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EMOTION REGULATION RELATED CHANGES IN *CORRUGATOR SUPERCILII*
ACTIVITY AND SKIN CONDUCTANCE RESPONSE: A COMPARISON OF
DISTRACTION AND FOCUSED BREATHING

Research Paper

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Running head: Comparison of distraction and focused breathing

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Emotion Regulation Related Changes in *Corrugator Supercilii* Activity and Skin
Conductance Response: A Comparison of Distraction and Focused Breathing

Abstract

The present study investigated the effectiveness of two attentional deployment emotion regulation strategies, distraction and mindfulness-based focused breathing. *Corrugator supercilii* activity and skin conductance responses were recorded while 56 participants viewed neutral, low intensity and high intensity negative pictures during a control condition, implementation of distraction and focused breathing and later re-exposure. Distraction was hypothesized to be more effective in immediately lowering high intensity negative emotions and focused breathing to have better lasting effects. *Corrugator supercilii* activity and skin conductance results showed no significant differences between the two strategies, while focused breathing was more effective in lowering self-reported negative affect than distraction. Neither physiological data nor self-reported ratings revealed any significant differences or effects of the two strategies during re-exposure.

Keywords: emotion regulation, mindfulness, attentional deployment, distraction, focused breathing, EMG, SCR, affective pictures

Tähelepanu kõrvale juhtimise ja hingamisele keskendumise võrdlus: emotsioonide reguleerimisega seotud muutused kulmukortsutaja lihase aktiivsuses ja naha elektrijuhtivuses

Kokkuvõte

Käesolev uurimistöö uuris kahe tähelepanu juhtimise kaudu toimiva emotsiooni regulatsiooni strateegia, tähelepanu kõrvale juhtimise ja teadvelolekul põhineva hingamisele keskendumise efektiivsust. Selleks mõõdeti 56 osaleja kulmukortsutaja lihase aktiivsuse ning naha elektrijuhtivuse muutust vastusena neutraalsetele ja madala ning kõrge intensiivsusega negatiivsetele piltidele kontrolltingimuses, tähelepanu kõrvale juhtimise tingimuses ja hingamisele keskendumise tingimuses ning piltide hilisemal taasesitamisel. Eeldati, et tähelepanu kõrvale juhtimine on kõrge intensiivsusega negatiivsete emotsioonide reguleerimisel esialgu tõhusam, ent hingamisele keskendumisel on paremad kestvamad regulatsiooniefektid. Kulmukortsutaja lihase aktiivsus ja naha elektrijuhtivuse tase kumbki ei näidanud kahe strateegia tõhususe vahel erinevusi. Subjektiivsete hinnangute kohaselt oli aga hingamisele keskendumine negatiivse afekti vähendamisel esialgu tõhusam kui tähelepanu kõrvale juhtimine. Kestvamaid regulatsiooniefekte ei näidanud kumbki strateegia ei taasesituse aegsete füsioloogiliste näitajate ega subjektiivsete hinnangute põhjal.

Märksõnad: emotsiooni regulatsioon, teadvelolek, tähelepanu juhtimine, tähelepanu kõrvale juhtimine, hingamisele keskendumine, EMG, naha elektrijuhtivus, afektiivsed pildid

Emotions guide attention to salient environmental stimuli, generally improve decision making and enhance episodic memory (Gross, 2014; Scherer, 1982). However, when emotional responses are inappropriate for the present situation, they can lead to interpersonal conflict, poor decisions and mental health issues among other problems (Berking & Wupperman, 2012; Gross & Munoz, 1995; Halperin, 2013; Hu et al., 2014; Mulki, Jaramillo, Goad, & Pesquera, 2015; Repetti, Taylor, & Seeman, 2002). As a result, people often regulate their emotions to achieve a more appropriate affective state (Gross, 1998b; Thompson, 1994). This can happen intrinsically or extrinsically and consciously or unconsciously, meaning that people can regulate their own or other people's emotions and can do so deliberately or automatically (Gross, 2014). Emotion regulation (ER) can be used to either amplify or decrease negative or positive emotions (Parrott, 1993). Oftentimes ER serves a hedonic purpose, which results in the desire to decrease negative emotions and increase positive emotions (Gross, Richards, & John, 2006; Larsen, 2000). However, ER can also be used to increase negative emotion, for example working yourself up before a fight, or decreasing positive emotion, like reducing amusement during a serious work meeting (Tamir, Mitchell, & Gross, 2008). That said, the current research paper focuses on the effectiveness of intrinsic down-regulation of negative emotional responses.

There are many different strategies to regulate one's emotions. One approach to classifying all the possible ER techniques is the process model of ER (Gross, 1998b). The process model is based on the modal model of emotion (Barrett, Ochsner, & Gross, 2007; Gross, 1998a), where emotion generation is described through a situation-attention-appraisal-response sequence. According to the modal model, an emotion episode starts with an internally or externally relevant situation. Salient aspects of the situation are attended to and then assessed during the appraisal phase. That assessment, in turn, gives rise to the multicomponent emotional response, that entails experiential, behavioural and physiological changes (Gross, 2014). For example, you hear about the devastating effects of climate change on the radio (*situation*), you focus on the hosts saying that if humans do not act fast, the planet will become unliveable in the near future (*attention*). You evaluate the situation as highly threatening (*appraisal*), making you feel anxious and raising your heart rate (*response*).

According to the process model (Gross, 2014), ER can take place at every stage of the emotion generation sequence. The emotion can be regulated prior to the situation by *situation selection*. Following the previous example, the emotion-eliciting situation could be avoided altogether by not listening to the radio. The emotion can also be regulated during the situation through *situation modification* by turning off the radio when the hosts start to talk about climate

change. During the attention phase, emotion can be regulated through *attentional deployment*. This can be done by distracting yourself from the radio show by thinking about what to cook for dinner or by picking up your smartphone to check social media. *Cognitive change* can be applied to regulate emotion during the appraisal phase by changing how you view the situation. Instead of thinking of the situation as highly threatening, you might think that surely it cannot be as severe or that governments will take action to eliminate the threat. Another way to regulate emotion is via *response modulation* by altering the already generated emotional response. As an example, negative emotion could be alleviated by eating something that creates satisfaction, such as ice cream.

ER is one of the fastest growing fields in psychological research (Gross, 2015). Despite this, mechanisms of individual ER strategies still need further investigation. In addition to just gaining knowledge and insight into different ER strategies from researching them, doing so also gives a better overview of which strategy works best in which situation so they could be recommended and implemented more effectively. As Gross (2001) has suggested, it is also important to not only investigate the immediate or short-term effects, which can be observed while the strategy is being implemented, but also the more lasting or long-term effects. The various immediate and lasting effects of different strategies are what make them unique and hence useful in different situations. This paper takes into focus the immediate and lasting effects of attentional deployment strategies, broadening the scope from classical ER to increasingly popular mindfulness.

