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Distraction and reappraisal efficiency on immediate negative emotional responses: role of trait anxiety

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ABSTRACT

Background and Objectives: Emotion regulation involves attempts to influence emotion unfolding and may target experiential, expressive and physiological responses. Several strategies can be used, such as *reappraisal* (re-evaluating the emotional situation to reduce its emotional meaning) or *distraction* (turning the attention toward non-emotional aspects of the situation). Previous research on these regulation strategies produced contrasting results regarding their efficiency and we hypothesize that this could be due to individual differences such as trait anxiety.

Design and Methods: Participants ($N = 77$) were confronted with negative pictures and we examined the differential emotional reactivity according to trait anxiety, followed by a comparison of the efficiency of reappraisal and distraction in reducing emotional responses.

Results: Results show that trait anxiety has no impact on reactivity at the experiential and expressive levels, but has an impact at the physiological level, where high anxiety individuals show increased cardiac orienting effect, as well as higher skin conductance and respiratory rate. Regarding regulation, reappraisal and distraction successfully reduce emotional experience and expressivity, but not physiological arousal.

Conclusions: Such contrasting results involve that high trait anxiety individuals might benefit from the use of other kinds of strategies than reappraisal and distraction, some that may successfully target physiological responses.

KEYWORDS
Emotional reactivity; emotion regulation efficiency; distraction; reappraisal; trait anxiety; autonomic nervous system recordings

Introduction

Emotion is defined as a rapid psychological process resulting in behavior modifications (Gross & Feldman Barrett, 2011) and strongly impacting our health and social functioning (Fox, 2015; Parrott, 2007). Emotion follows a situational trigger and includes sets of patterned responses of experience, expression, and physiological arousal (Buck, 1984; Levenson, 1994; Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005).

Because of social display rules, personality, and individual preferences, a significant portion of emerging emotional episodes are regulated (Izard, Libero, Putnam, & Haynes, 1993; Tomkins, 1984). *Emotion regulation* refers to any process that will impact emotion unfolding (Gross, 1998b) and shape the resultant affective reaction. Functional emotion regulation is crucial in promoting health, well-being (Gross & John, 2003; Gross & Muñoz, 1995), and efficient social functioning (Eisenberg, Fabes, Guthrie, & Reiser, 2000); whereas difficulties in emotion regulation have been associated with substance dependencies (Hayes, Wilson, Gifford, Follette, & Strosahl, 1996), anxiety and mood disorders (Campbell-Sills & Barlow, 2007), and heightened posttraumatic stress disorder (Cloitre, Stovall-McClough, Miranda, & Chemtob, 2004). Understanding the impact of different emotion regulation types, or *strategies*, and whether they have chances to be functional is thus an important research aim.

Different strategies can be used to regulate emotions. In the Process Model of Emotion Regulation, Gross (2001, 2007) presents five typical strategies used at different times along the emotion generative process. Two of these strategies are *Distraction* (i.e., turning one's attention away from emotion stimulation or emotional features of the stimulation), and *Reappraisal* (i.e., changing the meaning of the emotional situation). Past research has shown that *distraction* can be either an efficient strategy (Denson, Moulds, & Grisham, 2012; Kanske, Heissler, Schönfelder, Bongers, & Wessa, 2011; Lieberman, Inagaki, Tabibnia, & Crockett, 2011; McRae et al., 2010; Sheppes, Catran, & Meiran, 2009; Sheppes & Meiran, 2007; Strauss, Ossenfort, & Whearty, 2016), or an inefficient strategy (Rusting & Nolen-Hoeksema, 1998), possibly depending on the individuals' underlying attitudes (Wolgast & Lundh, 2017). On the other hand, *reappraisal* has been regularly shown to be efficient in decreasing the negative experience of emotion (Butler, Gross, & Barnard, 2014; Goldin, McRae, Ramel, & Gross, 2008; Gross, 1998a, 2002; Gross & John, 2003; Gruber, Hay, & Gross, 2014; Ray, McRae, Ochsner, & Gross, 2010; Urry, 2009, 2010; Wolgast, Lundh, & Viborg, 2011). At the expressive level, both strategies triggered a reduction of muscular facial activity (Schönfelder, Kanske, Heissler, & Wessa, 2014). Finally, and more importantly, these two strategies were shown to have contrasting impacts on the physiological arousal of emotion. Indeed, depending on the study and context, these strategies have shown either a positive impact on physiological responses, or no impact at all (Gross, 1998a, 2002; Pavlov et al., 2014; Sammy et al., 2017; Sheppes et al., 2009; Urry, 2009).

