International Journal of Psychophysiology 162 (2021) 130–144

Contents lists available at ScienceDirect

International Journal of Psychophysiology

journal homepage: www.elsevier.com/locate/ijpsycho

Situation selection for the regulation of emotion responses: Non-meaningful choice options retain partial physiological regulatory impact

Simon Thuillard [a,b], Elise S. Dan-Glauser [a,*]

[a] University of Lausanne, Lausanne, Switzerland
[b] University of Fribourg, Fribourg, Switzerland

ARTICLE INFO

Keywords:
Situation selection
Emotion regulation strategy
Negative experience
Physiological arousal
Non-meaningful choice

ABSTRACT

Situation selection consists in choosing an upcoming emotional situation in order to regulate emotions. It was found to be a strategy with powerful effects on emotional negative experience and physiological arousal. *Situation selection* is supposed to be efficient through the empowering effect of choice itself. In the present study, we wanted to replicate results on *Situation selection* efficiency and explore its limits by examining the implications of a non-meaningful choice procedure preceding the emotional trigger, expecting that even this non-meaningful choice would be regulatory. Sixty-one participants (40 females, mean age 21.4 years) were presented with emotional pictures, either with no particular instruction (no regulation) or with the task to make a choice between two options. This task was either a classical *Situation selection* task, with the label corresponding to the image that could be later seen (Word *Situation selection*), or non-meaningful options (Non-word *Situation selection*). The effect of *Situation selection* for negative experience was replicated. Effects on physiological arousal showed reduced heart rate and respiratory rate at the end of the viewing period, particularly for positive viewing. In negative viewing, Non-word *Situation selection* did not reduce negative experience, but did reinforce the calming effect of *Situation selection* on heart and respiratory rate. These results confirm *Situation selection* as a valid emotion regulation strategy, particularly regarding physiological arousal. Significant understanding of the options seems to constitute a strategic part of the regulation on the full spectrum of emotion responses but is not mandatory if only some specific physiological responses are targeted.

1. Introduction

Emotions are everywhere and constitute fundamental reactions shaping our behavior and actions in our environment. They help reacting appropriately to a large range of social situations, thus promoting functional social interaction and adaptation (Lazarus, 1991). Whether in private or professional settings, emotions bridge environmental changes and our thriving to reach our goals (Stein and Levine, 1990). However, adaptation also depends on the amount of emotion responses we are able to handle and what aspects of emotion we let other people know about. In order to find the right balance between expression and concealment, individuals need to regulate their emotions nearly constantly (Tomkins, 1984).

Emotion regulation refers to "the processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions" (Gross, 1998, p. 275). When effective, emotion regulation alters the trajectories of the unfolding emotion responses and shapes a resulting, perceptible, affective reaction. Efficient emotion regulation has been found to play a crucial role in healthy adaptation (Gross and John, 2003; Gross and Muñoz, 1995) and efficient social functioning (Eisenberg et al., 2000). In contrast, difficulties in emotion regulation are associated with substance dependencies (Hayes et al., 1996), anxiety and mood disorders (Campbell-Sills and Barlow, 2007; Mennin et al., 2002; Mennin et al., 2005; Tull and Roemer, 2007), increased posttraumatic stress disorder (Cloitre et al., 2004), and personality related symptoms and pathologies (Glenn and Klonsky, 2009; Henry et al., 2007; Westermann et al., 2013). Therefore, reaching functional emotion regulation is one of the main targets to promote individuals' health, well-being, and social adaptation.

Of the many studies testing the functionality of emotion regulation strategies, only a few tested *Situation selection*. *Situation selection* "involves taking actions that make it more (or less) likely that we will end up in a situation we expect will give rise to desirable (or undesirable)

* Corresponding author at: Institute of Psychology, University of Lausanne, Unil-Mouline-Géopolis, 1015 Lausanne, Switzerland.
E-mail address: elise.danglauser@gmail.com (E.S. Dan-Glauser).

https://doi.org/10.1016/j.ijpsycho.2021.02.009
Received 3 September 2020; Received in revised form 4 February 2021; Accepted 8 February 2021
Available online 10 February 2021
0167-8760/© 2021 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

emotions." (Gross and Thompson, 2007, p. 11; see also Jazaieri et al., 2017). *Situation selection* has been shown to be quite efficient for regulating emotions, especially in people who fall short of alternative strategies to regulate emotions (Webb et al., 2018). *Situation selection* is generally considered as a unitary concept but it has been suggested that its regulatory mechanism relies on at least two processes (Thuillard and Dan-Glauser, 2017). The first one is related to the chosen situation: when comparatively evaluating the available options, people generally choose the most beneficial one and consequently experience a more positive situation (Livingstone and Isaacowitz, 2015; Sands and Isaacowitz, 2016). In the second mechanism, *Situation selection* acts through the empowering action of making a decision about one's own emotions. In other words, the act of performing a choice itself has a regulatory action on our emotional process. It has been hypothesized that, regardless of the options presented or selected, emotional responses to two identical situations might differ depending on whether the situation was chosen or not. To our knowledge, only two studies have examined this question to date. In these two studies, a special within-subject protocol contrasted reactions to identical emotional stimuli under two different conditions: a) when a stimulation was chosen, and b) when the same stimulation was presented without any prior choice procedure. The results of these studies showed that having the choice in negative situations decreased negative experience, skin conductance, and respiration reactivity. This two latter parameters additionally showed a particular dynamic, showing their effects a few seconds after the emotional stimulation started. In contrast, choosing a positive image before seeing it did not affect its positive value. Thus, *Situation selection* successfully lowered negative reactions without affecting positive responses. (Thuillard and Dan-Glauser, 2017, 2020). The second of these studies (Thuillard and Dan-Glauser, 2020) additionally investigated whether choice needed to be followed up by the chosen situation in order for the regulation to be efficient. This question was crucial for the implementation of *Situation selection* in daily activities, as we may need to be sure that all options are available when offering a choice to customers or patients. It appeared that an *Illusory choice*, i.e., performing *Situation selection* but without getting what we chose, eliminated the regulatory impact of *Situation selection* on negative experience. However, it surprisingly conserved its regulatory function on physiological parameters. Specifically, having the choice decreased skin conductance and respiratory arousal toward the end of the situation unfolding, regardless of whether the choice was respected or not. Hence, having the choice about an upcoming emotional situation, no matter if we really ended-up in this situation, gave a sense of control that might have been sufficient to alleviate physiological responses to stressors.

1.1. The present research

Since *Situation selection*, and its empowering effect of choice in particular, are fairly new in the literature, it is necessary to gain a better understanding of its regulatory mechanism. More specifically, we wanted to investigate the extent to which a lack of a clear understanding of what the options imply could still result in efficiency of *Situation selection* procedure for regulating emotions. Measuring the variation in the understanding of the consequences of the choice is however methodologically challenging so we turned to the extreme limits of the spectrum between fully uncertain and fully informed consequence assessment. In the present study, we thus investigated the maintenance of the regulatory function of *Situation selection* when a choice has to be performed between non-meaningful options and results in a random situation. We used non-meaningful words in the choice so that participants cannot predict the consequences of the choice they made. The added-value of such protocol is to be able to know whether a given choice to regulate emotion should contain perfectly clear options with predictable and unambiguous consequences or whether *Situation selection* could still work independently of that. This is of interest when one is considering implementing a choice procedure in contexts that are unfamiliar to individuals, or when one has doubts about the level of abstraction or reasoning of the person who is about to carry out regulation through *Situation selection*. Our question was then: if given non-meaningful options, would *Situation selection* still be efficient? If that is the case, it would mean that the effect of *Situation selection* already starts with the act of choosing, no matter if the choice in itself makes no sense at all.

The present research was thus designed with two objectives. First, since studies on the regulatory effect of *Situation selection* are still scarce, we wanted to replicate the effects found in the two previous studies on the topic. We thus first focused on the impact of *Situation selection* on experience, expressivity and physiological arousal responses. Second, we wanted to further decompose the mechanism by which *Situation selection* may act on emotion responses by investigating the case in which *Situation selection* is performed based on non-meaningful options. In such cases, does choice retain its regulatory effect? Or, on the other hand, does absence of meaning on the choice cancel out the effect of the regulation? To test this question, we used a within-subject design and induced emotions by presenting emotional pictures, as already used in numerous studies (Bradley et al., 1993; Codispoti et al., 2001; Dan-Glauser and Gross, 2011; Dan-Glauser and Scherer, 2011). We first had a control condition in which there was no choice of the upcoming situation (no *Situation selection*), called the *Imposed* condition. We further tested two experimental conditions. First, a condition in which people could perform a choice about the emotional content of the upcoming image based on verbal descriptors of the images (Word *Situation selection*). Second, we additionally included a condition called Non-word *Situation selection,* in which participants performed a choice between two labels, which were actually non-words. Non-words are classically used in classification tasks to explore linguistic cognitive organization. Such methodology helped to reveal the mechanisms of phonological processing and relationship to memory (see e.g., Novik, 1974; Stanners et al., 1971; Whaley, 1978). Interestingly however, very few studies have explored non-words in the context of affective studies: non-word was used either as prime (Giffard et al., 2009) or as non-meaningful stimuli that could be conditioned to be neutral or emotional in a similar way in all participants (Blanchette and Richards, 2004). We here however explore the potential of these non-meaningful stimuli to increase our understanding of the unfolding of cognitive (choice) and affective (reactions) processing in combination during a task with emotion regulation objectives.

Timing of emotional response development is crucial in describing emotional arousal unfolding (Esslen et al., 2004; Stein et al., 1993). Moreover, specific dynamics regarding emotional reactions to pictures have been previously identified (Bradley and Lang, 2000; Codispoti et al., 2001). It is therefore crucial to consider response dynamics when investigating fast emerging emotion responses to pictures. This is particularly true when studying the impact of emotion regulation, which has shown different dynamics depending on the considered responses (Dan-Glauser and Gross, 2011, 2015). Even more relevant to the current work, different dynamics were already shown for *Situation selection* (Thuillard and Dan-Glauser, 2017, 2020). We therefore also included a time factor in our design to identify and isolate effects that are only transient, or that appear only after a few seconds of viewing.

Regarding our first objective, we expected to replicate the previously found effects (Thuillard and Dan-Glauser, 2017, 2020). Namely, our hypotheses were:

H1a. For experience: a decrease in negative experience with unchanged positive experience.

H1b. For expressivity: since we have contradictory results concerning expressivity, we have no particular expectation for this channel. The majority of the results for this channel however shows relative insensitivity to *Situation selection* (no effect).

H1c. For physiological arousal: we expect to find a decrease in heart rate following *Situation selection*, particularly for positive viewing and relatively late in the viewing period. Skin conductance should show an interaction pattern with higher levels at the beginning of the viewing period and lower levels at the end of the viewing period for *Situation selection* as compared to the *Imposed* condition. Respiratory rate should show a decrease in *Situation selection* condition, particularly toward the end of the recording period, while the amplitude should be lower for negative (late viewing) and higher for positive (early viewing) in the *Situation selection* condition, as compared to the *Imposed* condition.

With respect to our second objective we had no background literature on how non-meaningful indications about an upcoming situation could modify the triggered reactions. In a recent study, we stressed the importance of the choice procedure, regardless of the outcome (what we have called an *Illusory choice*, Thuillard and Dan-Glauser, 2020). In an *Illusory choice* condition, participants had a choice procedure that was unrelated to the upcoming situation. In such condition, the participant's preparedness for the upcoming situation was not congruent with the situation. This is somewhat similar to the present non-word condition, where participants still have a choice to perform but are not given the opportunity to prepare to the upcoming situation (since they have no idea about it). We built on the similar uncertainty of the coming situation in a choice procedure to parallel our *Illusory Choice* results with the hypotheses we made for Non-word *Situation selection*. We thus expect for Non-word *Situation selection*:

H2a. For emotional experience (as compared to Word *Situation selection*): retained decrease in negative experience but decreased positive experience.

H2b. Physiological arousal (as compared to Word *Situation selection*): Retained decrease in heart rate, but possibly more transient effect; retained regulatory impact on skin conductance level (lower level at the end of the viewing period), particularly for positive viewing; and conservation of the same effect as Word *Situation selection* on respiratory channels.

2. Method

2.1. Participants

A power analysis with a power of 0.8 (Cohen, 1988), with effect sizes derived from partial eta squares from previous similar studies (f = 0.20, see Dan-Glauser and Gross, 2011, 2015; Thuillard and Dan-Glauser, 2017), and α = 0.05, yielded a target sample size of 63 participants. We were able to recruit 65 participants. Of these, three did not return to the second part of the experiment and one had to be excluded because of technical issues with the recordings. Sixty-one participants were thus included in our analyses (40 women and 21 men). Participants were all either first year Psychology university students participating for course credits (N = 34), or Psychology or other discipline first year students participating for the equivalent of $50 (N = 27). They were recruited during first year Psychology courses or via advertisements posted on University information boards with a brief description of the project, without mention of emotion regulation. Exclusion criteria were pregnancy, medication, and diagnosis of anxiety or mood disorder. Inclusion criteria were age between 18 and 45 years old and general good health. Regarding age, participants ranged between 18.3 and 30.2 years, with a mean of 21.4 years (SD = 2.07 years). Regarding health, participants were tested with the 12-Item Short-Form Health Survey (SF-12, Ware et al., 1996) and scored an average of 74.7% (SD = 11.2) of good health (100% being excellent mental, physical and social health).

2.2. Design and conditions

We used a within-subject design in a picture-viewing paradigm. The experiment consisted of 10 blocks of pictures, each testing one of the three conditions described below.