Mindfulness and emotion regulation

Mindfulness has been defined as non-judgmental awareness of the present moment experience (Bishop et al., 2004; Farb, Anderson, Irving, & Segal, 2014; Kabat-Zinn, 1990; Shapiro, Carlson, Astin, & Freedman, 2006). Mindfulness is an adaptation of the Buddhist meditative practices that have a goal to reduce suffering and increase well-being (Hanh, 1976). Mindfulness differs from most ER approaches since it does not try to change the emotions in a hedonic way, but views every experience as it is in the moment, regardless of its uncomfortableness (Brown, Ryan, & Creswell, 2007). Any emotions and cognitions that arise are meant to be observed nonjudgmentally (Farb et al., 2014).

Differences and similarities between Western ER strategies and mindfulness derived from Buddhist meditation practices is an area of interest since the latter have been increasingly incorporated into Western therapies and self-help programs. A large amount of research has shown that mindfulness-based interventions reduce psychological distress both in clinical (Allen et al., 2006; Baer, 2003; Van Dam et al., 2018) as well as healthy populations (Shapiro,

Schwartz, & Bonner, 1998). However, the specific link between mindfulness and ER needs further investigation (Chambers, Gullone, & Allen, 2009; Roemer, Williston, & Rollins, 2015). Recent works have shown that mindfulness-based techniques are effective in reducing negative emotions and decreasing relapse in patients with anxiety or depression (Goldin & Gross, 2010; Kumar, Feldmann, & Hayes, 2008; Piet & Hougaard, 2011). Mindfulness has also been shown to reduce emotional reactivity in healthy individuals (Arch & Craske, 2006). When considering mindfulness from the perspective of the process model, it relies heavily on attentional deployment (Farb et al., 2014; Lindsay & Creswell, 2017; Naragon-Gainey, McMahon, & Chacko, 2017).

Attentional Deployment

As described earlier, attentional deployment strategies interfere with the emotion generation process during the attention stage (Gross, 2014). Situations compose of various aspects attention can be focused on and implementing attentional deployment would mean directing attention to another aspect of the situation (Gross, 2014). Attentional deployment is applied early in the emotion-generation process and is used mostly when changing the situation is difficult or impossible (Gross, 2014). Because attentional deployment restricts the processing of emotional info promptly, it is an effective ER strategy for down-regulating emotions with high intensity (Sheppes, Scheibe, Suri, & Gross, 2011).

One of the most common attentional deployment strategies is distraction (Naragon-Gainey et al., 2017; Thiruchselvam, Hajcak, & Gross, 2012). Distraction either focuses attention on less intense aspects of the emotion-eliciting situation or moves attention away from the situation entirely, either externally or internally (Thiruchselvam et al., 2012). If we follow the original example, external distraction would be picking up your smartphone to check messages or social media when you hear about the planet becoming unliveable, while internal distraction in the same situation would mean thinking about something else, like a shopping list. Empirical studies have shown that distraction is effective in down-regulating negative emotions (Broderick, 2005; Rusting & Nolen-Hoeksema, 1998; Van Dillen & Koole, 2007). Distraction has mainly been compared to reappraisal, a cognitive change strategy (Kanske, Heissler, Schönfelder, Bongers, & Wessa, 2011; McRae, Hughes, Chopra, & Gabrieli, 2010; Sheppes & Meiran, 2007; Sheppes & Meiran, 2009; Thiruchselvam, Blechert, Sheppes, Rydstrom, & Gross, 2011; Thiruchselvam et al., 2012). From this comparison, it can be said that distraction has an advantage in modifying high intensity emotions compared to reappraisal (Sheppes, 2014; Sheppes et al., 2011). Even though distraction is immediately effective, it is also an avoidance-oriented strategy that restricts the processing of affective information,

intervening with affective adaptation, hence making distraction inefficient in the long-term (Kross & Ayduk, 2008; Paul, Kathmann, & Riesel, 2016; Uusberg, Uusberg, Talpsep, & Paaver, 2016).

As previously mentioned, in the ER framework mindfulness can also be classified as attentional deployment strategy (Farb et al., 2014; Lindsay & Creswell, 2017; Naragon-Gainey et al., 2017). Several mindfulness-based techniques include focused attention and awareness on current experience (Kober, 2014; Neacsiu, Bohus, & Lineham, 2014). Distraction has been previously compared to open monitoring, where attention is focused on all aspects of the present moment (Uusberg et al., 2016). Crucially, open monitoring does not rely solely on attention deployment but also contains a cognitive change component, acceptance (Uusberg et al., 2016). In order to have a deeper understanding of the effects of the attentional component of mindfulness as well as whether and how it differs from distraction, a more precise comparison has to be made.

Another method of practising mindfulness is through focused breathing, during which a person focuses their attention on the sensations of breath (Arch & Craske, 2006). Focusing attention on breathing means that less cognitive resources are available to process the emotion-eliciting aspects of the situation. There is a limited amount of research on the effects of focused breathing. However, Arch & Craske (2006) have found that a short focused breathing exercise makes people with no previous mindfulness experience adapt better to situations that cause negative emotions.

Upon first impression, it seems that distraction and focused breathing share common features, mainly by being categorised as attentional deployment, despite deriving from different historical backgrounds. Existing research, however, also suggests that there might be important differences in their immediate and lasting effects. Distraction has been shown to be effective in the short term but is relatively ineffective in the long term (Kross & Ayduk, 2008; Paul et al., 2016; Uusberg et al., 2016). Previous studies that have investigated similar techniques give reason to believe that focused breathing allows the stimulus to be processed more thoroughly than distraction (Uusberg et al., 2016). On one hand, greater exposure to the situation provided by focused breathing should make later encounter with a similar situation less emotional (Uusberg et al., 2016). However, larger exposure to the situation should also make downregulating high intensity emotions more difficult (Sheppes & Meiran, 2009; Uusberg et al., 2016).

There are just a few papers comparing distraction and mindfulness (e. g., Broderick, 2005; Uusberg et al., 2016). To the best of author's knowledge, there are none that compare

distraction with focused breathing. The aim of the current study was to clarify the differences and similarities between the immediate and lasting effects of distraction and focused breathing. In order to have the most objective way of comparing the two strategies, psychophysiological markers of emotional reactivity were used.

Objective Markers of Emotion

There are various different theories on emotions, yet emotion researchers generally agree that emotions elicit physiological reactions, implicating it being an essential part of emotion (Bradley & Lang, 2007). Importantly, there are objective physiological markers that correspond to two key dimensions of emotional experiences - valence and arousal (Russell, Lewicka, & Niit, 1989). Valence describes whether the emotion is positive or negative, while arousal describes the intensity of the emotion (Chanel, Ansari-Asl, & Pun, 2007).

Corrugator supercilii activity, a facial expression marker, has been shown to be sensitive to valence (Larsen, Norris, & Cacioppo, 2003). *Corrugator supercilii* is an upper face muscle located above the brow (Dawson, Schell, & Fillion, 2007), which brings the brow into a frown (Larsen et al., 2003). Greater *corrugator supercilii* activity, measured with facial electromyography (EMG) has been uniquely associated with the display of negative emotions (Larsen et al., 2003; Schwartz, Fair, Salt, Mandel, & Klerman, 1976) which makes it a useful objective marker of negative affect. Changes in *corrugator supercilii* activity have also been used to assess ER effectiveness (Schönfelder, Kanske, Heissler, & Wessa, 2013).