These discrepancies may result from different attentional processes involved in the performing of these strategies (Strauss et al., 2016), or the recruitment of different cerebral circuitries (see e.g., McRae et al., 2010; Thiruchselvam, Blechert, Sheppes, Rydstrom, & Gross, 2011). However, an intriguing element that does not match these explanations is the difference in efficiency that is often found for apparently similar attentional allocation or context. For example, when directly comparing reappraisal and distraction, a study showed that reappraisal was more efficient than distraction in the decrease of negative experience (McRae et al., 2010) but another study, testing an older sample, found the opposite: distraction leading to a greater reduction in negative affect than reappraisal (Smoski, LaBar, & Steffens, 2014). Thus, it could be argued that, beyond cognitive and cerebral processes, individual differences may also influence the efficiency of emotion regulation strategies.

Individual traits significantly influence individuals' thoughts, emotions and behaviors (Izard et al., 1993). Trait anxiety is the predisposition to attribute a threatening interpretation to environmental stimuli (Spielberger & Sydeman, 1994) and is strongly linked to the negative emotions that occur in daily life. Trait anxiety has been linked to processing and encoding bias, primarily affecting attention, perception, and memory (Broadbent & Broadbent, 1988; Etkin et al., 2004; Eysenck & Derakshan, 1997; Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006). Beyond cognitive processes, emotions are also affected by this disposition. For example, increased attention to fearful stimuli may increase the likelihood of negative emotion experiences (Dennis, 2007; Mauss, Wilhelm, & Gross, 2003).

Regarding the different emotional responses, trait anxiety has been positively associated with emotional intensity (Mahmud, Mousavi, & Imani, 2016; Qi et al., 2016), whereas it does not seem to influence facial expressivity (Weinberger, Schwartz, & Davidson, 1979). Physiologically, the heart rate change in an emotional situation was found to be marginally lower in low anxiety participants (Weinberger et al., 1979). Despite these few elements, our knowledge of the emotional reactivity as a function of trait anxiety level is surprisingly scarce.

Since emotion regulation plays a crucial role in many symptom appearance and maintenance, we can expect emotion regulation and trait anxiety to be linked (Congard, Dauvier, Antoine, & Gilles, 2011; Mennin, Heimberg, Turk, & Fresco, 2002). Indeed, trait anxiety has been negatively associated with heart rate variability (Friedman, 2007), indicating a reduced emotion regulation potential toward aversive stimuli (Appelhans & Luecken, 2006). Trait anxiety has also been associated with regular use of some particular emotion regulation strategies. For example, it has been repeatedly shown that people with higher trait anxiety tend to use more suppression (i.e., trying to conceal any manifestations of emotion) and less reappraisal (Arndt, Hoglund, & Fujiwara, 2013; Christophe, Antoine, Leroy, & Delelis, 2009). These studies do not, however, indicate whether these strategies are efficient. To our knowledge, the efficiencies of distraction and reappraisal in modulating emotional responses still remain to be compared across different trait anxiety levels.

