomes. As can be seen in Table 2, the interaction between time and condition was not significant for SBP, DBP, HR, or RMSSD. This demonstrates that the change over time in cardiac activity during the manipulation phase did not differ significantly between the EC and CC. So, SEC did not have an impact on cardiac activity. Yet there was a significant effect of time on SBP and RMSSD. As can be seen in Figure 2 and Table 2, SBP and RMSSD increased slightly for all participants over time (resp. B = 3.73, $p = .015$ and B = 0.03, $p = .047$).

GENERAL DISCUSSION

In three experiments, we examined whether SEC increased implicit and explicit self-esteem by repeatedly coupling the self with positive affective words (subliminally), thereby testing whether increased self-esteem moderates the effect of a stressor. Altogether, the experiments failed to proof the effectiveness of SEC for improving self-esteem, affect, cardiovascular activity, and reactivity. As implicit self-esteem was not increased using SEC, we were unable to examine whether an implicit process manipulation can affect physiology activity. In other words, the findings failed to test whether unconscious or unreported processes can have an effect on physiological activity [38]. The results from Experiment 2 showed that individuals with high trait self-esteem had lower SBP and DBP responses to the stressor. Specifically, all individuals showed an increased cardiovascular response in reaction to the stressor, but this increase in reactivity was higher in individuals with low trait self-esteem and greater reactivity in response to a stressor is associated with poorer cardiovascular health [260]. However, this finding did not vary as a function of state self-esteem or implicit self-esteem. This latter finding is not in line with the idea that unconscious levels of stress can be associated with physiological activity [38], but the finding must be interpreted with caution as it is based on exploratory analyses.

In Experiment 1, it was found that SEC did not increase implicit or explicit self-esteem directly after the manipulation. Likewise, 2 hr after the manipulation, no effects were found on implicit self-esteem or on affect (both implicit and explicit). In Experiment 2, similar null-findings were obtained for self-esteem and affect (both implicit and explicit) in high worrying participants. Additionally, SEC had no effect on cardiovascular reactivity (i.e., SBP, DBP, and HR) in response to a stressor. In Experiment 3, the effect of a personalized SEC task was examined in high worrying participants and implicit