Skin conductance response (SCR) is an indicator of sympathetic nervous system activity that measures sweat gland activity (Dawson et al., 2007; Troy, Shallcross, Brunner, Friedman, & Jones, 2018). SCR has been shown to be specifically sensitive to psychologically induced sweat gland activity, making it an effective marker of psychological arousal (Fernandez et al., 2012; Lang, Greenwald, Bradley, & Hamm, 1993; Winton, Putnam, & Krauss, 1984). Relatedly, more intense emotional stimuli have been shown to elicit a larger SCR (Fernandez et al., 2012). This has found to be true with both negative and positive emotions (Lang et al., 1993; Winton et al., 1984). SCR has also been used to study the effectiveness of ER strategies (Bradley, Codispoti, Cuthbert, & Lang, 2001; Sheppes & Meiran, 2009).

Present Study

The goal of this study was to investigate the immediate and lasting effects of attentional deployment ER strategies in internal down-regulation of negative emotions, focusing on distraction and mindfulness-based focused breathing. The study was conducted on novices in mindfulness to eliminate the potential effects of long-term practice (Chiesa, Serretti, &

Jakobsen, 2013; Hölzel et al., 2011; Taylor et al., 2011). Based on previously described research it was hypothesised that (1) distraction is more effective in immediately reducing high intensity negative emotions than focused breathing and that (2) focused breathing has better lasting effects than distraction. To test these hypotheses, a laboratory experiment was designed, where participants were asked to regulate low and high intensity negative emotions induced by standardized affective images (Marchewka, Zurawski, Jednorog, & Grabowska, 2014) with distraction and focused breathing. Before implementing the regulation strategies, the baseline of emotional reactivity of each participant was measured during a control condition with the instruction to simply view pictures attentively. The differences between the control condition and the implementation of distraction and focused breathing were used to measure the immediate effects of regulation. After implementation, participants were re-exposed to the same stimuli to evaluate the lasting effects of both regulation strategies. The main dependent variables were the aforementioned markers of valence and arousal. Valence was measured with *corrugator supercilii* activity and arousal with SCR. Decrease in *corrugator supercilii* activity and SCR by an ER strategy compared to the control condition would show whether the ER strategy had been effective. In addition to measuring physiological markers, self-reported ratings of negative affect were gathered.

A second research paper was also written on this experiment (Poopuu, 2019). The contribution of the author of the current paper is as follows: taking part in designing and piloting the experiment, categorising the stimuli, conducting half of the experimental sessions, taking care of the logistics necessary for the experiment, writing the current research paper and executing all of the statistical analyses presented in the current research paper.

Method

Participants

Before data collection a power analysis was performed with MorePower 6.0 software to determine the number of participants required for 90% power to detect a 3×3 within-subject repeated measures ANOVA (rANOVA) interaction effect with an effect size of $\eta^2_p = .07$. This effect size estimate was based on a prior study using similar stimuli and instructions (Uusberg et al., 2016). The analysis estimated that 54 participants are required. Expecting a 10% loss of data, the target sample size was increased to 60. In line with that target, 60 people participated in the study but three were excluded due to the excessive artefacts in physiological signals and one due to missing data. Therefore, the final sample consisted of 56 people (16 men) with the mean age of 27.52 years (age range 18-58 years, $SD=9.82$). Participants were initially asked

not to have practiced mindfulness or meditation for more than 30 hours in their lifetime (lifetime hours). Out of 56 participants 31 had never tried any spiritual practices, 20 had tried either yoga or meditation or both and the remaining 5 had tried other spiritual practices. Out of 15 who had tried meditation or mindfulness one had 1003 lifetime hours (meditation and yoga), other 14 averaged in 30.79 lifetime hours ($SD = 35.97$). Participants were also required not to be currently taking psychiatric medications or be involved in psychotherapy due to the potential impact on emotional experience and the specific emotion regulation skills investigated in the study. Twelve of the participants reported a history of psychological disorder in a post-experiment survey. No formal screening of current psychiatric disorders was conducted. Approximately two thirds of the participants were university students. Undergraduate students of psychology at the University of Tartu were offered research participation credit equal to three hours. All other participants were entered in a lottery pool to win a 30€ bookstore gift card, no other monetary compensation was given. Every participant signed an informed consent form prior to the laboratory experiment. The study was approved by the Research Ethics Committee of the University of Tartu.

Stimuli

To induce emotional reactions in a controlled manner, one of the most widely used options was used, showing affective pictures derived from a standardized picture set. High-resolution pictures with neutral and negative content from the Nencki Affective Picture System (NAPS) were used as stimuli, see supplementary material for codes. NAPS is especially relevant to this study since the normative affective ratings of valence and arousal were collected from mainly European participants (Marchewka et al., 2014), which is also the cultural background of the participants of this study.

When selecting stimuli, only negative and neutral images that had an aspect ratio of 3:4 and resolution of at least 600×800 pixels were considered. Such images were then manually reviewed and excessively disturbing pictures (e.g., depictions of very severe bodily mutilations) were eliminated. The remaining pictures were divided into three emotion categories according to their normative valence and arousal ratings (Marchewka et al., 2014): neutral (NTR), low intensity negative (LIN) and high intensity negative (HIN). The pictures were then divided into three stimulus sets A, B and C. Each stimulus set consisted of 36 pictures, 12 from each emotion category. Stimuli in different sets and affective categories were balanced according to their semantic content (e.g., depictions of humans, animals, and inanimate objects) and perceptual features such as luminance, contrast, colour distribution and

spatial frequency. In order to check the necessary affective similarity between the different sets and the contrast between emotion categories, additional analyses were carried out in SPSS. In addition to calculating mean normative rating values of each set with standard deviation (see Table 1 in Supplementary Materials), two separate 3 [set (A, B, C)] \times 3 [stimulus category (NTR, LIN, HIN)] ANOVAs were carried out for normative valence and arousal ratings. Confirming the suitability of sets and categories, there was a significant stimulus category main effect for both valence and arousal ratings but no significant set main effects or set \times stimulus category interaction effects, see Table 2 in supplementary materials.

Procedures

Experiments took place from the 7th of February to the 27th of March in 2019 at the University of Tartu Laboratory of Experimental Psychology in Tartu, Estonia. Participants were recruited primarily via social media platform Facebook by setting up a public event. The experiment consisted of four parts, three different viewing conditions and a subsequent re-exposure condition. Each part lasted for approximately ten minutes. The experiment always started with the WATCH block. The order of DISTRACTION and FOCUSED BREATHING blocks were counterbalanced across participants. Overview of the experimental design is displayed in Figure 1. The experiment was conducted in a dimly lit electrically shielded room. Instructions and stimuli were presented to the participant from a distance of 1 metre on a 19-inch flat screen monitor.