1) The Word *Situation selection* condition (3 blocks) was operationalized as previously described (Thuillard and Dan-Glauser, 2017). In a picture-viewing paradigm, the participants had to choose the image that would be presented to them. The options were given with category words stating possible image content (see the *Stimuli* section below for further details on the images and contents). The selected image was presented 3.5 s after the choice was made.
2) In the Non-word *Situation selection* condition (3 blocks), the task was the same as in the Word-*Situation selection*, i.e., participants were given a choice and then presented with an image. The difference was that the options were non-meaningful and given with non-words (see the *Non-word selection* section below for further details). A randomly selected image was presented 3.5 s after the choice was made.
3) In the *Imposed* condition (4 blocks), participants were not given the opportunity to choose the upcoming image; they simply watched the pictures as they were displayed. To be able to partially control for specific image content effect, all images presented in the first two conditions were also seen in the *Imposed* condition (either before or after, depending on the random allocation of blocks and images to blocks). For the analyses, the trials were further separated in two groups: 1) Images seen in the *Imposed* condition that were also seen in the Word *Situation selection* (Word-Imposed) and 2) Images seen in the *Imposed* condition that were also seen in the Non-word *Situation selection* (Non-word Imposed). The stimuli that were not seen in the *Situation selection* conditions were not considered for analyses in the *Imposed* condition.

2.3. Stimuli

Eighty seven images were taken from the Geneva Affective Picture Database (GAPED, Dan-Glauser and Scherer, 2011), which gathers negative and positive stimuli that can be labelled according to group of content. Having an available label for each picture category is seminal for operationalizing *Situation selection*, as it allows participants to make a choice based on written descriptors of the upcoming situations. The images of the negative category consisted of four content types: spiders, snakes, animal mistreatment and human mistreatment. These same words were used as labels to offer a choice between categories in the Word *Situation selection* condition and to announce the upcoming category in the *Imposed* condition. The positive image categories also included four types of content: landscapes, human babies, mammals (usually offspring), and sport (inspirational) pictures. Since examples of the latter type of content are rare in the GAPED, we added nine pictures of sport/inspirational images from the International Affective Picture System (IAPS, Lang et al., 1999). The labels used to offer the choice for positive categories were “Landscape”, “Baby”, “Mammal”, and “Sport”. Of the final 96 pictures, 48 were negative and 48 were positive, with 12 pictures of each type of content. We presented emotional stimuli for 8 s and examined participants' emotional responses during this time-frame.

2.4. Non-word selection

For the Non-word *Situation selection* condition, choice was given with non-word labels. Non-word labels were selected with WordGen (Duyck et al., 2004). This software generates non-words, which letter combinations conserve characteristics of the words of a given language (for example with respect to letters that are often found next to each other). We originally wanted to pair the eight labels of the Word *Situation selection* with eight non-word labels. However, learning processes would have rapidly turned non-words into meaningful image categories, even in case of random pairing. For example, risk was that if, randomly, the label “sailruton” was several times associated with a spider image, association between the two would have been created, turning “sailruton” into another word for spider. We thus decided to select as many labels as there were images and to match non-words with length of the meaningful labels. We thus selected 96 non-words, 12 of 4 characters, 12 of 5 characters, 12 of 7 characters, 24 of 8 characters, 12 of 9 characters and 24 of 20 characters. These last 24 were matched in length to the “Human/Animal mistreatment” labels. Since these labels are composed of two words (of 12 and 7 characters), non-word labels for these categories were composed of two non-words of the corresponding length (e.g., “retoirpanrer pensode”). Note however that any of the 96 labels could randomly be assigned to any image (thus not inducing the idea that two non-words would be about mistreatment). Each non-word label appeared only once for each participant.

2.5. Measures

Three classes of emotional responses were measured, corresponding to the three main emotional systems: experience, expressivity, and physiological arousal (Kring and Gordon, 1998; Matsumoto et al., 2007; Mauss et al., 2005). For each class, we derived parameters that reliably reflected rapid emotion emergence, and which are proved to be sensitive to both our induction method and emotion regulation attempts.

2.5.1. Emotional experience

Participants used a rating slider to report their emotional experience (Variable Assessment Transducer, Biopac Systems, Inc., Goleta, CA, USA). Measures were taken continuously throughout the picture presentation. The slider is unipolar with negative reports on the left side and positive reports on the right side. The output voltage (0–9 V) was extracted as is and converted into a negative scale and a positive scale.

2.5.2. Expressivity

Expressivity was assessed using bipolar surface electromyography (EMG). Electrodes were standard 4 mm Ag-AgCl sensors. Because of its reliable link to negative expressivity, left *Corrugator Supercilii* (Lang et al., 1993; Larsen et al., 2003) was the targeted site for negative expressivity. The left *Zygomaticus Major*, and the left *Orbicularis Oculi* were the two sites chosen for positive expressivity. The zygomatic region is generally used to measure positive expressivity, but is not a completely direct measure of it (Larsen et al., 2003). We thus decided, in addition to this popular site, to add a supplementary channel for positive expressivity. We targeted *Orbicularis Oculi*, a region that is a reliable readout of Duchenne’s smile (Frank et al., 1993). The electrode placement followed recommendations of Fridlund and Cacioppo (1986). The skin was first gently rubbed with NuPrep® gel (Weaver and Cie). Excess gel was then removed with alcohol pads (Kendall Webcol® skin cleansing alcohol pads, Tyco healthcare). Finally, the electrodes were filled with Signagel® (Parker Laboratories, Inc).

2.5.3. Physiology

To answer our research question with respect to physiological arousal, we measured cardiovascular, exocrine, and respiratory activities.

1. Electrocardiography (ECG): Three standard disposable pre-gelled Ag/AgCl electrodes were used for ECG recordings. One was placed approximately 5 cm below the lower rib on the left side of the abdomen. A second electrode was placed just below the right clavicle, along the mid-clavicular line. A third electrode, which served as a ground, was placed at the level of the C7 cervical vertebrae.
2. Electrodermal activity: Skin conductance level was recorded with two pre-gelled disposable Ag/AgCl sensors. They were placed on the thenar and hypothenar eminences of the non-dominant hand palm.
3. Respiration: Thoracic and abdominal respiration recordings were collected with two respiration belts. The abdominal belt was placed around the waist, whereas the thoracic belt was placed high on the chest.

All parameters were recorded and amplified with MP150 compatible modules from Biopac Systems (Goleta, CA, USA). All sensors were from the same company. All acquired channels were sampled at 1000 Hz.

2.6. Procedure

Participants first undertook a questionnaire session, and then came back for the main testing phase, which included the picture-viewing task. In the first session, participants came in the laboratory and completed the SF12 (see Participants section). They also completed other emotion-related questionnaires that served for another study. A few days later, participants returned for the Emotion regulation task session. Upon arrival at the laboratory, participants were informed about the procedure of the experiment and prepared for the physiological recordings. All instructions were presented on screen in order to be consistent across participants. They were told that we were interested in people’s reactions to different scenes and that they would see different emotional images. The dial permitting to report the emotional experience was introduced and a few training trials were presented to familiarize participants with the rating system. They were then instructed about the *Situation selection* task. Instructions were as follow: “Sometimes in this session (in certain blocks), you will have the opportunity to choose yourself, from two options, the image you would like to see. Using the arrows on the keyboard, select the image category, then return to the slider and concentrate on your feelings to report them with the cursor.”. The participants again performed a few training trials (with images that were not presented in the main session) in which they chose between two proposed options and reported their feelings when viewing the image. After this phase, participants were told that in some blocks, they would be given the opportunity to perform a choice between two letter strings, independently of the image that would follow. Participants were then again given a few training trials for this task. Finally, they were instructed that the experiment was divided into blocks, during which they would sometimes choose images, sometimes choose letter strings, and sometimes just watch pictures while reporting their feelings. Block specific instructions was repeated before their respective start.

This study had a within-subject design. All participants saw blocks of images in the three conditions (see section above *Design and conditions*). Each participant completed the 10 blocks of trials, which were separated by a pause screen allowing participants to progress at their own pace and take breaks if necessary. The number of stimuli per block was arranged such that each block had approximately the same duration (as choosing a picture takes longer than when a picture is imposed). There were 24 trials for the *Imposed* condition blocks and 16 for the *Situation selection* conditions blocks (Word and Non-word). The block presentation was semi-randomized to control for habituation and order effects, only restricting the randomness by prohibiting the presentation of the same condition in consecutive blocks. The 24 trials of the *Imposed* blocks were composed of 12 positive and 12 negative pictures, each with 3 images from each content category. *Situation selection* blocks (both Word and Non-word blocks) were generally composed of 8 positive and 8 negative pictures. The last Word *Situation selection* block differed in the number of trials. This is due to the pairing procedure, the program exiting the last Word *Situation selection* block when it was no longer possible to couple unseen images of two different categories of the same valence, which would have permitted to give a choice.

On average, participants performed 185 trials (range = 182–187), 96 in the *Imposed* condition, 48 in the Non-word *Situation selection* condition, and on average 41 in the Word *Situation Selection* condition. All the Word *Situation selection* blocks were thus of 16 trials except the last one, averaging 9 trials. Each trial consisted of a blank screen (0.5 s), the choice screen (displayed until choice was made), a blank screen again (1.5 s), a fixation cross (1.5 s), a blank screen again (0.5 s) and the picture presentation (8 s). Fig. 1 shows the different trial unfoldings. Between each trial, participants were instructed to return the cursor to a middle position to be ready to evaluate their experience to the next image. Under the *Imposed* condition, the choice screen was replaced by the announcement of the picture category about to be presented (for 1

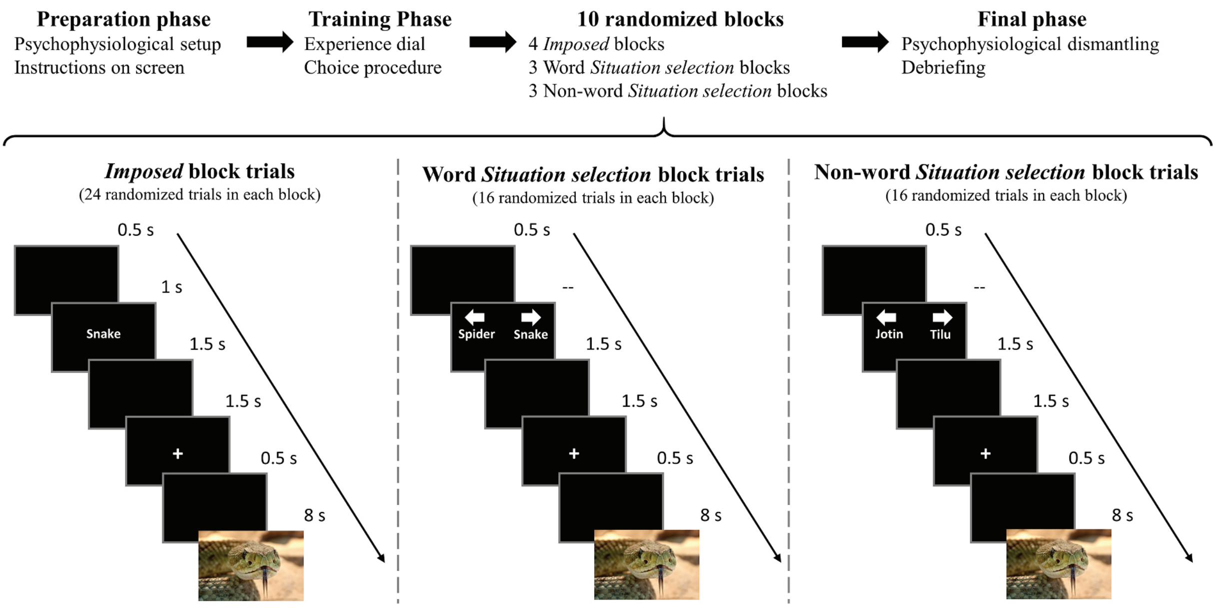

Fig. 1. Illustration of the testing procedure. An example of trial in each of the condition (*Imposed*, Word *Situation selection*, Non-word *Situation selection*) is presented with the corresponding timing of each screen.

s). After the computer session, which lasted approximately 55 min, the sensors were removed and participants were fully debriefed.

All participants gave written informed consent to participate in the study. The procedure was reviewed and authorized by the institutional and regional ethical committee (CER-VD, protocol 2015-00071), in accordance with the current national legal requirements (Ordinance on Human Research) and the latest version of the declaration of Helsinki.

2.7. Data reduction

All data were processed with Acknowledge 4.4 (Biopac System, Goleta, CA, USA). Some channels were band-pass filtered to increase the signal-to-noise ratio (20–500 Hz for EMG, 0.5–35 Hz for ECG, and 0.05–1 Hz for respiration). Movement or electric interferences in each channel were corrected by signal interpolation. To assess the temporal dynamics of emotional response unfolding, the continuous parameters were segmented into 16 epochs of 0.5 s each. In addition to the image presentation duration of 8 s, which was fully taken into account, a 3.5 s epoch was calculated for each trial and each parameter, spanning from 3.5 s before the picture presentation to the time of the picture onset. Thus, each trial had this reference period, which was used to normalize the response and obtain the relative change in the parameter following each picture presentation.