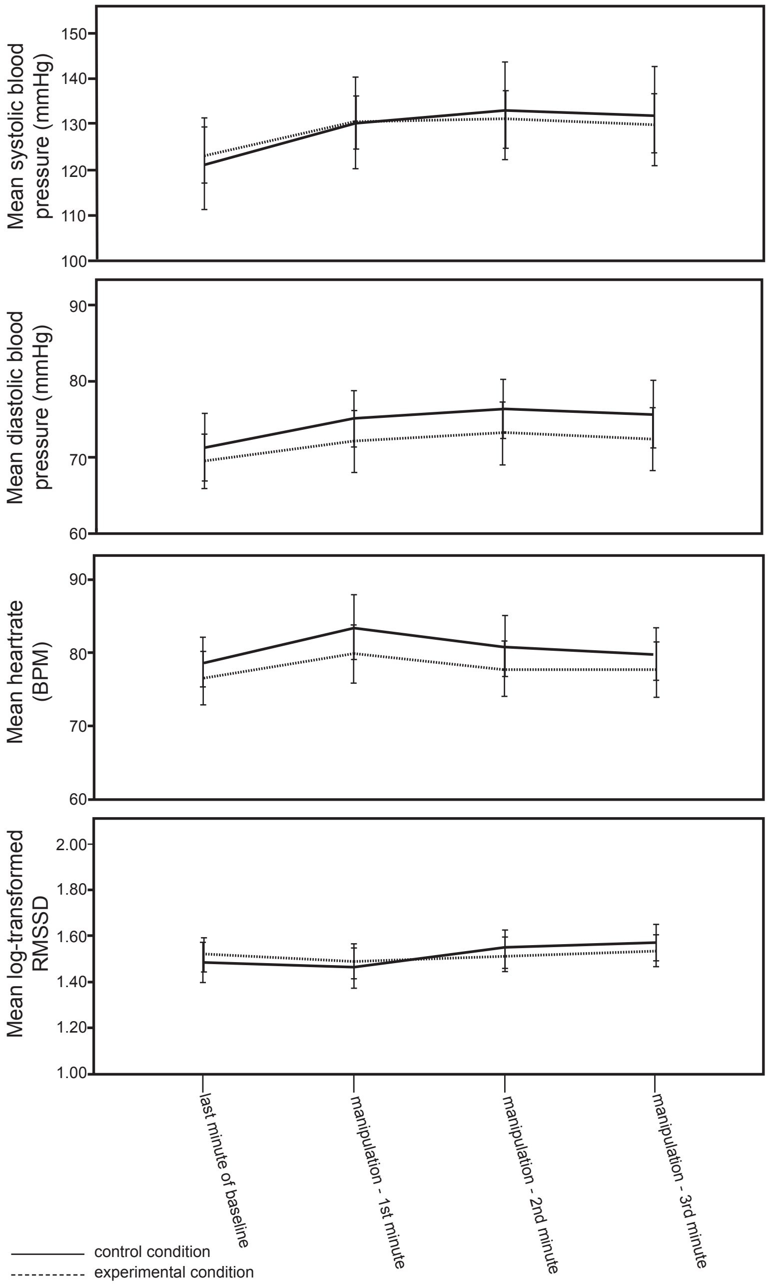

Figure 2 Line graphs representing the mean systolic and diastolic blood pressure, heart rate in beats per minute (BPM), and the root mean square of successive differences (RMSSD) per condition during baseline and during the self-esteem manipulation (Experiment 3). Error bars represent ± 2 SE.

self-esteem was measured in a personalized manner. Again, SEC had no effect on self-esteem, affect or on cardiac activity during the experiment. However, an increase over time in SBP and RMSSD was observed in all participants.

Explaining Null-Findings

Our findings are in contrast with previous research on SEC (e.g., [78, 79]). One strength of the current studies—when compared to these previous studies—are the consistent findings across three studies with large sample sizes (*n* between 77 and 84). Several explanations can be brought forward to explain the difference in findings. First, in the current studies, a different version of the IAT was used to measure implicit self-esteem. Specifically, a validated measure of the IAT [243] was used instead of a shortened version of the IAT, which was used in the previous studies (i.e., [78, 79]). By using fewer trials in a reaction time task—like the IAT—the measure is more vulnerable to problems of unreliability [220]. Therefore, it is possible that previously reported positive effects on implicit self-esteem are the result of an inaccurate measurement of implicit self-esteem.

Although the original IAT is less vulnerable to unreliability than the shortened version, the IAT itself might reduce the effects of SEC. To explain, the IAT pairs self-words with either positive or negative words and in this way could be considered a manipulation of implicit self-evaluations. However, if there was an effect of SEC, it seems unlikely that this effect was completely mitigated with the use of the original IAT as 50% of trials were positive and 50% were negative, and previous evaluative conditioning studies have found effects on this measure (e.g., [261]).

Another explanation for the null-indings relates to the sample of high worrying participants that were targeted in Experiments 2 and 3. As there is a negative association between worry and self-esteem [94], it is conceivable that the negative self-image in high-worrying individuals is more heavily ingrained compared to low-worrying individuals. Therefore, it might be more difficult to change implicit self-esteem in high-worrying individuals using SEC. Yet the effect of SEC on self-esteem was not moderated by trait worry or trait self-esteem in Experiments 1 to 3. This indicates that initial levels of worry (or self-esteem) did not have an impact on the effectiveness of SEC.

Changing Implicit Attitudes

The null-findings regarding SEC are inconsistent with the dual-system theory [234, 235], because an associative learning procedure that targeted self-related associations did not affect implicit self-esteem. Even though research has shown that implicit attitudes can change [262, 263], the specific process and the number of required trials underlying this attitude change are not fully known. Gregg et al. [262] examined the process of attitude change by using a series of experiments in which the induction and reversing of implicit attitudes for fictional social groups was studied. The results demonstrated that implicit attitudes—once formed—are quite resistant to change. Nevertheless, Rydell et al. [263] showed that change in implicit attitudes can be accomplished (albeit more slowly), but that change happens linearly. That is, when providing more counter attitudinal information (e.g., 'I' + 'smart' in individuals with low self-esteem), more change in implicit self-esteem is obtained. These studies, however, used supraliminal information to change implicit attitudes, and it is unknown whether this change can also be expected with subliminally presented stimuli. A meta-analysis suggests that the effectiveness of evaluative conditioning varies depending on whether the conditioned or unconditioned stimuli is presented subliminally or supraliminally [264]. To date, a comprehensive study incorporating a cross-over design in which the conditioned and unconditioned stimuli are presented subliminally and supraliminally is missing. Additionally, it is unknown how many trials would be needed to accomplish a change in implicit attitudes, making this an interesting venue for future research.

Limitations

A limitation is that no baseline measure of state self-esteem was included. It is therefore possible that there were baseline differences between conditions, and these differences could have obscured an increase in self-esteem in the EC. Yet it is unlikely that baseline differences in implicit self-esteem have masked the effect of SEC. First, even though the chance exists that there were baseline differences in self-esteem between conditions in one experiment, the chances are low that this would have occurred in all three experiments, especially considering the large sample sizes. Second, trait self-esteem did not differ between conditions. Altogether, it is improbable that baseline differences in self-esteem are the reason for the null-findings.