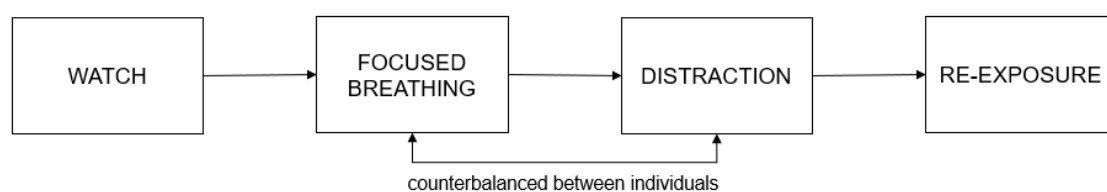


Figure 1. Experimental design.

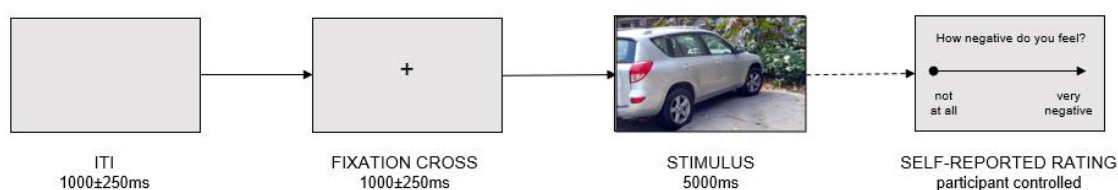
In the WATCH condition the participants were instructed to simply view the stimuli attentively and focus on the details of the depicted scenes in order to measure their baseline emotional reactivity. In the DISTRACTION condition, participants were asked to silently count backwards from randomly generated three-digit numbers (from 300 to 600) presented on the screen. In the FOCUSED BREATHING condition, the instruction was to focus on the

sensation of breath in the region of one's nose. In the final, re-exposure block, participants were instructed to view all previous stimuli attentively once again (same instruction as the WATCH condition) and rate how negative each picture made them feel in the current moment.

In each of the first three conditions, participants were presented with one stimulus set (36 pictures, 12 from each emotion category) repeated twice. The pairing of conditions (WATCH, DISTRACTION and FOCUSED BREATHING) and sets (A, B and C) was randomised between participants. In the final, re-exposure condition, every participant would be presented with all of the 108 pictures.

Written and oral instructions were presented prior to each block of the experiment. First, participants had to read the instructions on the monitor and then report back how they understood the task. Any misunderstandings were corrected and key points were repeated orally by the experimenter. Prior to the FOCUSED BREATHING condition, a short (approximately two minutes long) instructed focused breathing exercise was carried out in addition to oral and written instructions to make the task of this block clearer to the participant. The script of the focused breathing exercise is presented in the supplementary materials of Poopuu (2019) in Estonian. Participants also practiced each task with six trials, three while the experimenter was present and three alone. Practice stimuli were different from the ones used in the experiment (see Supplementary Materials for codes).

A. Single trial during implementation



B. Single trial during re-exposure

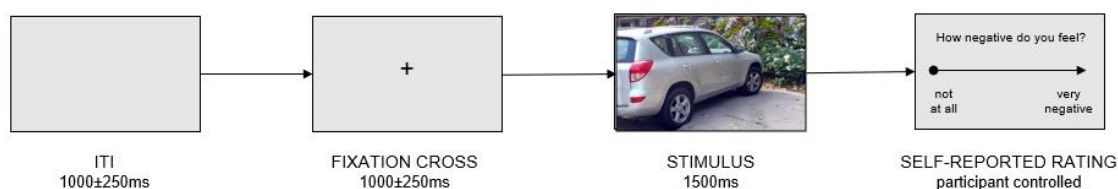


Figure 2. Single trial during the three experimental conditions (A) and re-exposure (B). Dotted line indicates that during the three experimental conditions the self-reported rating was presented after every 6 stimuli.

The time course of a single trial is illustrated in Figure 2. Each trial began with an inter-trial interval (ITI) with an average duration of 1000ms (randomised length between 750ms and 1250ms), followed by a fixation cross with an average duration of 1000ms (randomised length between 750ms and 1250ms). The stimulus was presented for 5000ms during implementation (blocks WATCH, DISTRACTION and FOCUSED BREATHING) and for 1500ms during re-exposure. Additional self-reported questions were asked during and after the blocks. During each implementation block, *self-reported affect* ratings and, as a manipulation check, estimates about paying *attention to the task* were collected after every 6 trial. During DISTRACTION participants were also asked about which number they reached. At the end of each implementation block, there were two additional questions on *task difficulty* and *task success*. During re-exposure, *self-reported picture valence* ratings were collected after every stimulus. All self-reported questions are brought out in Supplementary Materials.

The participants also completed two web questionnaires, one prior to the experiment and another immediately after the experiment. The data collected with the questionnaires was not analysed in the current paper. The content of both questionnaires is brought out in the supplementary materials of Poopuu (2019).

Psychophysiological Recordings and Pre-Processing

Recordings were made with BioSemi ActiveTwo system with a sampling rate of 512 Hz. EMG was recorded with two electrodes placed 1 cm apart on the surface of the skin over the *corrugator supercilii* muscle above the left eyebrow. Two electrodes were placed on the volar surface of the index and middle finger of the non-dominant hand to measure SCR. Additionally, we measured EEG signals with 32 scalp electrodes. The EEG data collected from this experiment is analysed in another research paper by Poopuu (2019).

EMG activity was recorded as an index of facial emotion-expressive behaviour. The signals from the two electrodes were subtracted from one another. Raw EMG signals were filtered with a 20 Hz high-pass cut-off and notch filtered between 48-52 Hz, full-wave rectified and smoothed with a moving average over 125ms. The data was segmented beginning 1000ms prior picture onset to picture offset (5000ms for the implementation trials and 1500ms for the re-exposure trials) and converted to within-subject z-scores. EMG scores were calculated as activity change relative to the baseline period and averaged over the whole duration of the stimuli.

SCR were extracted using the Ledalab software (Benedek & Kaernbach, 2010). Sampling rate was reduced to 32 Hz and then Continuous Decomposition Analysis was applied. The Continuous Decomposition Analysis divides skin conductance data into two components,

skin conductance level and SCR. We used the mean post-stimulus value of the SCR component for our data analysis.

Statistical Analyses

Baseline corrected changes in *corrugator supercilii* activity, SCR amplitudes and self-reported ratings were analysed with IBM SPSS Statistics version 25. Implementation effects were tested with two separate 3 [condition (WATCH, DISTRACTION and FOCUSED BREATHING)] × 3 [emotion (NTR, LIN, HIN)] × 2 [repetition (first, second)] within-subjects repeated-measures ANOVAs (rANOVAs) for *corrugator supercilii* activity and SCR to see whether the response to different stimuli depended on the condition it had been presented in. Re-exposure effects on *corrugator supercilii* activity were controlled with a 3 [condition (WATCH, DISTRACTION and FOCUSED BREATHING)] × 3 [emotion (NTR, LIN, HIN)] within-subjects rANOVA to check any lasting effects of ER. In the re-exposure rANOVA, ‘condition’ represented the experimental condition the stimuli had first been presented in. SCR re-exposure data was not analysed due to the insufficient length of the re-exposure presentation. Self-reported affect during implementation was analysed with a three-level rANOVA of the ‘condition’ factor. Self-reported picture valence during re-exposure was analysed with 3 (condition) × 3 (emotion) rANOVA.