The present study first aims at investigating the emotional reactivity to negative emotional situations as a function of trait anxiety. The second, and main goal, is to compare the efficiency of distraction and reappraisal, according to the level of trait anxiety of the people who performed these regulation processes. We evaluate reactions at the experiential, expressive and physiological levels. We make the general hypothesis that both strategies could be efficient in regulating emotion, but potentially at different degrees according to trait anxiety level. More precisely, we can formulate the following hypotheses:

(1) *Emotion Reactivity:* Following up on previous results (see e.g., Mahmud et al., 2016; Qi et al., 2016; Weinberger et al., 1979), trait anxiety should positively correlate with experience (Hyp.1a) and physiological arousal (Hyp.1b). However, similarly to what was found by Weinberger and colleagues (1979), emotional expressivity should show no significant correlation with trait anxiety (Hyp.1c).
(2) *Emotion Regulation*: Both strategies should be efficient to reduce negative emotional experience, expressivity and physiological arousal (Hyp.2a). However, since trait anxiety moderates the attentional shifting to and away from emotional stimulation (Arndt & Fujiwara, 2012; Frewen, Dozois, Joanisse, & Neufeld, 2008; Johnson, 2009), distraction efficiency should be negatively associated with trait anxiety level (Hyp.2b). Similarly, since an interaction effect was shown between cognitive aspects of anxiety and reappraisal on autonomic changes, such that low anxiety and highly reappraising individuals show more cardiovascular adaptation (Knepp, Krafka, & Druzina, 2015), reappraisal efficiency should also be negatively associated with trait anxiety level (Hyp.2c).

Methods

Participants

As this is one of the first exploratory study examining trait anxiety impact on emotion regulation efficiency, and given that gender and laterality effects were not part of our hypotheses, we decided to focus on a right-handed female sample to eliminate gender and laterality variability. This is particularly important regarding gender since important differences have been noted regarding trait anxiety (McLean & Anderson, 2009). We therefore chose the gender presenting the more chances to give us variability in our anxiety measure, avoiding potential floor effect with male participants coming from a general population. A power analysis for within-subject design, performed by using a power of 0.80 (Cohen, 1988), medium effect sizes ($f = 0.15$), and an alpha of 0.05, yielded a target sample size of 73. To account for potential technical difficulties and participant drop-off, this study enrolled 77 participants. All were first-year psychology students participating for course credits. Their age ranged from 18 to 37 years old (mean age = 20.7, SD = 2.35). Exclusion criteria were pregnancy, medication, or diagnostic of anxiety or depressive disorder. Inclusion criteria were good general health, age between 18 and 45 and right-handedness.

Stimuli

Among the different emotion elicitation techniques, one widely used is the presentation of pictures, the efficiency of which has recently received additional validation (Uhrig et al., 2016). 108 images were thus selected from the GAPED (Dan-Glauser & Scherer, 2011), an emotion picture database featuring images of different valence groups, along with the corresponding valence and arousal ratings.

Since only negative stimuli were the focus of interest for this research, 72 negative images were selected, with different thematic contents. We chose mildly negative pictures to retain sufficient variance for analyses (no ceiling effect in the experience rating). Mean valence rating of this stimuli sample was 28.97 (SD = 16.19) on a scale going from 0 (extremely negative) to 100 (extremely positive). In order not to have an exclusive negative stimulus set to present to the participants, 36 positive images were also included in the design (but not analyzed). Positive images had a mean valence of 91.98 (SD = 5.38), measured on the same scale as negative images. The image number and ratings are available in a Supplementary Table (S1).

We controlled the uniformity of the normative ratings for the stimuli presented under each condition following the random assignment procedure. The pictures in the three conditions had a mean valence rating of 28.84 (SD = 2.24), 29.26 (SD = 2.49) and 28.80 (SD = 2.24) for unregulated, distraction, and reappraisal, respectively. A one-way ANOVA confirmed no significant difference between the conditions on valence ratings, $F_{(2,\ 152)} = 0.61$, $p = .54$. Similarly, the pictures in the three conditions had a mean arousal rating of 62.20 (SD = 1.88), 62.02 (SD = 1.99) and 62.15 (SD = 1.79) for unregulated, distraction, and reappraisal, respectively. Again, a one-way ANOVA confirmed no significant difference between the conditions on arousal ratings, $F_{(2,\ 152)} = 0.12$, $p = .89$.