A second limitation pertains to the measurement of implicit self-esteem. Psychometric properties of implicit measures are generally considered to be weak [220] and may not correctly measure implicit attitudes. Nevertheless, the IAT is considered the most promising (e.g., acceptable stability over time and predictive validity) [220, 221].

Another limitation is the unequal distribution of males and females across the three experiments (88% female, 213/242). It would be useful to examine whether the findings generalize to male populations.

Conclusion

No effects were found of SEC on implicit or explicit self-esteem or affect in either the general student population or in high-worrying students. Furthermore, SEC had no effect on cardiac reactivity to a stressor or on cardiac activity in high-worrying students. It was shown that individuals with higher trait self-esteem had lower SBP and DBP in response to the stressor, possibly suggesting that people high in self-esteem show lower cardiovascular responses to stressful events. Our results do not support the use of SEC as an intervention. Future studies should more thoroughly examine whether subliminal stimuli—compared to supraliminal stimuli—can indeed be used to change implicit attitudes, and whether increasing the number of SEC trials has an effect on the outcomes. As stress is common and is associated with a range of negative consequences, it is important that—preferably short and cost-effective—evidence-based interventions become available.

6

APPENDIX 1 Methodological details of the subliminal evaluative conditioning task and the Implicit Association Test

Words used in the subliminal evaluative conditioning task (Experiments 1-3)

Experimental condition	Control condition
warm (warm)	balpen (ball pen)
lief (sweet)	emmer (bucket)
aardig (nice)	duim (thumb)
oprecht (sincere)	ingang (entrance)
eerlijk (honest)	deur (door)
mooi (beautiful)	voetpad (footpath)
vrolijk (cheerful)	hek (fence)
slim (smart)	raam (window)
sterk (strong)	lade (drawer)
wijs (wise)	staan (to stand)
gezond (healthy)	melk (milk)
leuk (funny)	jas (coat)
blij (happy)	tas (bag)
prettig (nice)	bord (board)
positief (positive)	scherm (screen)

Note. The positive words in the experimental condition are derived from Dijksterhuis (2004) and the neutral words in the control condition are derived from De Houwer, Hendrickx, and Baeyens (1997).

Words used in the Implicit Association Test (Experiment 1[a] - Experiment 2)

Self category	Other category	Positive category	Negative category
ik (I)	zij (they)	geluk (happiness)	bom (bomb)
mezelf (myself)	anderen (others)	zomer (summer)	kanker (cancer)
mij (me)	hun (their or theirs)	lach (smile)	coma (coma)
zelf (self)	zjin (his)	strand (beach)	gemeen (mean)
mijn (mine)	haar (her)	zon (sun)	hel (hell)

Note. Words were selected from Dijksterhuis (2004).
[a]These words were only used in the first Implicit Association Test.

Words used in the Implicit Association Test (Experiment 1[a])

Self category	Other category	Positive category	Negative category
ik (I)	zij (they)	vreugde (joy)	dood (death)
mezelf (myself)	anderen (others)	warmte (warmth)	gif (poison)
mij (me)	hun (their or theirs)	plezier (pleasure)	pijn (pain)
zelf (self)	zjin (his)	paradijs (paradise)	tragedie (tragedy)
mijn (mine)	haar (her)	vrede (peace)	ziekte (sickness)

Note. Words were selected from Greenwald and Farnham (2000).
[a]These words were only used in the second Implicit Association Test.

Words used in the Implicit Association Test (Experiment 3)

Self category	Other category	Positive category	Negative category
ik (I)	zij (they)	vrijheid (freedom)	moord (murder)
mezelf (myself)	anderen (others)	liefde (love)	ziekte (sickness)
mij (me)	hun (their or theirs)	vrede (peace)	ongeluk (accident)
zelf (self)	zjin (his)	vriend (friend)	dood (death)
mijn (mine)	haar (her)	plezier (pleasure)	vergif (poison)

Note. Words were selected from Olson and Fazio (2004).

Category names and the number of traisl per block as used in the Implicit Association Test

Block	Left categor(y)(ies)	Right category (y)(ies)	Number of trials
1.	self	other	20
2.	positive	negative	20
3.	self	other	20 practice trials + 40
	positive	negative	
4.	negative	positive	20
5.	self	other	20 practice trials + 40
	negative	positive	

Note. Words were selected from Olson and Fazio (2004).