Secondary analyses were carried out to investigate other self-reported ratings given during the experiment. To analyse self-reported task success and difficulty during implementation, separate three-level rANOVAs of the ‘condition’ factor were conducted. Self-reported attention to the task was analysed as a manipulation check with the same three-level rANOVA of ‘condition’.

If the assumption of sphericity was violated according to Mauchly’s Test of Sphericity, Greenhouse-Geisser corrected degrees of freedom and p-values were reported. Effects were considered statistically significant if the significance level was <.05. Effect sizes were reported using partial eta square (η^2_p). Significant effects were decomposed with LSD post-hoc tests or paired-samples t-tests.

Results

***Corrugator supercilii* Activity**

A 3 (condition) × 3 (emotion) × 2 (repetition) rANOVA test of main effect of repetition was not statistically significant, $F(1, 55) = 3.55, p = .07, \eta^2_p = .06$, nor were the interaction effects of repetition (p 's > .21), hence the *corrugator supercilii* activity of the first and second

repetition of viewing instruction implementation were averaged and analysed together. A subsequent 3 (condition) \times 3 (emotion) rANOVA revealed a significant main effect of emotion on *corrugator supercilii* activity, see Table 1. According to post-hoc tests HIN stimuli elicited stronger responses than NTR stimuli and LIN stimuli, while the difference between NTR and LIN stimuli was not statistically significant, see Figure 3. This suggests that *corrugator supercilii* was overall a sensitive marker of emotional valence. There were no significant condition main or interaction effects, which means that corrugator activity was not sensitive to ER.

A separate 3 (condition) \times 3 (emotion) rANOVA also showed a significant main effect of emotion on *corrugator supercilii* activity recorded during re-exposure, see Table 1. Once again HIN stimuli elicited stronger response than NTR stimuli and LIN stimuli with the latter two eliciting comparable responses, see Figure 3. There was no significant condition main or interaction effects for re-exposure either, indicating no lasting effects of ER.

Table 1

Experimental effects of *corrugator supercilii* activity

	Implementation					Re-exposure				
	<i>df</i>	<i>df_{error}</i>	<i>F</i>	<i>p</i>	η^2_p	<i>df</i>	<i>df_{error}</i>	<i>F</i>	<i>p</i>	η^2_p
Condition	1.94	106.91	1.78	.17	.03	1.95	107.07	.25	.77	.01
Emotion	2.00	110.00	5.93	<.01	.10	2.00	110.00	5.58	<.01	.09
Condition*Emotion	4.00	220.00	1.15	.34	.02	3.65	200.73	1.10	.36	.02

Note. This table presents the results of two separate 3 [condition (WATCH, DISTRACTION, FOCUSED BREATHING)] \times 3 [emotion (neutral, low intensity negative, high intensity negative)] repeated measures ANOVAs for *corrugator supercilii* activity, one from the data collected during the implementation of the experimental conditions (blocks 1 through 3) and other from the data during re-exposure (block 4). *df* = degrees of freedom; *df_{error}* = degrees of freedom, error; *F* = F-test statistic; *p* = level of significance; η^2_p = Partial Eta Squared. Statistically significant results ($p < .05$) are emphasized in bold.

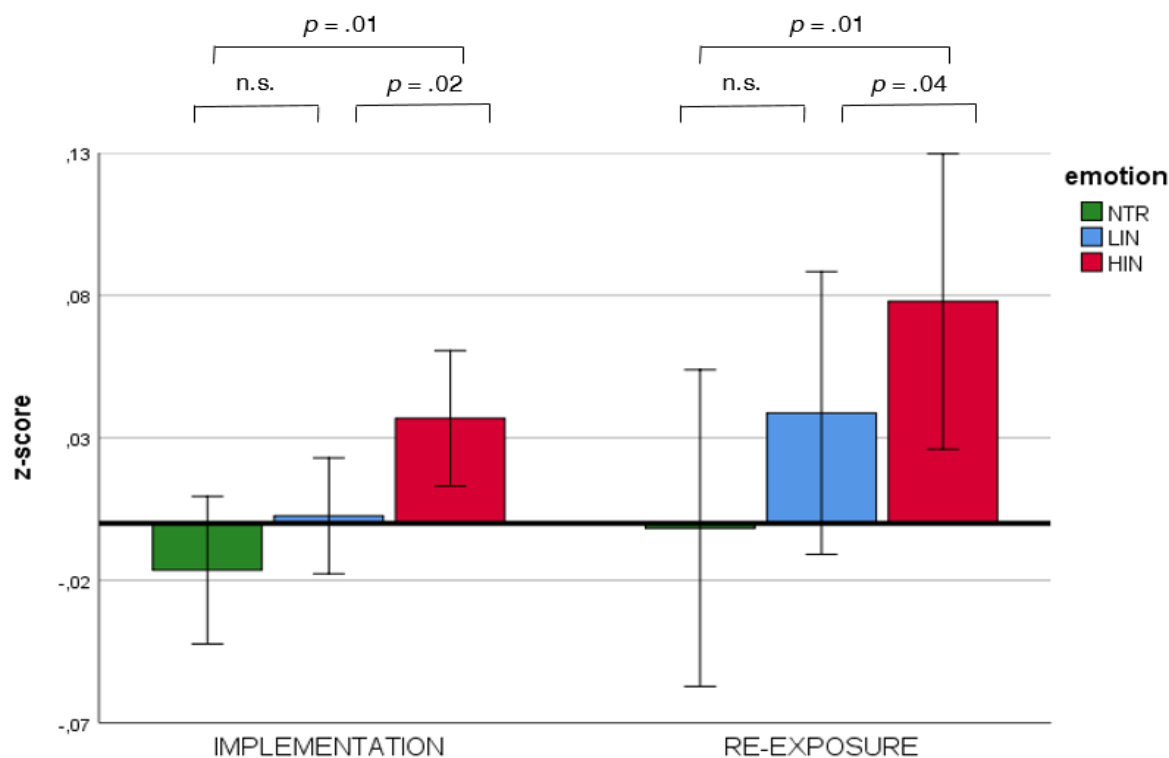


Figure 3. Mean *corrugator supercilii* activity (individual z-scores) and confidence intervals of 95% as error bars in response to neutral (NTR), low intensity negative (LIN) and high intensity negative (HIN) stimuli during implementation and re-exposure. Non-significant interactions are labelled as n.s.

Skin Conductance Response

For the SCR that was recorded during the implementation of different viewing instructions, a 3 (condition) \times 3 (emotion) \times 2 (repetition) rANOVA revealed a significant interaction effect between condition and repetition, see Table 2. The rANOVA revealed no other significant main or interaction effects. In order to unpack this condition by repetition interaction effect, six new variables were calculated with values averaged across the three emotion categories, one for both repetitions of all three experimental conditions. Paired-samples t-tests revealed that on average SCR was larger in the first repetition of WATCH condition than in the second repetition of WATCH, see Figure 4. In the first repetition of FOCUSED BREATHING on average SCR was smaller than in the second repetition of FOCUSED BREATHING, see Figure 4. The two repetitions of DISTRACTION did not differ significantly, see Figure 4.