Measures

Trait anxiety

Trait anxiety was evaluated with the corresponding 20 items of the State-Trait Anxiety Inventory (STAI-Y) developed by Spielberger and his collaborators (Spielberger, Gorsuch, & Lushene, 1970). Participants answered a translated form of this questionnaire (Bruchon-Schweitzer & Paulhan, 1993) with a paper-pencil form and reported their level of agreement to the item on a four-level Likert scale going from 1 (Not at all) to 4 (Very much).

Emotional responses

Emotional measures targeted the main emotional responses, i.e., experience, expressivity, and physiological arousal (see e.g., Buck, 1994; Levenson, 1994).

Experience. Participants used a slider for reporting their emotional experience during the viewing of the pictures (Variable Assessment Transducer, Biopac Systems, Inc., Goleta, CA, USA), as previously described and used with similar tasks (Dan-Glauser & Gross, 2011, 2015; Hutcherson et al., 2005; Thuillard & Dan-Glauser, 2017). The slider was anchored at one side with *very negative* and on the other side with *very positive*.

Expressivity. Expressivity was assessed using bipolar surface EMG. Electrodes were standard 4 mm Ag-AgCl sensors. Activity of the left *Corrugator Supercilii* region was recorded, given the high reliability of this measure for negative expressivity (Cacioppo, Petty, Losch, & Kim, 1986; Lang, Greenwald, Bradley, & Hamm, 1993). The skin was first gently rubbed with NuPrep® gel (Weaver and Cie), and then cleaned with alcohol pads (Kendall Webcol® skin cleansing alcohol pads, Tyco healthcare). Electrodes were filled with Signagel® (Parker Laboratories, Inc).

Physiological arousal. Three measures were obtained for autonomous system activity. First, *electrocardiography* was recorded with three standard disposable pre-gelled Ag/AgCl electrodes. One was placed approximately 5 cm below the lower rib on the left side of the abdomen. A second electrode was placed just under the right clavicle, along the mid-clavicular line. A third electrode (ground), was placed at the level of C7 cervical vertebrae. Second, we measured *skin conductance level* with two pre-gelled disposable Ag/AgCl sensors. They were placed on the thenar and hypothenar eminences of the non-dominant hand palm. Third, we measured *respiratory activity* (thoracic and abdominal) with two respiration belts. The abdominal belt was placed around the waist just above the pants, whereas the thoracic belt was placed high on the chest below the armpits. All signals were recorded at a rate of 1000 Hz, and all sensors were material from Biopac Systems (Goleta, CA, USA).

Procedure

Participants were first welcomed into the lab and informed about the unfolding of the experiment. After signing the consent form, they were familiarized with the physiological recording material and could ask any question about the recordings. Sensors were then attached to the participants. Participants filled the questionnaires either at this stage or after the main task in a randomized scheme. They were then given short instructions about the main task and how to use the experience slider. Participants were then left alone in an electrically shielded room, with interphone connection with the control room. From this point on, all instructions were presented on the computer screen.

Participants were presented with the rating slider and explained that the principal task of the study was to report their feeling by moving the cursor. A few training trials were then proposed in order for them to get accustomed to the task. They were then instructed about the emotion regulation task. They were told that, for each image presentation block, and in addition to reporting their emotional experience, they would need to perform one of three tasks corresponding to three instructions. The first instruction was WATCH: "Observe the picture and let your emotion come and go naturally. Let yourself feel." The second instruction was ANALYZE SCIENTIFICALLY: "Adopt a neutral and detached attitude toward the image. Think that you are a scientist envisaging the scene in an analytical way." The third instruction was COUNT BACKWARD: "Think about something different from the image. To do so, count backward starting at 100 during the visioning of the image." The first instruction corresponded to the unregulated condition, the second instruction to the reappraisal condition, while the third instruction was the distraction condition. All instructions were French translations from instructions used in similar settings in previous experiments (Dan-Glauser & Gross, 2011; Sheppes & Meiran, 2007, 2008; Zhang et al., 2013). At the end of the procedure, participants answered a question about the task that showed that they understood the difference between the conditions correctly.