2.7.1. Emotional experience

Ratings were exported to obtain average values for each epoch. The cursor position before each trial (i.e., the position at which the participant returned the cursor to after the previous image) was considered as the starting point to calculate emotion intensity for this trial. Any value below this position was considered as a negative feeling and any value above as a positive feeling. Note that “negative” and “positive” labels were written on dial as anchors. Ratings were thus transformed into an emotion intensity scale extracted as percentages, representing the distance travelled by the cursor between its 0 point (starting point) and its position reached on either side during each epoch. Data for each of the valence sides thus go from 0 = absence of emotional experience once confronted to the picture to 100 = extreme emotion intensity.

2.7.2. Expressivity

The EMG signals were rectified and smoothed (5 Hz) before being averaged for each epoch. Given the wide variability in the contraction capacity of each individual, each EMG time-frame value was then expressed as the percentage of contraction with respect to the corresponding trial antecedent level (voltage recorded for a given time-frame / voltage recorded during the 3.5 s preceding the trial * 100) (de Wied et al., 2006; Van Boxtel, 2010). Negative expressivity was measured with the *Corrugator* site values, whereas Positive expressivity was measured with an average of the reactions measured on the *Zygomaticus* and *Orbicularis* sites, given the high correlation found for these parameters, $r_{(60)} = 0.61$, $p < .001$.

2.7.3. Physiology

Heart rate was calculated from the ECG channel by transforming the inter-beat interval (duration between successive R waves). Skin conductance level was exported as mean values for each epoch. Ten participants had to be removed from the skin conductance response analyses since they were *non-responders*. *Non-responders* are people showing no phasic responses in their skin conductance level (Gatti et al., 2018; Kredlow et al., 2017), making their responding irrelevant for trial-by-trial examination of physiological reactivity. Respiratory rate and respiratory amplitude were calculated for each epoch. The respiratory rate was obtained by converting the duration of the cycle intervals into a number of cycles per minute (c/min). The respiratory amplitude was interpolated by using the difference in volts between the point of maximum inspiration and the point of maximum expiration. Given the high correlations between thoracic and abdominal respiratory parameters, $r_{(54–60)} = 0.29–0.53$, from $p < .001$ to $p = .026$, the values of both sites were averaged. For respiration, one participant had to be excluded because of technical difficulties experienced with the respiratory belts during the recordings. All the physiological response channel data were calculated as the change in activity with respect to each trial antecedent level.

2.8. Data analyses

We first computed the descriptive values for each parameter in the *Imposed* condition, as a manipulation check on reactivity. To test for the expected induction, we contrasted the distribution of affective experience with a 0-centered distribution to confirm induction of presumed positive and negative emotions.

Two steps of analyses were then successively conducted for each parameter.

a) **The impact of *Situation selection*:** In order to replicate previous findings about *Situation selection* effect (Thuillard and Dan-Glauser, 2017), we first focused on *Situation selection* only. ANOVAs were used with two within-factors: Regulation (comparing the *Imposed* condition, but only the matched trials Word-*Imposed*, and the Word *Situation selection* condition) and Time (16 epochs). Separate ANOVAs were performed for negative and positive trials for two reasons. First, contrasting positive and negative trials was not part of our research question. Second, previous research has shown different emotion (Dolcos et al., 2004; Kensinger and Schacter, 2006; Lang et al., 1997; Palomba et al., 1997; VanOyen Witliet and Vrana, 1995; Winton et al., 1984) and emotion regulation patterns (Hubert and de Jong-Meyer, 1991; Kim and Hamann, 2007; Mak et al., 2009) for positive and negative responses. Except for the main effect of Time, which is relevant to the response dynamic but not to our research questions, all effects were of interest: (i) the main effect of *Situation selection*, for evaluating the general effect of choice as compared to the *Imposed* conditions, and (ii) the two-way interaction *Situation selection* × Time.
b) **The effect of choosing between non-meaningful options:** As a first step, we conducted repeated measures ANOVAs like in the previous section, but this time using the imposed images that were also seen in the Non-word *Situation selection* condition. We contrasted the factor NWSS (Non-word *Imposed* vs. Non-word *Situation selection*) to Time (16 time-frame). Then, we contrasted *Situation selection* based on meaningful labels (Word *Situation selection*) to *Situation selection* based on non-words (Non-word *Situation selection*) by creating a difference index. This index reflected to what extent having proposed a similar image with a choice that is non-meaningful gives different reactions than when the choice was meaningful (see red arrow in Fig. 2). Comparing this index to a 0-centered distribution gives the indication about the effect of label meaning, provided that we take into account the difference of reaction to the images, since for these two groups the images were different. We thus created another index, calculating the difference of reactivity in the *Imposed* condition between the group of images that were also seen in the Word *Situation selection* condition, to the group of images that were also seen in the Non-word *Situation selection* condition (see blue arrow in Fig. 2). Time was not taken into account when no interaction occurred in a control ANOVA contrasting Word and Non-word *Situation selection* (factor Word-Non-Word, WNW) in Time. When significant interactions occurred, the significant time frames were considered for interpretation with respect to the other conditions.

In all testing, Greenhouse-Geisser corrections were applied where the assumption of sphericity was violated, and corrected degrees of freedom were reported in these cases. Effect sizes are reported using partial eta squares (η_p^2) or *ds* when appropriate. *p*-Values for interaction effects were corrected for multiple comparisons with the Holm-Bonferroni criterion. Threshold for significance was set to 0.05 (bilateral, unless otherwise specified).

3. Results

3.1. Emotional reactivity to the pictures

We first examined the imposed trials to look at the emotional reactivity of the participants while facing the positive and the negative pictures (Table 1).

In order to confirm successful emotion induction in the expected valence, we conducted two *t*-tests (one for the negative trials and one for the positive trials) that compared the experience mean to a 0-centered distribution. Both tests yielded significant results, $t_{(60)} = 20.29$, $p < .001$, $d = 2.60$ for negative trials and $t_{(60)} = 22.23$, $p < .001$, $d = 2.85$ for positive trials.

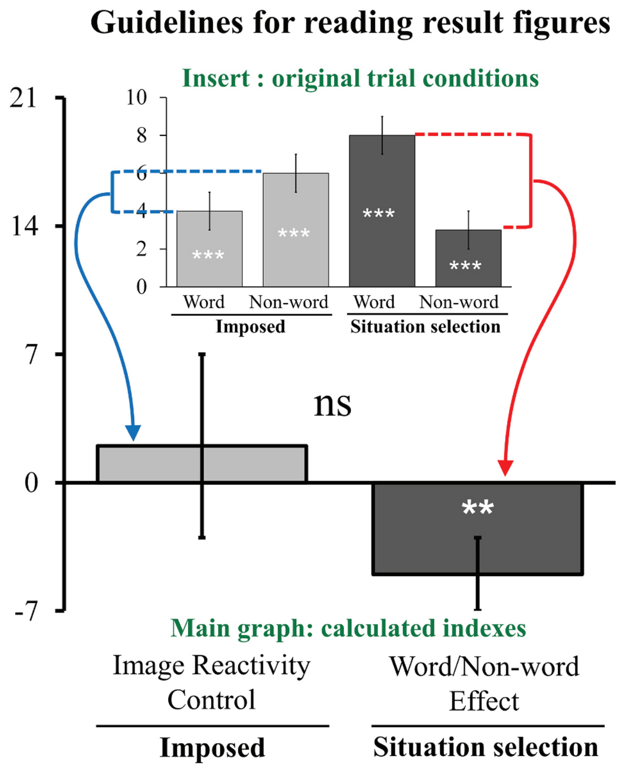

Fig. 2. Illustration of the calculation of the indexes used in the second part of the data analyses. Word/Non word index for *Situation selection* represents the difference observed for each parameter between the condition Word *Situation selection* and Non-word *Situation selection* (red arrow). This index represents to what extent presenting images with a non-meaningful choice preceding it changes its regulatory impact with respect to having a meaningful choice beforehand. Image reactivity control index represents the difference observed for each parameter between the two groups of *Imposed* images: those also seen in the Word *Situation selection* condition and those also seen in the Non-word *Situation selection* condition (blue arrow). Since these images are different, this index reports the difference in reactivity for the two groups of image independently of any regulation attempts and reflects different emotion induction potentials of the different images. This index is used to decide if differences between emotion regulation conditions can or cannot be attributed to the different images. Significance indication within the bars indicates results of independent sample *t-test* (0-centered distribution) while significance indications between the two indexes represent results of paired *t-test* computed between them. (For interpretation of the references to color in this figure, the reader is referred to the web version of this article.)

3.2. The impact of Situation selection

3.2.1. Experience

During negative picture viewing, we observed a marginal effect of Regulation, $F_{(1,60)} = 3.78$, $p = .057$, $\eta_p^2 = 0.06$, but no Regulation × Time interaction, $F_{(3, 173)} = 0.74$, $p = .522$, $\eta_p^2 = 0.01$. Given that we had a directed hypothesis for the level of experience due to the robust and recurrent findings of other studies examining *Situation selection*, we dropped time altogether and ran a paired t-test on the negative experience during negative imposed trials, as compared to negative experience during negative *Situation selection* trials. We found a significant t-test $t_{(60)} = 1.94$, $p = .028$, $d = 0.25$. When participants chose the image they wanted to see, this image triggered a negative experience (42.5) that was significantly lower than the reaction to the same image viewed without being chosen (43.8).

Table 1
N, Mean, Standard Error of the Mean (SEM), and 95% Confidence interval CI [95%] of the reaction to negative and positive trials in the *Imposed* condition.

		Negative viewing			Positive viewing		
	N	Mean	SEM	CI [95%]	Mean	SEM	CI [95%]
Experience (/100)	61	46.5	2.3	[41.9; 51.1]	42.6	1.9	[38.8; 46.5]
Expressivity (%Baseline)	61	147	10	[127; 167]	143	8	[126; 159]
Physiological arousal							
Heart rate (Δbpm)	61	−1.33	0.15	[−1.62; −1.03]	−1.00	0.11	[−1.22; −0.78]
Skin conductance (ΔμS)	51	0.02	0.02	[−0.01; 0.06]	−0.07	0.01	[−0.09; −0.05]
Respiratory rate (Δc/min)	60	0.007	0.055	[−0.103; 0.116]	0.023	0.053	[−0.083; 0.129]
Respiratory amplitude (ΔmV)	60	0.007	0.008	[−0.010; 0.023]	−0.013	0.009	[−0.030; 0.004]

During positive picture viewing, the effect of Regulation was not significant, $F_{(1,60)} = 0.24$, $p = .627$, $\eta_p^2 \leq 0.01$. We also found no Regulation × Time interaction, $F_{(3,\ 161)} = 0.64$, $p = .573$, $\eta_p^2 = 0.01$.

3.2.2. Expressivity

The analyses performed on the negative trials did not show a significant effect of Regulation, $F_{(1,60)} = 2.49$, $p = .120$, $\eta_p^2 = 0.04$, nor a significant Regulation × Time interaction, $F_{(4,\ 266)} = 1.02$, $p = .403$, $\eta_p^2 = 0.02$.

The analyses on the positive trials gave no main effect of Regulation, $F_{(1,60)} = 0.41$, $p = .527$, $\eta_p^2 \leq 0.01$, and a marginally significant Regulation × Time interaction, $F_{(5,\ 290)} = 2.24$, $p = .053$, $\eta_p^2 = 0.04$. Post-hoc tests at each time point with Holm-Bonferroni corrections showed a very transient difference in positive expressivity between 5.5 and 6 s after stimulus onset, *Situation selection* triggering less positive expressivity (139%) than when the same image is seen in the *Imposed* condition (153%), $p = .044$, $d = 0.26$.

3.2.3. Heart rate

The analyses on the negative trials gave no main effect of Regulation, $F_{(1,60)} = 1.01$, $p = .319$, $\eta_p^2 = 0.02$, and a marginally significant Regulation × Time interaction, $F_{(3,\ 182)} = 2.13$, $p = .098$, $\eta_p^2 = 0.03$. Post-hoc tests at each time point with Holm-Bonferroni corrections showed a difference between conditions between 0 and 1 s after stimulus onset, *Situation selection* triggering a heart rate change (0.38 bpm, $t_{(60)} = 2.29$, $p = .025$, $d = 0.29$) that was significantly higher than the decrease observed in the *Imposed* condition (−0.52 bpm, $t_{(60)} = 3.34$, $p = .001$, $d = 0.43$), first time-frame: $p < .001$, $d = 0.53$, and second time-frame: $p = .004$, $d = 0.41$.

The analyses on the positive trials gave no main effect of Regulation, $F_{(1,60)} = 0.89$, $p = .348$, $\eta_p^2 = 0.02$, but a significant Regulation × Time interaction, $F_{(3,\ 157)} = 8.59$, $p < .001$, $\eta_p^2 = 0.13$. Post-hoc tests at each time point with Holm-Bonferroni corrections showed that, in the window spanning between 0 and 1 s after stimulus onset (corrected p values ≤.001–.016), *Situation selection* trials triggered no change in heart rate as compared to baseline, $t_{(60)} = 0.68$, $p = .499$, $d = 0.09$, M = 0.14 bpm. This result was significantly different from the decrease already observed in the *Imposed* condition, $t_{(60)} = -4.16$, $p < .001$, $d = -0.53$, M = −0.91 bpm. On the other end, toward the end of the recording period, from 4.5 to 5.5 s after stimulus onset (corrected p values = .024–.04), the opposite situation appeared: imposed pictures triggered a return to baseline level, M = 0.11, $t_{(60)} = 0.47$, $p = .638$, $d = 0.06$, while for *Situation selection* pictures heart rate remained below the baseline, M = −0.77, $t_{(60)} = -2.87$, $p = .006$, $d = -0.37$. This effect is illustrated in Fig. 3.