In the first repetition of FOCUSED BREATHING the average amplitude of SCR was lower than in the first repetition of WATCH condition ($p = .02$). However, in the second

repetition, the average SCR amplitudes of WATCH ($p = .02$) and DISTRACTION ($p = .03$) were lower than of FOCUSED BREATHING. There were no other significant between-condition differences in either of the repetitions.

Table 2

Experimental effects of skin conductance response

	df	df_{error}	F	p	η^2_p
Condition	1.88	103.61	.20	.82	<.01
Emotion	2.00	110.00	.62	.54	.01
Repetition	1.00	55.00	.00	.96	.00
Condition*Emotion	4.00	220.00	.65	.63	.01
Condition*Repetition	1.97	108.14	10.24	<.001	.16
Emotion*Repetition	1.90	104.39	.39	.67	.01
Condition*Emotion*Repetition	4.00	220.00	1.34	.26	.02

Note. This table presents the results of a 3 [condition (WATCH, DISTRACTION, FOCUSED BREATHING)] \times 3 [emotion (neutral, low intensity negative, high intensity negative)] \times 2 [repetition (first, second)] repeated measures ANOVA for skin conductance response. df = degrees of freedom; df_{error} = degrees of freedom, error; F = F-test statistic; p = level of significance; η^2_p = Partial Eta Squared. Statistically significant results ($p < .05$) are emphasized in bold.

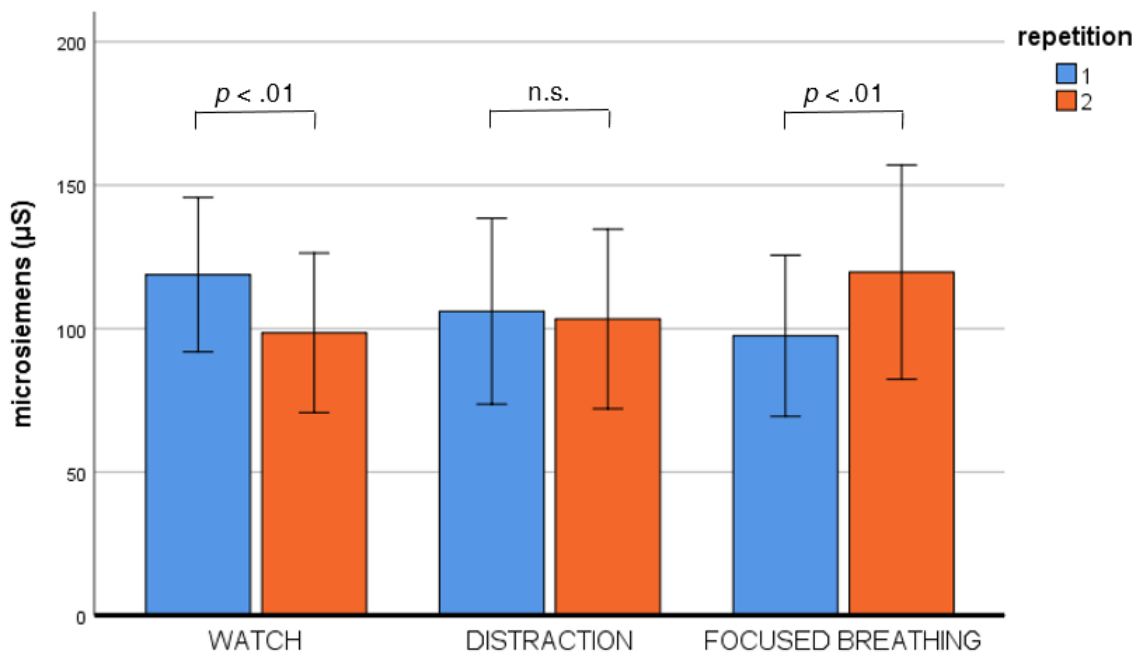


Figure 4. Mean skin conductance response (averaged across emotional categories) and confidence intervals of 95% as error bars according to the repetitions (first and second) of all three experimental conditions (WATCH, DISTRACTION and FOCUSED BREATHING). The unit of measurement is microsiemens (μS). Non-significant interactions are labelled as n.s.

Self-reported Ratings

Negative affect during implementation. Three level rANOVA of self-reported negative affect revealed a significant main effect of experimental condition, $F(2, 110) = 3.35$, $p = .04$, $\eta^2_p = .06$. Post-hoc tests revealed that participants reported significantly less negative affect during the FOCUSED BREATHING condition than during the WATCH condition ($p = .01$), see Table 3 for mean values of the ratings. There were no other significant between-conditions differences in self-reported negative affect.

Picture valence during re-exposure. A 3 (condition) \times 3 (emotion) rANOVA of self-reported picture valence revealed a significant main effect of emotion, $F(2, 110) = 85.19$, $p < .001$, $\eta^2_p = .61$. According to post-hoc analysis there was a significant difference (p 's $< .001$) between all emotion categories in the expected direction, HIN stimuli eliciting the strongest emotional response, followed by LIN and NTR stimuli, see Table 3 for mean values. The main effect of condition, $F(1.82, 100.16) = 2.93$, $p = .06$, $\eta^2_p = .05$, and the interaction effect of condition and emotion, $F(4, 220) = .65$, $p = .63$, $\eta^2_p = .01$, were not significant.

Task difficulty. Three level rANOVA of self-reported task difficulty revealed a significant main effect of experimental condition, $F(2, 110) = 38.40$, $p < .001$, $\eta^2_p = .41$. WATCH was reported to be significantly easier than FOCUSED BREATHING ($p < .001$) and DISTRACTION ($p < .001$), see Table 3 for mean values. There was no significant difference in task difficulty between FOCUSED BREATHING and DISTRACTION.

Task success. Three level rANOVA of self-reported task success also showed a significant main effect of condition, $F(1.87, 102.97) = 20.01$, $p < .001$, $\eta^2_p = .27$. Implementation of WATCH instruction was rated as more successful than DISTRACTION ($p = .01$) and FOCUSED BREATHING ($p < .001$) and implementation of DISTRACTION was rated as more successful than FOCUSED BREATHING ($p = .001$), see Table 3 for mean values.

Attention to the task. Three level rANOVA of self-reported attention to the task also showed a significant main effect of condition, $F(2, 110) = 9.62$, $p < .001$, $\eta^2_p = .15$. People reported that they paid more attention to the task during the WATCH condition than during the DISTRACTION ($p < .001$) and FOCUSED BREATHING conditions ($p < .001$), see Table 3 for mean values. There was no significant difference between DISTRACTION and FOCUSED BREATHING.