Each participant went through nine blocks of trials (three for each of the three conditions), each separated by a screen through which participants could progress at their own pace, allowing them to take breaks when needed. The block order was semi-randomized. Before each block, a reminder of the instruction was presented to the participant. Each block consisted of 12 pictures, from which 8 were negative. At the beginning of each procedure, each image from the image pool was randomly assigned to a specific condition. Thus, each image could be seen in the unregulated, distraction or reappraisal condition. Each trial had a duration of 12 s, consisting in a blank screen (0.5 s), a fixation cross (1.5 s), a black screen again (0.5 s), the emotional images (8 s), and ended with the instruction to reset the dial (1.5 s). Images were centered on the screen, presented with an approximate size of 26×20 cm at a distance of about 60 cm.

After the computer session, the sensors were removed, and participants were fully debriefed. The whole procedure lasted about 90 min.

Data reduction

All the recordings were treated with Acknowledge 4.4 (Biopac Systems Inc.). Channels were band-pass filtered to increase the signal to noise ratios (20–500 Hz for EMG, 0.5–35 Hz for ECG, 0.05–1 Hz for respiration). EMG signal was then rectified and smoothed (3 ms moving average window). All anomalies in ECG peak detection were manually scanned and corrected (signal interpolation over missing or movement generated peaks). Respiration parameter extreme peaks were manually scanned and corrected via signal interpolation when they did not correspond to original signal change. Signal over the eight-second viewing period was averaged for each trial. In addition, a baseline of 2.5 s was calculated for each trial. This period spanned from 2.5 s before the picture's presentation to the time of the picture onset.

Emotional experience

Ratings were exported as a function of where the participants replaced the cursor at the end of each trial. From then, rating data were transformed into an emotion intensity scale going from −100 = extreme positive emotion intensity to +100 = extreme negative emotion intensity, 0 level being an absence of emotional feeling.

Emotion-expressive Behavior

The EMG signal was rectified and smoothed (5 Hz). The EMG value for each trial was then expressed as the percentage of contraction with respect to the corresponding trial baseline level (voltage for a given time frame / voltage during baseline * 100).

Autonomic responses

Heart rate was calculated from the ECG channel by transforming the inter-beat interval. Skin conductance level was exported as mean values for each trial. Respiratory rate and respiratory amplitude were calculated for each trial. 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. A factorial analysis of the thoracic and abdominal parameters led to a two-factor solution discriminating respiratory rate and respiratory amplitude but clustering together the two respiratory sites. An average of respiratory rate and amplitude over both sites were thus calculated to reduce the number of parameters. All these autonomic responses were expressed as the change in activity with respect to each trial baseline.

Data analyses

We first controlled successful emotion induction, as well as explored the distribution of anxiety scores (see the first paragraph of the Results section). As a second step, and in order to investigate multicollinearity, we conducted Pearson's correlation analyses on all emotional response parameters to estimate the relationship between emotion response changes and trait anxiety during negative image viewing (see the second paragraph of the Result section). Finally, we conducted our main analyses, which consisted in six repeated-measures ANOVAs (one for each tested emotion response: experience, expressivity, heart rate, skin conductance level, respiratory rate, respiratory amplitude) with Regulation as factor (independent variable) and Trait Anxiety as continuous between-subject variable. We then separated the results in two groups, depending on the presence or the absence of a trait anxiety impact.

First, we re-analysed the parameters showing no significant relationship with trait anxiety level (no main effect of trait anxiety nor interaction with trait anxiety) to investigate the regulation efficiency, independently of trait anxiety. We performed three repeated-measures one-way ANOVAs with Regulation as factor, encompassing three levels (Unregulated, Distraction, and Reappraisal). Our goal was to test whether regulating emotion during the viewing of the negative pictures would significantly impact emotional responses, and, if yes, in which direction. Tukey post-hoc tests were used to contrast conditions when the main effect of Regulation was significant. η^2 are reported as effect size indications.