3.2.4. Skin conductance level

The analyses performed on the negative trials did not show a significant effect of Regulation, $F_{(1,50)} = 0.23$, $p = .634$, $\eta_p^2 < 0.01$, but showed a significant Regulation × Time interaction, $F_{(2,\ 85)} = 5.93$, $p = .006$, $\eta_p^2 = 0.11$. Post-hoc tests at each time point with Holm-Bonferroni corrections showed that, in the window spanning between 0 and 1 s after stimulus onset (corrected p-values = .003–.018), *Situation selection* trials triggered an increase in skin conductance level as compared to baseline, $t_{(50)} = 3.47$, $p = .001$, $d = 0.49$, M = 0.06 μS, that was significantly different from the unchanged level as compared to baseline seen in the *Imposed* condition, $t_{(50)} = -0.38$, $p = .703$, $d = -0.05$ M = −0.01 μS. This effect is illustrated in Fig. 4.

The analyses on the positive trials gave neither main effect of Regulation, $F_{(1,50)} = 0.35$, $p = .559$, $\eta_p^2 < 0.01$, nor significant

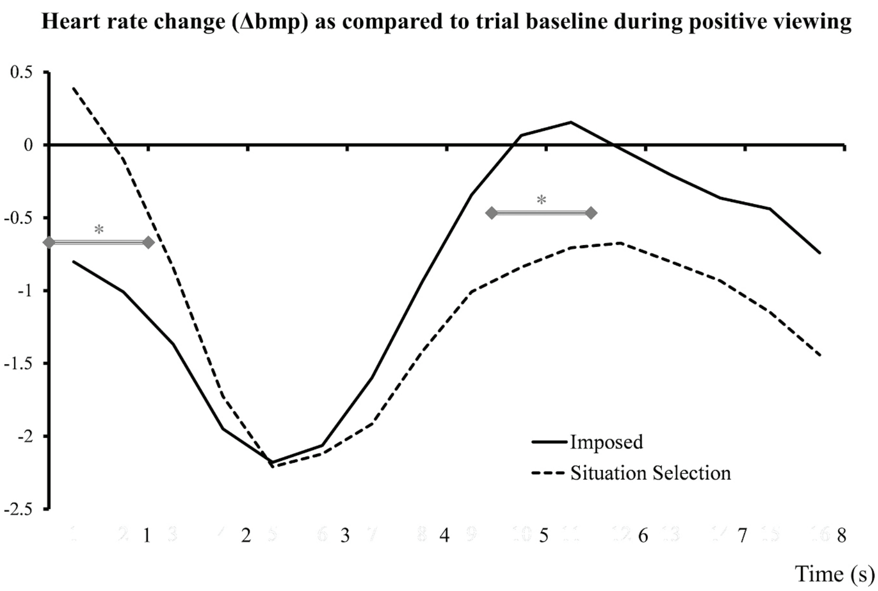

Fig. 3. Impact of *Situation selection* on heart rate during positive trials. The *Imposed* condition is represented with a black continuous lines and the *Situation selection* condition with a grey dashed line. The *Imposed* condition encompassed the responses to the exact same stimuli as the ones in the *Situation selection* (undistinguishable perceptual features and emotional content in these matched stimuli). Significant contrasts are given with diamond-ended lines along the time course. *$p < .05$ with Holm-Bonferroni corrections.

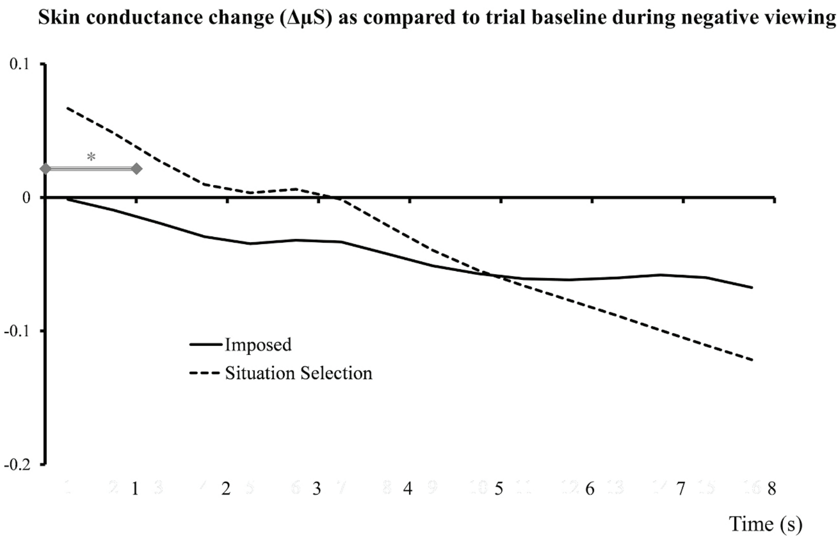

Fig. 4. Impact of *Situation selection* on skin conductance during negative trials. The *Imposed* condition is represented with a black continuous lines and the *Situation selection* condition with a grey dashed line. The *Imposed* condition encompassed the responses to the exact same stimuli as the ones in the *Situation selection* (undistinguishable perceptual features and emotional content in these matched stimuli). Significant contrasts are given with diamond-ended lines along the time course. *$p < .05$ with Holm-Bonferroni corrections.

Regulation × Time interaction, $F_{(2, 84)} = 1.69$, $p = .194$, $\eta_p^2 = 0.03$.

3.2.5. Respiratory rate

The analyses on the respiratory rate for negative viewing showed no effect of the Regulation condition, $F_{(1,59)} = 0.07$, $p = .786$, $\eta_p^2 < 0.01$, nor an Regulation × Time interaction effect, $F_{(3,150)} = 2.05$, $p = .120$, $\eta_p^2 = 0.03$.

Analyses of the respiratory rate for positive viewing also showed no main effect of Regulation, $F_{(1,59)} = 1.23$, $p = .273$, $\eta_p^2 = 0.02$, but revealed a significant interaction between Regulation and Time, $F_{(3,169)} = 8.61$, $p < .001$, $\eta_p^2 = 0.13$. Post-hoc tests at each time point with Holm-Bonferroni corrections showed that, in the window spanning between 5.5 and 6 s after stimulus onset, and from 7 s onwards (corrected p values = .007–.036), *Situation selection* trials triggered a decrease in respiratory rate as compared to baseline, $t_{(59)} = -3.30 - -2.87$, $p = .002$–$.006$, $d = 0.37$–0.43, M = −0.32 c/min on average, that was significantly different from the unchanged level as compared to baseline seen in the *Imposed* condition, $t_{(59)} = -0.14$–0.15, $p > .88$, $d \leq 0.01$–0.02, M = 0 c/min. This effect is illustrated in Fig. 5.

3.2.6. Respiratory amplitude

The analyses on the respiratory amplitude showed no effect of the Regulation condition, $F_{(1,60)} = 0.65$, $p = .423$, $\eta_p^2 = 0.01$, for negative viewing and $F_{(1,60)} = 0.01$, $p = .907$, $\eta_p^2 < 0.01$ for positive viewing, nor an Regulation × Time interaction effect, $F_{(2,126)} = 1.99$, $p = .138$, $\eta_p^2 = 0.03$ for negative and $F_{(3,162)} = 1.37$, $p = .255$, $\eta_p^2 = 0.02$ for positive.

3.3. The effect of choosing between non-meaningful options

3.3.1. Experience

For negative experience, repeated-measure ANOVAs with the NWSS factor (Non-word *Imposed* vs. Non-word *Situation selection*) and Time yielded non-significant effects, NWSS main effect: $F_{(1,60)} = 1.14$, $p = .290$, $\eta_p^2 = 0.02$; NWSS × Time: $F_{(3,177)} = 1.59$, $p = .194$, $\eta_p^2 = 0.03$. Since the WNW × Time interaction was also not significant, $F_{(2,144)} = 1.89$, $p = .146$, $\eta_p^2 = 0.03$, we considered for the next analysis the complete 8-s viewing.

Our complementary analyses showed that Non-word *Situation selection* trials triggered an affective experience that was 3.12 point superior to Word *Situation selection*, $t_{(60)} = -3.03$, $p = .004$, $d = 0.39$. This could however be explained by the difference of experience felt while seeing the different images of the different conditions, which also triggered a difference, this time of 2.51, $t_{(60)} = -2.62$, $p = .011$, $d = 0.34$. Both deltas were not statistically different, $t_{(60)} = 0.70$, $p = .487$, $d = 0.09$. This result is shown in Fig. 6 (left).

For positive experience, repeated-measure ANOVAs with the NWSS

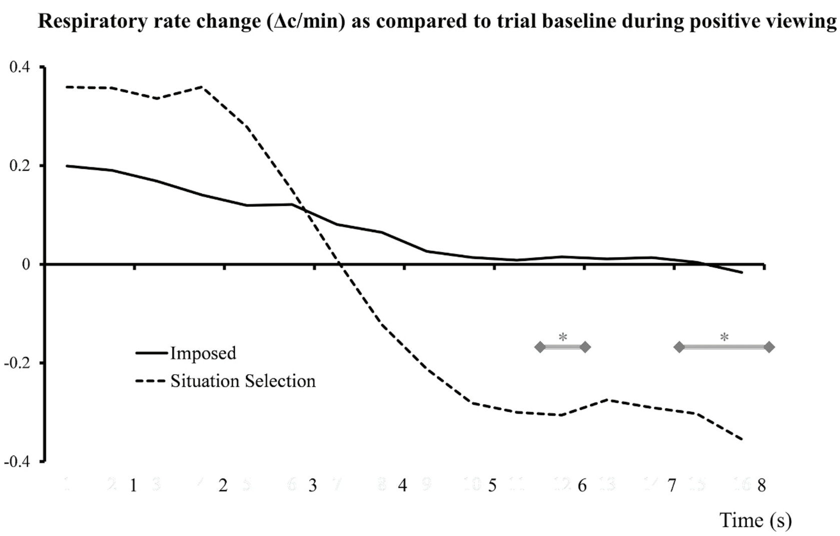

Fig. 5. Impact of *Situation selection* on respiratory rate during positive trials. The *Imposed* condition is represented with a black continuous line and the *Situation selection* condition with a grey dashed line. The *Imposed* condition encompassed the responses to the exact same stimuli as the ones in the *Situation selection* (undistinguishable perceptual features and emotional content in these matched stimuli). Significant contrasts are given with diamond-ended lines along the time course. *$p < .05$ with Holm-Bonferroni corrections.

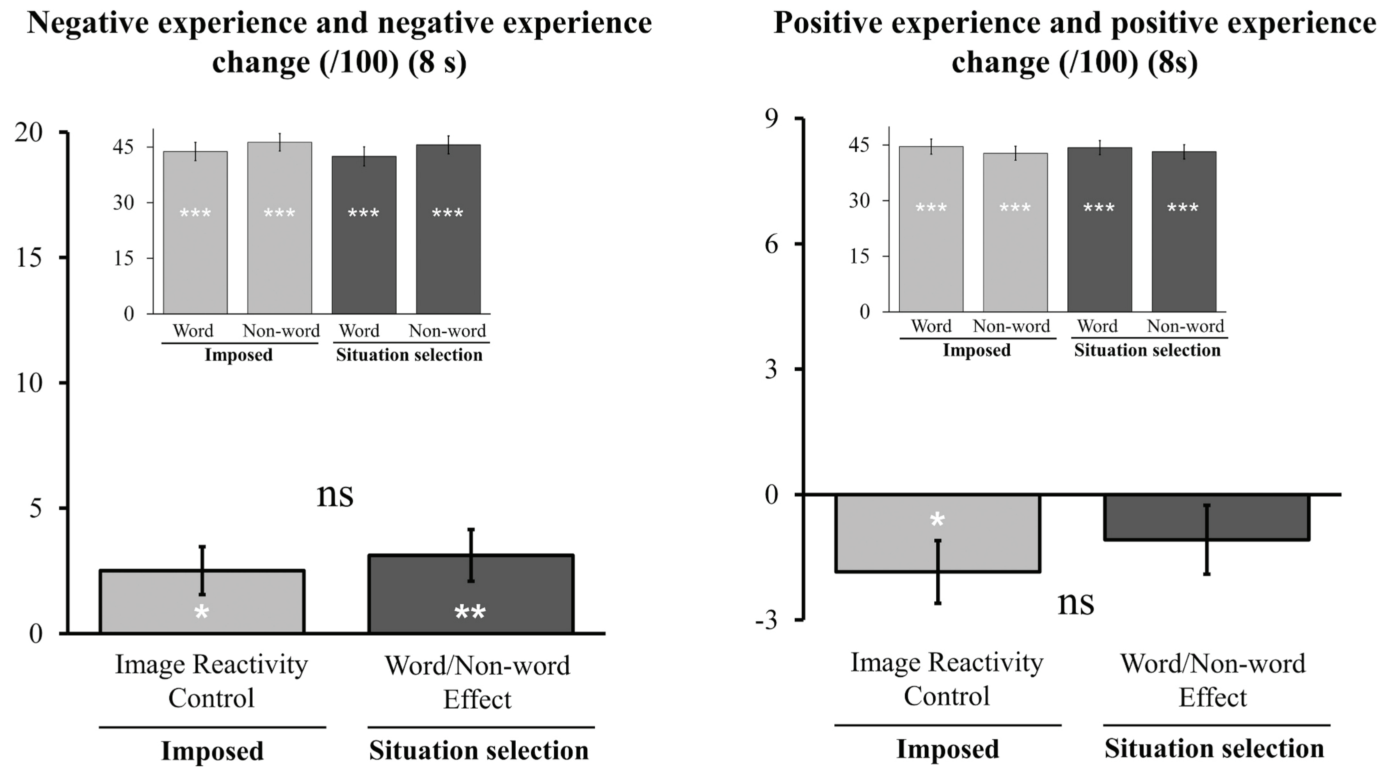

Fig. 6. Experience and experience change following negative (left) and positive (right) image presentation. Main figures illustrate the Word/Non-word effect (dark grey bars) as compared to the difference in image reactivity (control, light grey bars). Inserts present the reactivity to each condition helping for main figure interpretation. Error bars are SEM. Significance are indicated within the bars for contrast to 0-centered distributions, ***$p < .001$, **$p < .01$,*$p < .05$, ns = non-significant.

factor (Non-word *Imposed* vs. Non-word *Situation selection*) and Time yielded no significant effects, NWSS main effect: $F_{(1,60)} = 0.66$, $p = .421$, $\eta_p^2 = 0.01$; NWSS × Time: $F_{(3,150)} = 1.22$, $p = .302$, $\eta_p^2 = 0.02$. Since the WNW × Time interaction was also not significant, $F_{(3,150)} = 0.99$, $p = .390$, $\eta_p^2 = 0.02$, we considered for the next analysis the complete 8-s viewing.