Table 3

Mean values and standard deviations of self-reported ratings

		WATCH	DISTRACTION	FOCUSED BREATHING
Implementation	Negative affect	10.03 (11.23)	8.79 (11.44)	7.80 (9.56)
	Task difficulty	10.38 (18.51)	33.68 (27.67)	40.90 (28.66)
	Task success	89.89 (15.88)	82.48 (15.31)	70.63 (20.41)
	Attention to task	90.37 (10.39)	80.04 (20.48)	82.59 (15.45)
Re-exposure picture valence	Average	15.35 (1.69)	15.11 (1.65)	14.13 (1.62)
	NTR*	3.79 (6.99)	3.41 (7.50)	3.18 (7.03)
	LIN**	13.45 (13.43)	13.79 (13.21)	11.76 (12.02)
	HIN***	28.80 (22.00)	28.13 (21.21)	27.45 (21.94)

Note. Table shows mean values with standard deviation in the parentheses. Self-reported ratings were given on a visual analogue scale converted ratings from 0-100. Larger values indicated more negative affect, greater task difficulty, greater task success, greater attention to the task and more negative picture valence. NTR* - neutral pictures, *LIN - low intensity negative pictures, **HIN - high intensity negative pictures.

Discussion

This study examined how applying traditional and mindfulness-based attentional deployment ER strategies, distraction and focused breathing alters emotional responses during negative affective picture viewing. The hypotheses that distraction would be more effective in immediately lowering high intensity negative emotions than focused breathing and that focused breathing would have better lasting effects than distraction were not confirmed. The psychophysiological results displayed no significant differences between the immediate effectiveness of the two strategies, while self-reported ratings suggested that focused breathing was more effective in lowering negative affect. No significant differences in lasting effects were detected between the two strategies either from the physiological data or self-reported picture valence ratings.

As expected, *corrugator supercilii* was sensitive to valence and showed greater activity when the negativity of the picture was increased (Larsen et al., 2003). Contrary to expectation, neither of the ER strategies reduced *corrugator supercilii* activity in any emotion category. The obvious conclusion would be that either the strategies were not effective or the marker did not distinguish ER related changes. However, other studies have shown both distraction being effective (Broderick, 2005; Rusting & Nolen-Hoeksema, 1998; Uusberg et al., 2016; Van Dillen & Koole, 2007) and *corrugator supercilii* activity being a valid marker of ER related changes (Schönfelder et al., 2013). Even though our self-reported ratings of task difficulty showed that implementing the ER strategies was significantly more difficult than just looking

at the pictures, the tasks were likely easier than the distraction task used by Schönfelder and colleagues (2013) and may not have been sufficient to divert attention away from the processing of affective content. That said, it is also possible that the strategies showed no effect on EMG results because increased cognitive load associated with the implementation of the strategies counteracted any regulatory effects. Namely, higher *corrugator supercilii* activity is not only related to experiencing higher negative emotions, but also with performing mentally challenging tasks (Hess, Philippot, & Blairy, 1998). This assumption is also supported by the self-reported ratings of task difficulty, according to which implementing distraction and focused breathing was significantly more difficult than just looking at the pictures. However, increased cognitive load does not fully explain the lack of condition by emotion interaction effect. Therefore, the results of the current study suggest that easy attentional deployment manipulation does not reduce *corrugator supercilii* activity.

SCR also showed no interaction effect between condition and emotion, suggesting that implementing distraction and focused breathing was not effective in reducing arousal. However, SCR also had overall difficulties distinguishing different emotion categories of the pictures, hence not being effective in detecting affective arousal. *Corrugator supercilii* activity, self-reported valence ratings collected during re-exposure and normative valence and arousal ratings of picture sets imply significant differences between emotion categories. However, more intense emotional stimuli might be needed to amplify SCR in a picture viewing paradigm.

Despite the lack of emotion effect on SCR, a significant interaction effect of condition and repetition of the stimuli was observed. SCR is also a marker of sympathetic nervous system activity and is hence sensitive to general states of arousal (Dawson et al., 2007). In the first repetition, SCR was lower for focused breathing than for the 'watch' control condition. In the second repetition, however, both 'watch' condition and distraction had lower SCR than focused breathing. The decrease in SCR in 'watch' condition can probably be associated with natural habituation with the affective pictures. While SCR showed no significant change between the first and second repetition for distraction, focused breathing seems to have had some initial calming effect but eventually increased SCR. This dynamic of focused breathing may have several reasons. First, participants may have experienced exhaustion during focused breathing. However, this assumption is not supported by the fact that there was no such effect with distraction that was rated as equally difficult. Alternatively, given that our participants were primarily novices with limited mindfulness experience, the initial decrease and eventual increase in SCR while implementing focused breathing may be related to the novelty and unfamiliarity of the task. The method of focused breathing might simply need practice to have

expected effects (Chambers et al., 2009; Chiesa et al., 2013; Hölzel et al., 2011; Taylor et al., 2011). As we can see from the self-reported ratings of task success, implementing focused breathing was rated less successful than distraction, even though there was no difference in the self-reported difficulty of the two ER strategies. Initially participants may have tried to implement focused breathing but possibly found it too difficult and eventually got frustrated, which may have resulted in increased level of arousal. Finally, Lindsay and Creswell (2017) have suggested that in order for mindfulness techniques to be effective in reducing affective reactivity, there needs to be a component of acceptance, which was deliberately excluded from the focused breathing instruction for better comparison with distraction. It is important to note, however, that despite the increase in SCR, self-reported negative affect was the lowest during the implementation of focused breathing, implying that subjectively, this technique had the best results in lowering negative emotions.

There were no lasting effects of the ER strategies either from *corrugator supercilii* activity or self-reported picture valence ratings. Although *corrugator supercilii* activity distinguished emotion categories during re-exposure, there were no significant condition effects. This is not surprising since, as described earlier, *corrugator supercilii* activity did not even distinguish any immediate ER effects. SCR could not have been used to assess the lasting effects since the period of stimulus presentation during re-exposure was too short for detecting any accurate event-related changes in skin conductance. According to self-reported ratings of picture valence, participants distinguished different emotion categories, but there was no difference in ratings depending on the condition the stimuli had first been presented in. This suggests that even though focused breathing reduced subjective negative affect during implementation, it did not have any lasting effects. The results of the present study differ from Uusberg and colleagues' (2016) EEG study, where they compared distraction with open monitoring and found a positive lasting effect of the latter strategy. Considering this result with the suggestion of Lindsay and Creswell (2017) on the importance of acceptance, it can also be assumed that focused breathing alone is not as effective in reducing the intensity of affective experiences than it would be with the acceptance component.

Limitations and Future Research

The results of this paper need to be interpreted with caution. Since there was a relatively small amount of male participants, no gender-specific assumptions can be made from the current study nor can the results be generalised to the whole population. The study, therefore, needs to be replicated with a larger and more representative sample.

It is also important to note, that the effects of focused breathing in current study are not comparable to long-term mindfulness practice. Current study was conducted on mainly novices in mindfulness and meditation to test whether the strategy can be implemented successfully without prior practice. However, it has been found that practicing mindfulness changes the underlying mechanisms of mindfulness techniques and improves their effectiveness (Chiesa et al., 2013; Hölzel et al., 2011; Taylor et al., 2011). The study could be replicated and extended by conducting a comparison between novices and experts.

While the neutral, low intensity negative and high intensity negative emotion categories differed significantly in their intensity according to *corrugator supercilii* activity, self-reported ratings collected during re-exposure and normative ratings of valence and arousal, for SCR the intensity of the stimuli may have been overall too mild. SCR had difficulties in distinguishing affective arousal in our experiment, while others have found it to be an effective marker of arousal (Dawson et al., 2007; Troy et al., 2018). In future studies examining emotions or ER related changes with SCR, using more intense stimuli or using other emotion evocation techniques like film clips is suggested.