We next noticed that Non-word *Situation selection* triggered a similar positive affective experience to Word *Situation selection*, $t_{(60)} = 1.31$, $p = .194$, $d = 0.17$. This, despite the fact that the images of both group triggered in the *Imposed* condition a difference of 1.85 point in positive affective experience, $t_{(60)} = -2.47$, $p = .016$, $d = 0.32$. Both deltas were however not statistically different, $t_{(60)} = -0.93$, $p = .357$, $d = 0.12$. This result is shown in Fig. 6 (right).

3.3.2. Expressivity

Regarding negative expressivity, repeated-measure ANOVAs with the NWSS factor (Non-word *Imposed* vs. Non-word *Situation selection*) and Time yielded non-significant effects, NWSS main effect: $F_{(1,60)} = 0.78$, $p = .380$, $\eta_p^2 = 0.01$; NWSS × Time: $F_{(4,239)} = 1.41$, $p = .338$, $\eta_p^2 = 0.02$. Since the WNW × Time interaction was also not significant, $F_{(4,268)} = 0.84$, $p = .511$, $\eta_p^2 = 0.01$, we considered the full viewing window for the next analysis.

We next noticed that Non-word *Situation selection* triggered a similar negative expressivity to Word *Situation selection*, $t_{(60)} = -1.88$, $p = .064$, $d = 0.24$. There was also no difference in expressive intensity triggered by the different images allocated to the different groups, $t_{(60)} = 0.114$, $p = .910$, $d = 0.01$. Both deltas were also not statistically different, $t_{(60)} = 1.39$, $p = .170$, $d = 0.18$.

For positive expressivity, repeated-measure ANOVAs with the NWSS factor (Non-word *Imposed* vs. Non-word *Situation selection*) and Time yield a marginal main effect of NWSS: $F_{(1,60)} = 3.59$, $p = .063$, $\eta_p^2 = 0.06$, showing that participants were more prone to smile (154%) to the same image when they had previously chosen from non-meaningful words than without the choice (142%). NWSS × Time was not significant, $F_{(3,204)} = 1.16$, $p = .330$, $\eta_p^2 = 0.02$. Since the WNW × Time interaction was not significant, $F_{(4,262)} = 1.28$, $p = .275$, $\eta_p^2 = 0.02$, the full window was thus further considered.

We next noticed that Non-word *Situation selection* triggered a similar positive expressivity to Word *Situation selection*, $t_{(60)} = 1.67$, $p = .099$, $d = 0.21$. There was also no difference in expressive intensity triggered by the different images allocated to the different groups, $t_{(60)} = -0.97$, $p = .337$, $d = 0.12$. Both deltas were also not statistically different, $t_{(60)} = -1.58$, $p = .120$, $d = 0.20$.

3.3.3. Heart rate

For negative trials, repeated-measure ANOVAs with the NWSS factor (Non-word *Imposed* vs. Non-word *Situation selection)* and Time yielded a significant NWSS main effect: $F_{(1,60)} = 7.72$, $p = .007$, $\eta_p^2 = 0.11$, indicating that decrease in heart rate in reaction to imposed pictures was stronger (−1.41 bpm) than that when participants saw the same image but with a preceding non-meaningful choice (−0.76 bpm). NWSS × Time interaction was not significant, $F_{(3,199)} = 1.25$, $p = .294$, $\eta_p^2 = 0.02$. Since the WNW × Time interaction was also not significant, $F_{(3,204)} = 2.41$, $p = .060$, $\eta_p^2 = 0.04$, the full window was thus further considered.

We then noticed that Non-word *Situation selection* did not trigger significantly different heart rate change than the one observed in reaction to Word *Situation selection*, $t_{(60)} = 0.93$, $p = .356$, $d = 0.12$. This is similar to when comparing the images of both groups in an *Imposed* condition, $t_{(60)} = -1.11$, $p = .270$, $d = 0.14$. Both deltas were only marginally different, $t_{(60)} = 1.68$, $p = .097$, $d = 0.22$. For the sake of comparison to heart rate results with positive pictures, these null results are shown in Fig. 7 (left).

For positive trials, repeated-measure ANOVAs with the NWSS factor (Non-word *Imposed* vs. Non-word *Situation selection*) and Time yielded

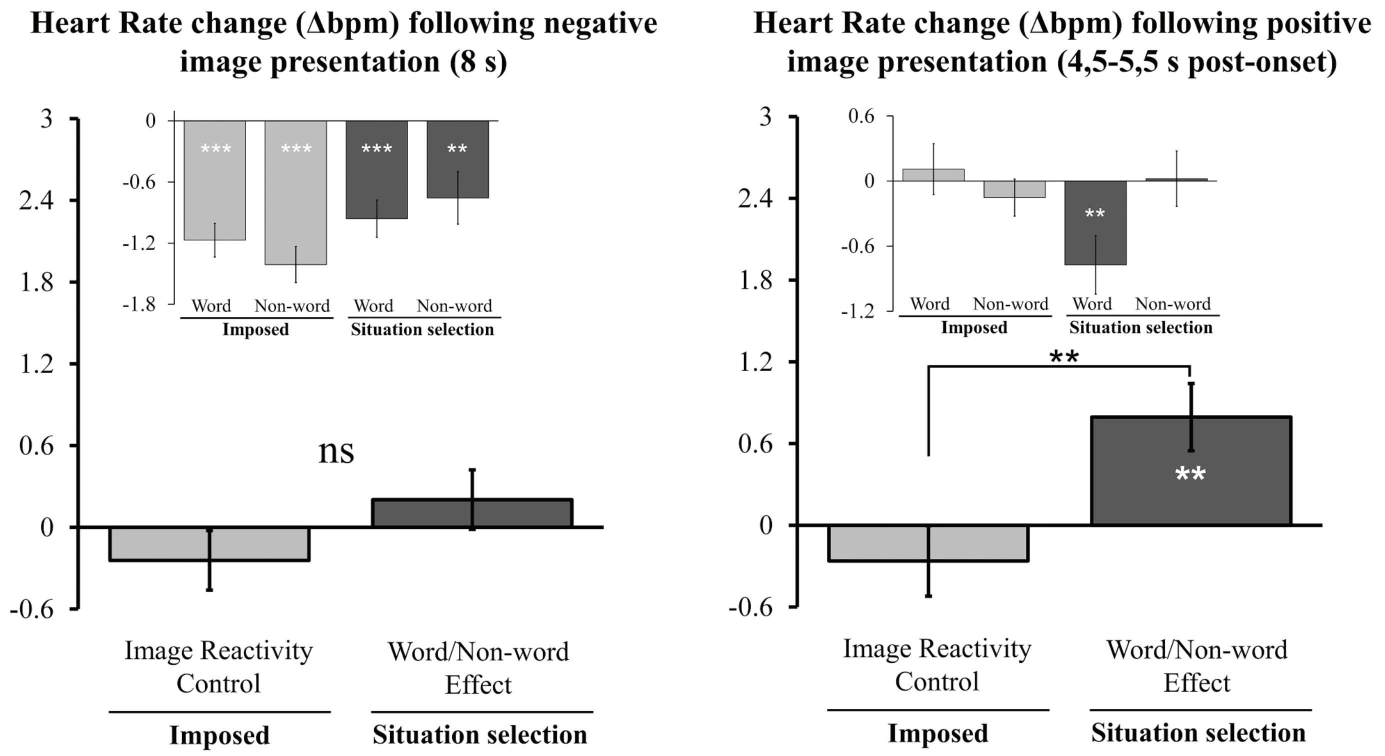

Fig. 7. Heart rate changes following negative (left) and positive (right) image presentation. Main figures illustrate the Word/Non-word effect (dark grey bars) as compared to the difference in image reactivity (control, light grey bars). Inserts present the reactivity to each condition helping for main figure interpretation. Error bars are SEM. Significance are indicated within the bars for contrast to 0-centered distributions, ***$p < .001$, **$p < .01$, ns = non-significant.

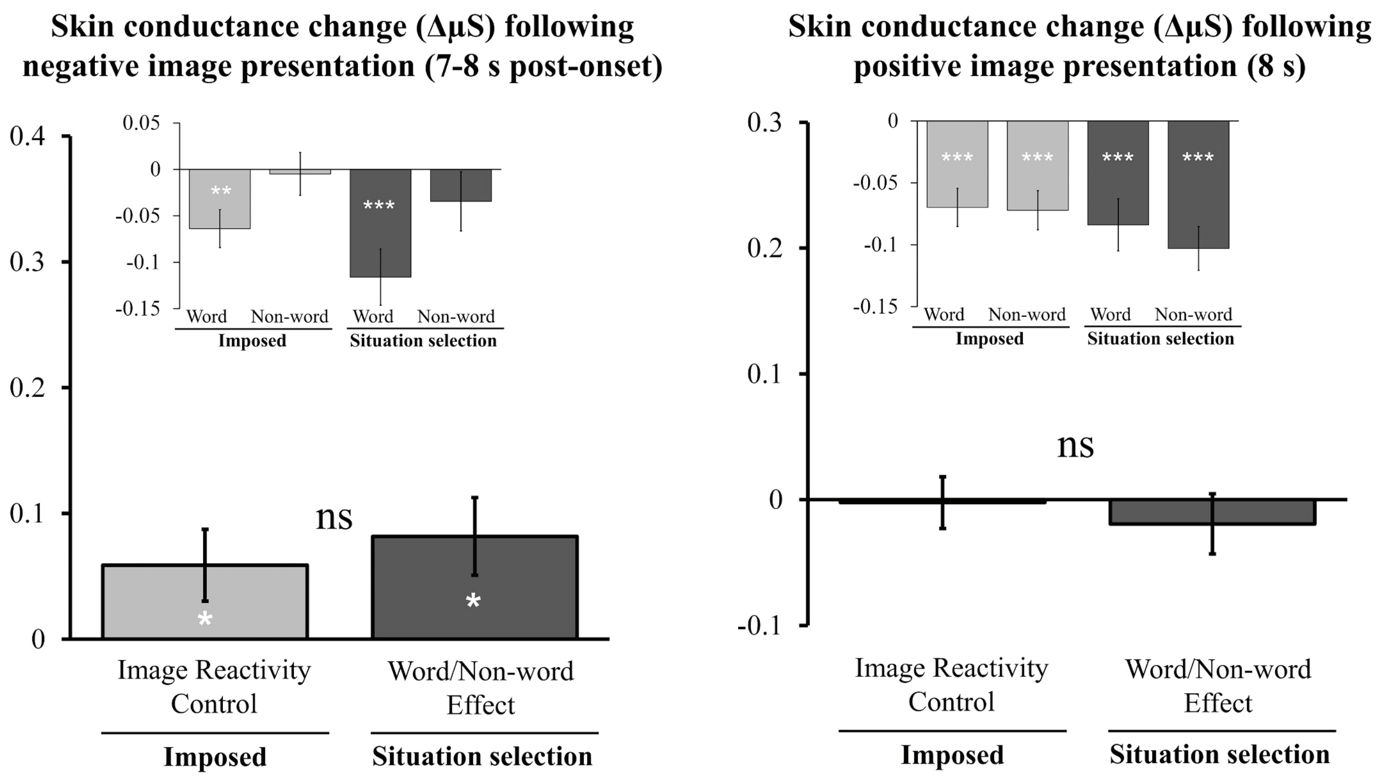

Fig. 8. Skin conductance changes following negative image presentation over the last second of the presentation (left) and positive image presentation over the entire viewing period (right). Main figures illustrate the Word/Non-word effect (dark grey bars) as compared to the difference in image reactivity (control, light grey bars). Inserts present the reactivity to each condition helping for main figure interpretation. Error bars are SEM. Significance are indicated within the bars for contrast to 0-centered distributions, ***$p < .001$, **$p < .01$, *$p < .05$, ns = non-significant.

non-significant effects, NWSS main effect: $F_{(1,60)} = 0.42$, $p = .522$, $\eta_p^2 < 0.01$; NWSS × Time: $F_{(3,176)} = 0.25$, $p = .859$, $\eta_p^2 < 0.01$. The WNW × Time interaction was however this time significant, $F_{(4,215)} = 3.56$, $p = .010$, $\eta_p^2 = 0.06$. Bonferroni-Holm contrasts showed that the difference between the conditions took place 4.5 to 5.5 s after stimulus onset, corrected $p = .002–.006$, $d = 0.40–0.41$. This window was thus considered for further analyses.

Within this time frame, we noticed that Word *Situation selection* triggered a decrease in heart rate (−0.773 bpm) that was not observed with Non-word *Situation selection*, M = 0.02 bmp, $t_{(60)} = 3.23$, $p = .002$, $d = 0.41$. This could not be attributed to the reactivity for the different images in the group, $t_{(60)} = -1.01$, $p = .316$, $d = 0.13$. Both deltas were significantly different, $t_{(60)} = -2.95$, $p = .005$, $d = 0.38$. Fig. 7 (right) illustrates this result.

3.3.4. Skin conductance

For negative trials, repeated-measure ANOVAs with the NWSS factor (Non-word *Imposed* vs. Non-word *Situation selection*) and Time yielded non-significant effects, NWSS main effect: $F_{(1,50)} = 0.60$, $p = .444$, $\eta_p^2 = 0.01$; NWSS × Time: $F_{(2,112)} = 0.55$, $p = .599$, $\eta_p^2 = 0.01$. WNW × Time was however significant for skin conductance change to negative viewing, $F_{(2,106)} = 4.41$, $p = .013$, $\eta_p^2 = 0.08$. Bonferroni-Holm contrasts showed that the difference between the conditions took place 7 to 8 s after the stimulus onset, corrected $p = .007–.036$, $d = 0.34–0.40$. This window was thus considered for further analyses.

Next, we noticed that Word *Situation selection* triggered a decrease in skin conductance (−0.12 μS) that was more important than that in Non-word *Situation selection* (−0.03 μS), $t_{(50)} = 2.64$, $p = .011$, $d = 0.37$. This difference could however be attributed to the difference in reactivity between the two groups of images, which also present similar differences, $t_{(50)} = 2.05$, $p = .045$, $d = 0.29$. Both deltas were not significantly different, $t_{(50)} = -0.54$, $p = .593$, $d = 0.07$. These results are shown in Fig. 8 (left).

For positive trials, repeated-measure ANOVAs with the factor NWSS (Non-word *Imposed* vs. Non-word *Situation selection*) and Time yield non-significant NWSS main effect: $F_{(1,50)} = 2.50$, $p = .120$, $\eta_p^2 = 0.05$; and marginally significant NWSS × Time: $F_{(2,113)} = 2.58$, $p = .073$, $\eta_p^2 = 0.05$. WNW × Time was also not significant, $F_{(2,112)} = 0.50$, $p = .631$, $\eta_p^2 = 0.01$, full window was thus further considered.

We noticed that Non-word *Situation selection* triggered a similar skin conductance decrease to Word-*Situation selection*, $t_{(50)} = -0.81$, $p = .422$, $d = 0.11$. This is congruent with the fact that the images of both group also triggered similar decrease in skin conductance, $t_{(50)} = -0.11$, $p = .910$, $d = 0.02$. Both deltas were not statistically different, $t_{(50)} = 0.46$, $p = .649$, $d = 0.04$. These results are shown Fig. 8 (right).

3.3.5. Respiratory rate

For negative trials, repeated-measure ANOVAs with the NWSS factor (Non-word *Imposed* vs. Non-word *Situation selection*) and Time yielded significant NWSS main effect: $F_{(1,59)} = 13.18$, $p < .001$, $\eta_p^2 = 0.18$ indicating that images seen in the Non-word *Situation selection* condition triggered a decrease in respiratory rate (−0.27 c/min) that was not observed when the same image was seen in an *Imposed* condition (0.05 c/min). Significant NWSS × Time interaction, $F_{(3,155)} = 5.63$, $p = .002$, $\eta_p^2 = 0.09$, indicates that this was true from 3.5 s of the viewing onwards. Since the WNW × Time interaction was not significant, $F_{(2,146)} = 0.65$, $p = .557$, $\eta_p^2 = 0.01$, the full window was thus further considered.

We noticed that Non-word *Situation selection* triggered a decrease in respiratory rate (−0.30 c/min) that was more important than that in Word *Situation selection* (−001 c/min), $t_{(59)} = -2.80$, $p = .007$, $d = 0.36$. This difference could not be attributed to the difference in reactivity between the two groups of image, $t_{(59)} = 0.89$, $p = .378$, $d = 0.11$. Both deltas are significantly different, $t_{(59)} = 2.70$, $p = .009$, $d = 0.35$. These results are shown in Fig. 9 (left).

For positive trials, repeated-measure ANOVAs with the NWSS factor (Non-word *Imposed* vs. Non-word *Situation selection*) and Time yielded

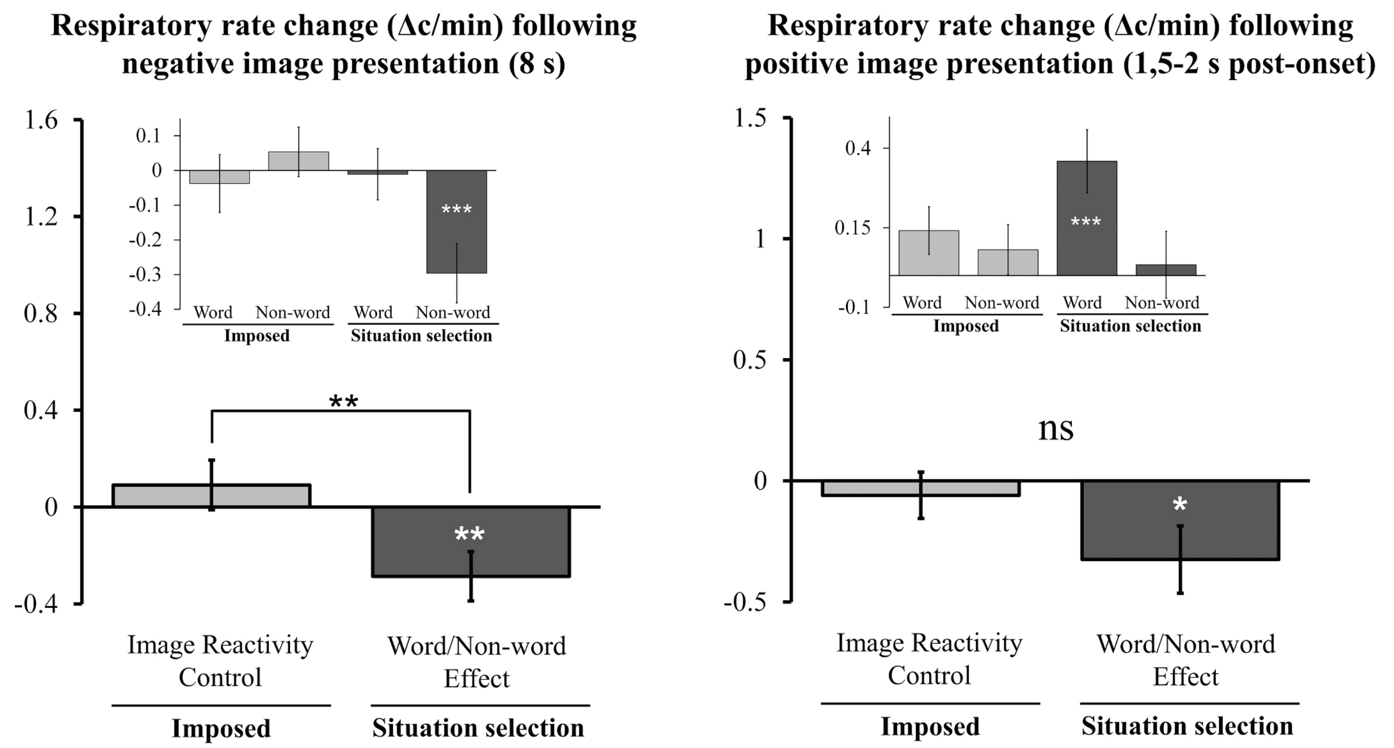

Fig. 9. Respiratory rate changes following negative image presentation over the entire viewing period (left) and positive image presentation over the period spanning between 1.5 and 2 s after image presentation (right). Main figures illustrate the Word/Non-word effect (dark grey bars) as compared to the difference in image reactivity (control, light grey bars). Inserts present the reactivity to each condition helping for main figure interpretation. Error bars are SEM. Significance are indicated within the bars for contrast to 0-centered distributions, ***$p < .001$, **$p < .01$, *$p < .05$, ns = non-significant.

non-significant effects, NWSS main effect: $F_{(1,59)} = 0.28$, $p = .602$, $\eta_p^2 = 0.01$; NWSS × Time: $F_{(3,182)} = 0.36$, $p = .785$, $\eta_p^2 = 0.01$. WNW × Time was however significant, $F_{(3,185)} = 5.34$, $p = .001$, $\eta_p^2 = 0.08$. Bonferroni-Holm contrasts showed that the difference between the Word and Non-word *Situation selection* took place during the fourth time frame, from 1.5 to 2 s after stimulus onset, corrected $p = .022$, $d = 0.30$. This window was thus considered for further analyses.

We noticed that Word *Situation selection* triggered an increase in respiratory rate (0.36 c/min) that was more important than that in Non-word *Situation selection* (0.03 c/min), $t_{(59)} = -2.35$, $p = .022$, $d = 0.30$. This difference could not be attributed to the difference in reactivity between the two groups of images, $t_{(59)} = -0.62$, $p = .536$, $d = 0.08$. Both deltas were however not significantly different, $t_{(59)} = 1.45$, $p = .151$, $d = 0.19$. These results are shown in Fig. 9 (right).

3.3.6. Respiratory amplitude

For negative trials, repeated-measure ANOVAs with the NWSS factor (Non-word *Imposed* vs. Non-word *Situation selection*) and Time yielded non-significant effects, NWSS main effect: $F_{(1,60)} = 0.21$, $p = .649$, $\eta_p^2 < 0.01$; NWSS × Time: $F_{(2,91)} = 0.50$, $p = .556$, $\eta_p^2 = 0.01$. WNW × Time was however significant, $F_{(2,147)} = 3.31$, $p = .030$, $\eta_p^2 = 0.05$. Bonferroni-Holm contrasts showed that the difference between the conditions took place during the first time frame, from 0 to 0.5 s after stimulus onset, corrected $p = .012$, $d = 0.33$. This window was thus considered for further analyses.

We noticed that Word *Situation selection* triggered a change in respiratory amplitude (0.04 mV) that was more important than the change observed in the Non-word *Situation selection* (0.01 mV), $t_{(60)} = -2.58$, $p = .012$, $d = 0.33$. This difference could not be attributed to the difference in reactivity between the two groups of images, $t_{(60)} = -0.20$, $p = .843$, $d = 0.03$. Both deltas were however not significantly different, $t_{(60)} = 1.54$, $p = .128$, $d = 0.20$. These results are shown in Fig. 10 (left).

For positive trials, repeated-measure ANOVAs with the NWSS factor (Non-word *Imposed* vs. Non-word *Situation selection*) and Time yielded non-significant effects, NWSS main effect: $F_{(1,60)} = 3.18$, $p = .080$, $\eta_p^2 = 0.05$; NWSS × Time: $F_{(3,159)} = 0.69$, $p = .542$, $\eta_p^2 = 0.01$. Since the WNW × Time interaction was also not significant, $F_{(3,172)} = 1.59$, $p = .196$, $\eta_p^2 = 0.02$, the full window was thus further considered.

We noticed that Non-word *Situation selection* triggered a similar respiratory amplitude change to Word *Situation selection*, $t_{(60)} = -0.27$, $p = .787$, $d = 0.03$. There was also no difference in amplitude change triggered by the different images allocated to the different groups, $t_{(60)} = -1.85$, $p = .069$, $d = 0.24$. Both deltas were also not statistically different, $t_{(60)} = -0.97$, $p = .336$, $d = 0.12$. For the sake of comparison with negative viewing, results of respiratory amplitude to positive images are presented in Fig. 10 (right).

4. Discussion

The present study had two goals. First, we aimed to replicate the results of the previous studies investigating the effect of *Situation selection* used as an emotion regulation strategy on experience, expressivity and physiological arousal. Second, and given the hypothesis that choice in itself is already regulatory, we wanted to test to what extent a non-meaningful choice would lead to reduced emotional arousal on subsequent emotional image viewing.