Finally, the self-reported ratings may have been influenced by response bias, which means that the range in which the scale was used might have differed considerably between participants. However, since within-subject changes were analysed, this limitation probably does not have a large impact on the results. Regardless, in future studies, it might be advisable to use a Likert-type scale with more explicitly defined values to reduce differences in understanding the intuitive visual analogue scale.

In addition to previously mentioned directions for further research into the similarities and differences of distraction and focused breathing, a comparison study of their effectiveness in healthy individuals and clinical samples is suggested. This is recommended since the main practical value of knowing the effects of ER strategies is the ability to recommend them effectively to those struggling with emotional experiences.

Conclusion

This study gave insight into the similarities and differences of two attentional deployment ER strategies, distraction and focused breathing, as well as researching ER with *corrugator supercilii* activity and SCR. While *corrugator supercilii* activity proved to be an effective marker of valence, it may have had difficulties in distinguishing ER related changes due to the coexisting cognitive load. Alternatively, the current ER instructions might not have been sufficiently engaging to limit the processing of affective information. SCR, on the other hand, had difficulties in differentiating the emotional intensity levels of stimuli, but revealed

some interesting ER dynamics as a general marker of physiological arousal. Namely focused breathing was characterized by initial decrease and subsequent increase in SCR. It is possible, that even though focused breathing was initially calming, it might have been difficult for mindfulness novices to implement the technique for a longer period. Self-reported ratings confirmed that focused breathing was subjectively the more challenging strategy. However, implementing focused breathing also decreased subjective affect the most. Even though focused breathing worked better subjectively, physiological findings and self-reported task difficulty suggest that focused breathing was challenging for novices. Further studies are needed to draw generalisable conclusions about the immediate and lasting effects of distraction and focused breathing on emotional response.

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Supplementary Materials

Stimulus Sets

The codes of the stimuli used are: Animals_138, Faces_006, Faces_057, Faces_220, Faces_224, Faces_309, Faces_311, Landscapes_081, Objects_234, Objects_279, People_097, People_164 (Set A, neutral); Animals_036, Faces_033, Faces_176, Faces_302, Landscapes_014, Objects_164, Objects_286, People_033, People_132, People_134, People_145, People_197 (Set A, medium negative), Animals_039, Faces_172, Faces_283, Landscapes_002, Objects_149, Objects_283, People_017, People_038, People_143, People_200, People_202, People_240 (Set A, high negative); Animals_141, Faces_030, Faces_049, Faces_078, Faces_216, Faces_276, Faces_281, Faces_315, Landscapes_043, Objects_216, Objects_276, People_061 (Set B, neutral); Animals_075, Faces_034, Faces_036, Faces_144, Faces_271, Faces_272, Faces_288, Landscapes_006, Objects_202, Objects_284, People_147, People_206 (Set B, medium negative); Animals_001, Faces_293, Faces_368, Landscapes_022, Objects_125, Objects_285, People_022, People_128, People_225, People_238, People_239, People_241 (Set B, high negative); Animals_088, Faces_048, Faces_065, Faces_198, Faces_305, Landscapes_015, Objects_248, Objects_312, People_091, People_146, People_150, People_159 (Set C, neutral); Animals_066, Faces_014, Faces_022, Faces_150, Faces_294, Landscapes_066, Objects_135, Objects_287, People_010, People_071, People_136, People_229 (Set C, medium negative); Animals_048, Faces_007, Faces_284, Landscapes_026, Objects_001, Objects_132, People_086, People_127, People_140, People_215, People_227, People_243 (Set C, high negative). The codes of the practice stimuli presented prior to the experimental blocks: Animals_211, Faces_023, Faces_041, Landscapes_005, People_009, People_133. Descriptive statistics of stimulus sets can be seen in Table 1 and tests of stimulus set equivalence in Table 2.

Table 1
Descriptive statistics of stimulus sets.

		normative valence	normative arousal
neutral	Set A	5.27 (.54)	4.84 (.43)
	Set B	5.21 (.57)	4.89 (.43)
	Set C	5.16 (.54)	4.79 (.30)
low intensity negative	Set A	3.38 (.69)	6.06 (.44)
	Set B	3.32 (.57)	6.38 (.61)
	Set C	3.40 (.74)	6.15 (.60)
high intensity negative	Set A	1.78 (.45)	7.56 (.59)
	Set B	1.71 (.51)	7.28 (.56)
	Set C	1.99 (.43)	7.29 (.45)

Note. Means and standard deviations (in brackets) presented by set and stimulus category for normative valence and arousal ratings (9-point scales; (Marchewka et al., 2014)).

Table 2
Tests of stimulus sets equivalence.

	set			stimulus category			set*stimulus category		
	<i>F</i>	<i>p</i>	η^2_p	<i>F</i>	<i>p</i>	η^2_p	<i>F</i>	<i>p</i>	η^2_p
normative valence	.30	.74	< .01	323.02	<.001	.87	.36	.84	.01
normative arousal	.45	.64	.01	233.15	<.001	.83	1.11	.36	.04

Note. Analyses of variance of mean values of single pictures ($n = 108$) with main effects of stimulus set (A, B, C) and category (neutral and negative) as well as their interaction.

Self-Reported Questions

WATCH block. After 6 stimuli: 1) How negative do you feel? (*Negative affect during implementation*), not at all ---- very negative; 2) How much attention did you give to the content of the picture? (*Attention to the task*), not at all ---- all of my attention. At the end of the block: 1) How difficult was it to follow the task of this block? (*Task difficulty*), not at all - --- very difficult; 2) How often were you able to follow the task of this block? (*Task success*), not at all ---- all of the time.

DISTRACTION block. After 6 stimuli: 1) How negative do you feel? (*Negative affect during implementation*), not at all ---- very negative; 2) How much attention did you give to counting the numbers? (*Attention to the task*), not at all ---- all of my attention; 3) Which

number did you reach? (*Attention to the task*), 300 ---- 600. At the end of the block: 1) How difficult was it to follow the task of this block? (*Task difficulty*), not at all ---- very difficult; 2) How often were you able to follow the task of this block? (*Task success*), not at all ---- all of the time.

FOCUSED BREATHING block. After 6 stimuli: How negative do you feel? (*Negative affect during implementation*), not at all ---- very negative; 2) How much attention did you give to your breathing? (*Attention to the task*), not at all ---- all of my attention. At the end of the block: 1) How difficult was it to follow the task of this block? (*Task difficulty*), not at all ---- very difficult; 2) How often were you able to follow the task of this block? (*Task success*), not at all ---- all of the time.

Re-Exposure. After each stimulus: How negative did this picture make you feel? (*Picture valence during re-exposure*), not at all ---- very negative.

Käesolevaga kinnitan, et olen korrekselt viidanud kõigile oma töös kasutatud teiste autorite poolt loodud kirjalikele töödele, lausetele, mõtetele, ideedele või andmetele.

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Kärt Puusepp