The two main results from this study are related to the experience and physiological arousal channels. For emotional experience, we found one-tailed test significance for a reduction in negative emotional experience in Word *Situation selection.* This confirmed hypothesis 1a, despite lower effect sizes than what was found in previous studies on the topic. However, this effect was lost in the Non-word *Situation selection* condition. Regarding positive experience, and congruently with expectation, we found no alteration of positive experience in the Word *Situation selection* condition. Regarding physiological arousal, the reactions were more complex. We expected *Situation selection* to decrease heart rate and

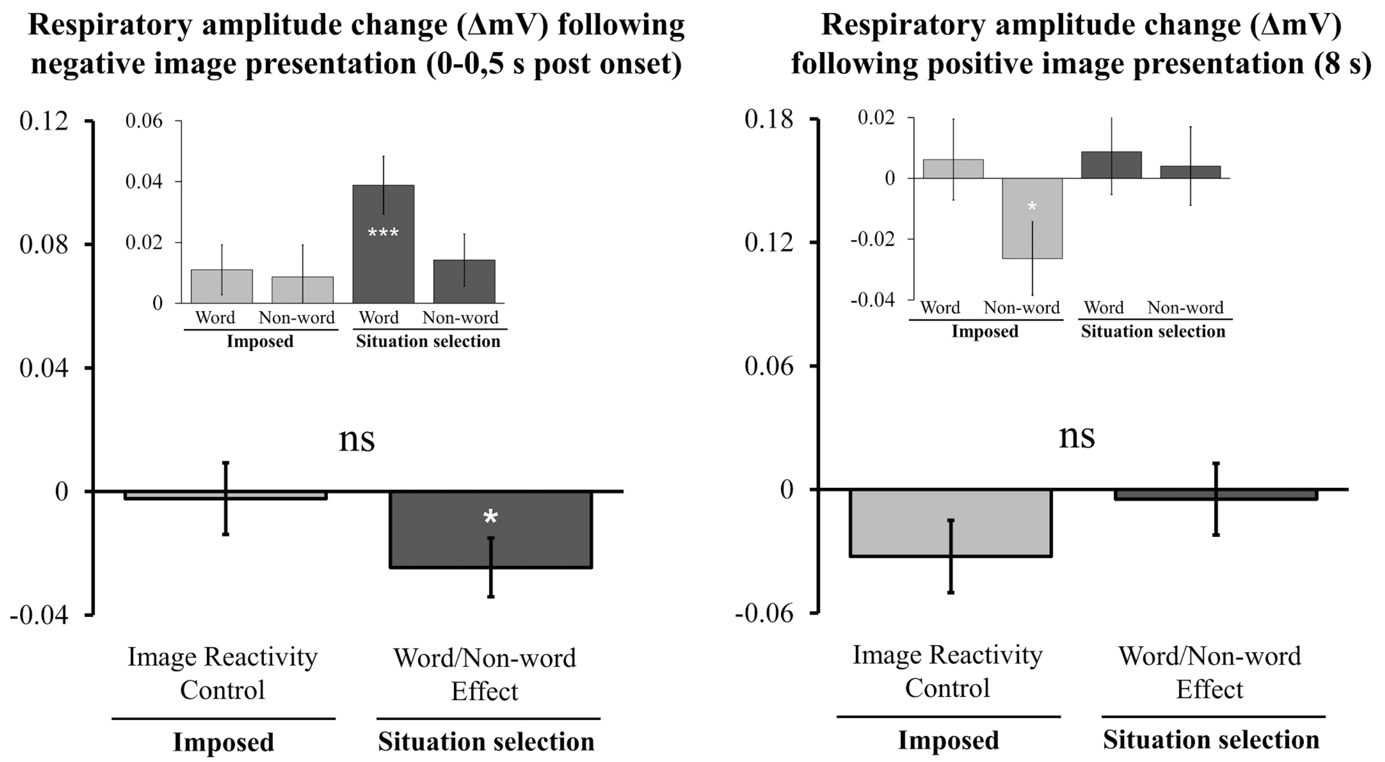

Fig. 10. Respiratory amplitude changes following negative image presentation over the period spanning between 0 and 0.5 s after image presentation (left) and positive image presentation over the 8 s presentation (right). Main figures illustrate the Word/Non-word effect (dark grey bars) as compared to the difference in image reactivity (control, light grey bars). Inserts present the reactivity to each condition helping for main figure interpretation. Error bars are SEM. Significance are indicated within the bars for contrast to 0-centered distributions, ***$p < .001$, *$p < .05$, ns = non-significant.

to cause an interaction pattern for skin conductance (higher levels at the beginning of the viewing period and lower levels at the end of the viewing period), as compared to the *Imposed* condition. Respiratory rate was expected to decrease, particularly toward the end of the recording period, while the amplitude was expected to be lower for negative pictures (late viewing) and higher for positive pictures (early viewing). We expected similar heart rate change (but transient) for Non-word *Situation selection*, similar skin conductance and respiratory changes. Our hypotheses were only partially confirmed, and summary results can be seen in Table 2 below. Hypotheses on heart and respiratory rates were confirmed but only for positive images. The expected skin conductance pattern was present but only partly significant. All these effects were lost when non-meaningful choice was presented beforehand. Interestingly however, Non-word *Situation condition* induced a weaker decrease in heart rate and lower respiratory rate for negative pictures. We discuss in the next paragraph two aspects of these main results, first how difference in image intensity could potentially have blunted the result of experience (see third column Table 2) and how we could interpret the choice procedure's impact on physiological arousal data taken altogether, particularly with respect to expectations.

First, regarding experience. The two groups of images used for testing Word and Non-word *Situation selection* were not equivalent (see Image Reactivity Control bars in Fig. 6). Indeed, despite random attribution of pictures to these conditions, it appears that the negative images that were seen in the Non-word *Situation selection* condition triggered a negative experience that was on average 2.51 points higher than the images presented in the Word *Situation selection* condition. Non-word *Situation selection* positive pictures also triggered less positive experience (1.85 points lower) than images in the Word *Situation selection* condition. Due to this unfortunate difference, we could wonder whether *Situation selection* effects would have been higher in meaningful choice (as it was the case in previous studies) and even were conserved with non-meaningful choice procedure, should the induction power of the picture group had been higher in both conditions. Further studies could also want to test the hypothesis that an interaction could take place between the intensity of the felt emotion and the respective efficiency of the different possible *Situation selection* strategies.

Table 2
Summary of the *Situation selection* effects, both in Word and Non-word condition, as compared to *Imposed*.

	Word *Situation selection*	Non-word *Situation selection*	Difference potentially attributable to different reactivity to images
Experience			
Negative	<I (one-tailed)	=I	Yes
Positive	=I	=I	–
Expressivity			
Negative	=I	=I	–
Positive	=I	=I	–
Physiological arousal			
Heart rate			
Negative	>I (0–1 s)	>I	No
Positive	>I (0–1 s) + <I(4.5–5.5 s)	=I	No
Skin conductance			
Negative	>I (0–1 s)	=I	Yes
Positive	=I	=I	–
Respiratory rate			
Negative	=I	<I	No
Positive	<I (5.5–6 s + 7–8 s)	=I	No
Respiratory amplitude			
Negative	=I	=I	–
Positive	=I	=I	–

A second important point is about the patterns of physiological arousal observed for both regular *Situation selection* and for Non-word *Situation selection.* Starting with regular *Situation selection* we did not find as strong results as for previous studies on the topic. Indeed, similar patterns were noticed (cf. for example that of skin conductance on negative pictures) but the tests hardly did or did not reach significance. This may be due to the fact that in this study, with respect to the previous one, we had about 10% less participants, and also that number of trials for regular *Situation selection* was between 30 and 50% less. Taken together, this may have caused the loss of many effects that should have been significant. Interestingly, *Situation selection* still had an impact on emotional arousal. The key aspect of our design resides in the fact that the same images were compared. Thus, any difference between pairs of trials could not be attributed to different reactivity to pictures that could have a differential emotion induction capacity, a different content or differences in physical property (e.g., luminosity) but uniquely by the fact that one was chosen and the other one was not. With this in mind, we can still assert that the choice procedure in *Situation selection* decreased heart rate and respiratory rate, particularly at the end of the viewing period, and particularly for positive pictures. The differences between our conditions that could occur at different points in time is interesting to note. For example, differences could be transient in the first part of the viewing and not be present at the end of the recording window (e.g., for skin conductance during negative viewing), while other differences seemed to emerge rather late in the process (e.g., for respiratory rate in positive conditions). For this latter case, it remains open whether these differences would remain beyond the 8 second post-stimulation threshold. It will therefore be crucial in future studies to specifically address the significance of this dynamic differences and uncover the biological mechanisms and relevance of the switch (if any) between transient and prolonged effect of emotion regulation.

Non-word *Situation selection*, on the other hand, triggered a decrease in respiratory rate for negative viewing, indicating a calming effect of this condition for negatively valenced pictures, in a similar way as it has already been shown (Thuillard and Dan-Glauser, 2017). Common processes may be at play here between Non-word and Word *Situation selection* that are more present in the current study for Non-word *Situation selection.* One of these components may be expectation, which is higher in the Word- than in the Non-word condition, since people in this latter condition are not aware of the upcoming situation. Affective anticipation has been shown to modify physiological arousal during the situation, but also during the anticipatory phase (Erk et al., 2006; Sabatinelli et al., 2001). Unfortunately, the anticipatory phase in our design has been also considered as a baseline. Chances are that we observed here an intertwined effect of anticipation (or lack thereof), which may explain the effect between our conditions. Future studies should control this important variable, for example by balancing warning to picture content with non-warning picture content so as to disentangle the effect of affective expectation with the effect of non-meaningful *Situation selection.*

The reduction in respiratory rate observed in Non-word *Situation selection* could also be compared to previous results found for Illusory choice (Thuillard and Dan-Glauser, 2020). In this past study, using a similar design as the present one, participants could choose between two pictures which one they wanted to see, but the non-chosen option was presented, thus representing an Illusory choice. This variant of *Situation selection* had been found to significantly reduce respiratory rate at the end of negative picture viewing, compared to Imposed pictures. The fact that the same effect was found in the present study might point to a robust, core effect of choice on physiological arousal. Indeed, choosing between negative options, and regardless of whether the choice is respected or not, and based on words or non-words, will reduce physiological arousal by slowing respiration rate. This effect has now been found repeatedly and appears to be quite robust and reliable, no matter if the situation unfolds as expected, or if the choice appears to be meaningful. This is probably one the major impact of choice effect in

Situation selection, even if the individual cannot foreseen the consequences of the choice that is made.

Several limitations can be highlighted regarding this study. First, we lacked a condition in which an imposed image would be preceded by a non-word. As a consequence, our Non-word *Situation selection* condition, as compared to the Non-word *Imposed* could not fully disentangle the effect of choice and the effect of expectation that was present in the *Imposed* but not in the *Situation selection* condition. Expectation may play an important role in emotional arousal as reactions may be anticipated, which could lead to a better control of the emotional responses when they happen, or an anticipatory arousal as previously discussed. Second, choice was limited to two options, which is very particular as we could not know whether the choice was made according to preference for the chosen option, or avoidance for the alternative. The choice given to participants would deserve to be extended to a less limited and more ecologically valid set of options. Third, we considered here broad valence affects (positive and negative) as raised by dimensional theorists of affect (Barrett et al., 2007; Posner et al., 2005; Russell, 1980). This distinction has the advantage of limiting the problem of boundaries between emotion categories, which are linked to the frequent occurrence of mixed emotions (Ellsworth and Scherer, 2003). Still, we admit that this approach cannot inform on the efficiency of *Situation selection* for particular emotions such as joy, fear, anger or sadness. Further investigations on the type of affect induced may provide more guidance for implementing *Situation selection* in daily situations.

This study investigated whether the effect of *Situation selection* goes beyond the choice we make and occurs irrespective of the meaning of the options that are presented. We confirmed that the choice process is determinant in the regulation effect for negative experience and some physiological measures of emotion such as skin conductance and respiration. However, we did not find as many regulatory effects when the options given as a choice in the *Situation selection* procedure were non-meaningful (non-words). This point is essential when reflecting upon implementing a decision to regulate emotion in daily life situations or for advising it in case of patient emotion regulation coaching. For this latter case, particular attention should be given to the concept of agency, which is reinforced by the meaningful aspect of a choice that is given (Cardona-Rivera et al., 2014). Hence, in this particular case, *Situation selection* should be advised only if there is a good understanding of the available options by the participant, or if the emotional response to be regulated is only limited in number (for example focusing on respiration). Thus, depending on the individual needs and capabilities, unclear consequences of each possible choice could thus be counterproductive and annihilate any positive regulatory mechanism of *Situation selection*. Altogether, our study hence confirms that *Situation selection* is an efficient emotion regulation strategy, but that each option given to select from to perform this strategy should be well-understood by the person who wants to downregulate negative emotions over the full spectrum of emotion responses. However, even non-meaningful options could be considered as regulation inducing if only specific channels are to be targeted.

Funding

This work was supported by two Swiss National Science Foundation grants, PZ00P1_161509 and PCEFP1_186836, to E.D-G.

References

Barrett, L.F., Mesquita, B., Ochsner, K.N., Gross, J.J., 2007. The experience of emotion. Annu. Rev. Psychol. 58, 373–403.

Blanchette, I., Richards, A., 2004. Reasoning about emotional and neutral materials: is logic affected by emotion? Psychol. Sci. 15 (11), 745–752. https://doi.org/10.1111/j.0956-7976.2004.00751.x.

Bradley, M. M., & Lang, P. J. (2000). Measuring emotion: behavior, feeling, and physiology. In R.D. Lane & L. Nadel (Eds.), Cognitive Neuroscience of Emotion (pp. 242–276). New York, NY: Oxford University Press.

Bradley, M. M., Greenwald, M. K., & Hamm, A. O. (1993). Affective picture processing. In N. Birbaumer & A. Öhman (Eds.), The Structure of Emotion: Psychophysiological, Cognitive, and Clinical Aspects (pp. 48–65). Toronto, CA: Hogrefe & Huber.

Campbell-Sills, L., & Barlow, D. H. (2007). Incorporating emotion regulation into conceptualizations and treatments of anxiety and mood disorders. In J. J. Gross (Ed.), Handbook of Emotion Regulation (pp. 542–559). New York, NY: Guilford Press.

Cardona-Rivera, R. E., Robertson, J., Ware, S. G., Harrison, B., Roberts, D. L., & Young, R. M. (2014, September). Foreseeing meaningful choices. Paper Presented at the Tenth Artificial Intelligence and Interactive Digital Entertainment Conference, Raleigh, NC, USA.

Cloitre, M., Stovall-McClough, K., Miranda, R., & Chemtob, C. M. (2004). Therapeutic alliance, negative mood regulation, and treatment outcome in child abuse-related posttraumatic stress disorder. J. Consult. Clin. Psychol., 72(3), 411–416. doi:https://doi.org/10.1037/0022-006X.72.3.411.

Codispoti, M., Bradley, M.M., Lang, P.J., 2001. Affective reactions to briefly presented pictures. Psychophysiology 38 (3), 474–478.

Cohen, J., 1988. Statistical Power Analysis for the Behavioral Sciences, 2nd ed. Erlbaum, Hillsdale, NJ.

Dan-Glauser, E.S., Gross, J.J., 2011. The temporal dynamics of two response-focused forms of emotion regulation: experiential, expressive, and autonomic consequences. Psychophysiology 48 (9), 1309–1322. https://doi.org/10.1111/j.1469-8986.2011.01191.x.

Dan-Glauser, E.S., Gross, J.J., 2015. The temporal dynamics of emotional acceptance: experience, expression, and physiology. Biol. Psychol. 108, 1–12. https://doi.org/10.1016/j.biopsycho.2015.03.005.

Dan-Glauser, E.S., Scherer, K.R., 2011. The Geneva affective picture database (GAPED): a new 730-picture database focusing on valence and normative significance. Behav. Res. Methods 43 (2), 468–477. https://doi.org/10.3758/s13428-011-0064-1.

de Wied, M., van Boxtel, A., Zaalberg, R., Goudena, P. P., & Matthys, W. (2006). Facial EMG responses to dynamic emotional facial expressions in boys with disruptive behavior disorders. J. Psychiatr. Res., 40(2), 112–121.

Dolcos, F., LaBar, K.S., Cabeza, R., 2004. Dissociable effects of arousal and valence on prefrontal activity indexing emotional evaluation and subsequent memory: an event-related fMRI study. NeuroImage 23 (1), 64–74.

Duyck, W., Desmet, T., Verbeke, L.P.C., Brysbaert, M., 2004. WordGen: a tool for word selection and nonword generation in Dutch, English, German, and French. Behav. Res. Methods Instrum. Comput. 36 (3), 488–499. https://doi.org/10.3758/BF03195595.

Eisenberg, N., Fabes, R.A., Guthrie, I.K., Reiser, M., 2000. Dispositional emotionality and regulation: their role in predicting quality of social functioning. J. Pers. Soc. Psychol. 78 (1), 136–157. https://doi.org/10.1037//0022-3514.78.1.136.

Ellsworth, P. C., & Scherer, K. R. (2003). Appraisal processes in emotion. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), Handbook of Affective Sciences (pp. 572–595). New York, NY: Oxford University Press.

Erk, S., Abler, B., Walter, H., 2006. Cognitive modulation of emotion anticipation. Eur. J. Neurosci. 24 (4), 1227–1236. Retrieved from. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1460-9568.2006.04976.x.

Esslen, M., Pascual-Marqui, R.D., Hell, D., Kochi, K., Lehmann, D., 2004. Brain areas and time course of emotional processing. NeuroImage 21 (4), 1189–1203. https://doi.org/10.1016/j.neuroimage.2003.10.001.

Frank, M.G., Ekman, P., Friesen, W.V., 1993. Behavioral markers and recognizability of the smile of enjoyment. J. Pers. Soc. Psychol. 64 (1), 83.

Fridlund, A.J., Cacioppo, J.T., 1986. Guidelines for human electromyographic research. Psychophysiology 23 (5), 567–589.

Gatti, E., Calzolari, E., Maggioni, E., Obrist, M., 2018. Emotional ratings and skin conductance response to visual, auditory and haptic stimuli. Scientific Data 5 (1). https://doi.org/10.1038/sdata.2018.120.

Giffard, B., Laisney, M., Eustache, F., Desgranges, B., 2009. Can the emotional connotation of concepts modulate the lexico-semantic deficits in Alzheimer's disease? Neuropsychologia 47 (1), 258–267. https://doi.org/10.1016/j.neuropsychologia.2008.07.013.

Glenn, C.R., Klonsky, E.D., 2009. Emotion dysregulation as a core feature of borderline personality disorder. J. Personal. Disord. 23 (1), 20–28.

Gross, J.J., 1998. The emerging field of emotion regulation: an integrative review. Rev. Gen. Psychol. 2 (3), 271–299. https://doi.org/10.1037/1089-2680.2.3.271.

Gross, J.J., John, O.P., 2003. Individual differences in two emotion regulation processes: implication for affect, relationships, and well-being. J. Pers. Soc. Psychol. 85 (2), 348–362. https://doi.org/10.1037/0022-3514.85.2.348.

Gross, J.J., Muñoz, R.F., 1995. Emotion regulation and mental health. Clin. Psychol. Sci. Pract. 2 (2), 151–164. https://doi.org/10.1111/j.1468-2850.1995.tb00036.x.

Gross, J. J., & Thompson, R. A. (2007). Emotion regulation: conceptual foundations. In J. J. Gross (Ed.), Handbook of Emotion Regulation (pp. 3–24). New York, NY: Guilford Press.

Hayes, S.C., Wilson, K.G., Gifford, E.V., Follette, V.M., Strosahl, K., 1996. Experiential avoidance and behavioral disorders: a functional dimensional approach to diagnosis and treatment. J. Consult. Clin. Psychol. 64 (6), 1152–1168. https://doi.org/10.1037/0022-006X.64.6.1152.

Henry, J.D., Green, M.J., de Lucia, A., Restuccia, C., McDonald, S., O'Donnell, M., 2007. Emotion dysregulation in schizophrenia: reduced amplification of emotional expression is associated with emotional blunting. Schizophr. Res. 95 (1), 197–204.

Hubert, W., de Jong-Meyer, R., 1991. Autonomic, neuroendocrine, and subjective response to emotion-inducing film stimuli. Int. J. Psychophysiol. 11 (2), 131–140.

Jazaieri, H., McGonigal, K., Lee, I.A., Jinpa, T., Doty, J.R., Gross, J.J., Goldin, P.R., 2017. Altering the trajectory of affect and affect regulation: the impact of compassion training. Mindfulness. https://doi.org/10.1007/s12671-017-0773-3.

Kensinger, E.A., Schacter, D.L., 2006. Processing emotional pictures and words: effects of valence and arousal. Cognitive, Affective, & Behavioral Neuroscience 6 (2), 110–126.
Kim, S.H., Hamann, S., 2007. Neural correlates of positive and negative emotion regulation. J. Cogn. Neurosci. 19 (5), 776–798.
Kredlow, A.M., Pineles, S.L., Inslicht, S.S., Marin, M.F., Milad, M.R., Otto, M.W., Orr, S. P., 2017. Assessment of skin conductance in African American and non-African American participants in studies of conditioned fear. Psychophysiology 54 (11), 1741–1754. https://doi.org/10.1111/psyp.12909.
Kring, A.M., Gordon, A.H., 1998. Sex differences in emotion: expression, experience, and physiology. J. Pers. Soc. Psychol. 74 (3), 686.
Lang, P.J., Greenwald, M.K., Bradley, M.M., Hamm, A.O., 1993. Looking at pictures: affective, facial, visceral, and behavioral reactions. Psychophysiology 30 (3), 261–273. https://doi.org/10.1111/j.1469-8986.1993.tb03352.x.
Lang, P.J., Bradley, M.M., Cuthbert, B.N., 1997. Motivated attention: affect, activation, and action. In: Lang, P.J., Simons, R.F., Balaban, M.T. (Eds.), Attention and Orienting: Sensory and Motivational Processes, vol. 97-136. Erlbaum Associates, Hillsdale, NJ.
Lang, P.J., Bradley, M.M., Cuthbert, B.N., 1999. International Affective Picture System (IAPS): Instruction Manual and Affective Ratings. Retrieved from Technical Report A-4. Center for Research in Psychophysiology.
Larsen, J.T., Norris, C.J., Cacioppo, J.T., 2003. Effects of positive and negative affect on electromyographic activity over zygomaticus major and corrugator supercilii. Psychophysiology 40 (5), 776–785. https://doi.org/10.1111/1469-8986.00078.
Lazarus, R.S., 1991. Emotion and Adaptation. Oxford University Press, London.
Livingstone, K.M., Isaacowitz, D.M., 2015. Situation selection and modification for emotion regulation in younger and older adults. Soc. Psychol. Personal. Sci. 6 (8), 904–910. https://doi.org/10.1177/1948550615593148.
Mak, A.K., Hu, Z.-g., Zhang, J.X., Xiao, Z.-w., Lee, T.M., 2009. Neural correlates of regulation of positive and negative emotions: an fMRI study. Neurosci. Lett. 457 (2), 101–106.
Matsumoto, D., Nezlek, J.B., Koopmann, B., 2007. Evidence for universality in phenomenological emotion response system coherence. Emotion 7 (1), 57.
Mauss, I.B., Levenson, R.W., McCarter, L., Wilhelm, F.H., Gross, J., 2005. The tie that binds? Coherence among emotion experience, behavior, and physiology. Emotion 5 (2), 175–190. https://doi.org/10.1037/1528-3542.5.2.175.
Mennin, D.S., Heimberg, R.G., Turk, C.L., Fresco, D.M., 2002. Applying an emotion regulation framework to integrative approaches to generalized anxiety disorder. Clin. Psychol. Sci. Pract. 9 (1), 85–90. https://doi.org/10.1093/clipsy.9.1.85.
Mennin, D.S., Heimberg, R.G., Turk, C.L., Fresco, D.M., 2005. Emotion regulation deficits as a key feature of generalized anxiety disorder: testing a theoretical model. Behav. Res. Ther. 43, 1281–1310.
Novik, N., 1974. Parralel processing in a word-nonword classification task. J. Exp. Psychol. 102 (6), 1015–1020. https://doi.org/10.1037/h0036459.
Palomba, D., Angrilli, A., Mini, A., 1997. Visual evoked potentials, heart rate responses and memory to emotional pictorial stimuli. Int. J. Psychophysiol. 27 (1), 55–67.
Posner, J., Russell, J.A., Peterson, B.S., 2005. The circumplex model of affect: an integrative approach to affective neuroscience, cognitive development, and psychopathology. Dev. Psychopathol. 17 (3), 715–734.
Russell, J.A., 1980. A circumplex model of affect. J. Pers. Soc. Psychol. 39, 1161–1178.
Sabatinelli, D., Bradley, M.M., Lang, P.J., 2001. Affective startle modulation in anticipation and perception. Psychophysiology 38 (4), 719–722. Retrieved from. https://onlinelibrary.wiley.com/doi/abs/10.1111/1469-8986.3840719?sid=nlm%3Apubmed.
Sands, M., Isaacowitz, D.M., 2016. Situation selection across adulthood: the role of arousal. Cognit. Emot. 31 (4), 791–798. https://doi.org/10.1080/02699931.2016.1152954.
Stanners, R.F., Forbach, G.B., Headley, D.B., 1971. Decision and search processings in word-nonword classification. J. Exp. Psychol. 90 (1) https://doi.org/10.1037/h0031359, 45-&.
Stein, N.L., Levine, L.J., 1990. Making sense out of emotion: the representation and use of goal-structured knowledge. Psychological and Biological Approaches to Emotion 45–73.
Stein, N. L., Trabasso, T., & Liwag, M. (1993). The representation and organization of emotional experience: unfolding the emotion episode. In M. Lewis & J. M. Haviland (Eds.), Handbook of Emotions (pp. 279–300). New York, NY: Guilford Press.
Thuillard, S., Dan-Glauser, E., 2017. The regulatory effect of choice in situation selection reduces experiential, exocrine and respiratory arousal for negative emotional stimulations. Sci. Rep. 7 (1), 12626 https://doi.org/10.1038/s41598-017-12626-7.
Thuillard, S., Dan-Glauser, E., 2020. Efficiency of illusory choice used as a variant of situation selection for regulating emotions: reduction of positive experience but preservation of physiological downregulation. Applied Psychophysiology and Biofeedback. https://doi.org/10.1007/s10484-020-09484-x.
Tomkins, S. (1984). Affect theory. In K. Scherer & P. Ekman (Eds.), Approaches to Emotion (pp. 353–400). Hillsdale, NJ: Erlbaum.
Tull, M.T., Roemer, L., 2007. Emotion regulation difficulties associated with the experience of uncued panic attacks: evidence of experiential avoidance, emotional nonacceptance, and decreased emotional clarity. Behav. Ther. 38 (4), 378–391.
Van Boxtel, A., 2010. Facial EMG as a tool for inferring affective states. Paper Presented at the Proceedings of Measuring Behavior, Wageningen.
VanOyen Witliet, C., Vrana, S.R., 1995. Psychophysiological responses as indices of affective dimensions. Psychophysiology 32 (5), 436–443.
Ware, J.E., Kosinski, M., Keller, S.D., 1996. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Med. Care 34 (3), 220–233.
Webb, T.L., Lindquist, K.A., Jones, K., Avishai, A., Sheeran, P., 2018. Situation selection is a particularly effective emotion regulation strategy for people who need help regulating their emotions. Cognit. Emot. 32 (2), 231–248. https://doi.org/10.1080/02699931.2017.1295922.
Westermann, S., Boden, M.T., Gross, J.J., Lincoln, T.M., 2013. Maladaptive cognitive emotion regulation prospectively predicts subclinical paranoia. Cogn. Ther. Res. 37 (4), 881–885.
Whaley, C.P., 1978. Word–nonword classification time. Journal of Verbal Learning & Verbal Behavior 17 (2), 143–154. https://doi.org/10.1016/S0022-5371(78)90110-X.
Winton, W.M., Putnam, L.E., Krauss, R.M., 1984. Facial and autonomic manifestations of the dimensional structure of emotion. J. Exp. Soc. Psychol. 20 (3), 195–216.