Second, we presented the regulation effect in parameters that were shown to be also impacted by the level of trait anxiety of our participants. To do this, we reported for each of the three concerned dependent variables (physiological parameters) the results of the repeated-measures ANOVAs, with Regulation as within-subject factor (three levels: Unregulated, Distraction, and Reappraisal) and STAI-Y trait score as between-subject independent variable. The model tested the effect of STAI-Y trait score, Regulation, as well as the interaction term between the two variables in the estimation of the emotional response's parameters. With these second section of analyses, we tested the regulation efficiency on physiological parameters when taking into account the anxiety levels of the participants.

Results

Emotion induction and trait anxiety

In the unregulated condition, negative pictures triggered a significant negative emotional experience averaging 35.7 points (/100), which was significantly different from a 0-centered distribution, $t(76) = 20.2$, $p < .001$, Cohen's $d = 2.31$, confirming successful emotional induction by the procedure. Cronbach alpha of the STAI-Y was 0.91 in our sample. With an average score of 2.12 (SD = 0.48), our sample was on the low side of trait anxiety, even though scores as high as 3.1 were recorded (over a maximum of 4). The range of anxiety scores spanned over 60% of the potential range (1.3–3.1 over a 1–4 scale).

Relationship between emotion response changes and trait anxiety

Table 1 presents the different parameter changes recorded in the different conditions and for each separate channel. Pearson's correlation coefficients with STAI-Y trait scores were also computed for each variable and condition. None of the experience, expressivity, and respiratory amplitude change conditions correlated significantly with the Trait Anxiety score. However, heart rate change, skin conductance level, and respiratory rate were significantly associated with STAI-Y trait scores, at least for some of the conditions.

Regulation efficiency independently of trait anxiety

Three parameters were not significantly associated with STAI-Y trait level (no main effect, no interaction with Regulation): Experience, Expressivity, and Respiratory Amplitude. For Experience, we had $F_{(1,73)} = 0.001$, $p = .98$ for the main effect and $F_{(2,146)} = 0.12$, $p = .89$ for the interaction. For Expressivity, we had $F_{(1,73)} = 0.38$, $p = .54$ for the main effect and $F_{(2,146)} = 0.66$, $p = .51$ for the interaction.

Table 1. Mean, Standard Error of the Mean (SEM), Confidence Interval (CI, 95%) and Pearson's r coefficients with STAI-Y trait scores for each emotional response and each condition investigated.

	Mean	SEM	CI	r Stai-T
Experience				
Unregulated	35.7	1.76	[32.24; 39.16]	−0.04
Distraction	30.2	1.75	[26.76; 33.64]	0.00
Reappraisal	18.4	1.81	[14.85; 21.95]	0.02
Expressivity (M.Corrugator)				
Unregulated	140	5.20	[129.56; 149.96]	0.09
Distraction	132	4.68	[122.94; 141.29]	0.02
Reappraisal	127	3.79	[119.65; 134.49]	0.04
Physiological responses				
ΔHeart rate (bpm)				
Unregulated	−0.24	0.15	[−0.53; 0.06]	−0.22(*)
Distraction	−0.31	0.13	[−0.57; −0.05]	−0.11
Reappraisal	−0.60	0.13	[−0.86; −0.34]	−0.32**
ΔSkin conductance level (μS)				
Unregulated	0.055	0.018	[0.02; 0.09]	0.27*
Distraction	0.017	0.014	[−0.01; 0.04]	0.21(*)
Reappraisal	0.027	0.016	[0.00; 0.06]	0.30*
ΔRespiratory rate (c/min)				
Unregulated	0.12	0.07	[−0.02; 0.26]	0.11
Distraction	0.16	0.07	[0.01; 0.30]	0.23*
Reappraisal	0.11	0.05	[0.00; 0.22]	0.24*
ΔRespiratory amplitude (mV)				
Unregulated	1.42	1.59	[−1.71; 4.55]	0.02
Distraction	2.97	1.83	[−0.60; 6.54]	−0.10
Reappraisal	2.19	1.15	[−0.07; 4.45]	−0.01

Note: Experience is reported over a 100 point scale describing negative feeling intensity, Expressivity is reported as percentage of baseline (100% = baseline), Physiological changes are reported as difference with baseline in the indicated unit. *$p < .05$, **$p < .01$, (*)$p < .1$.

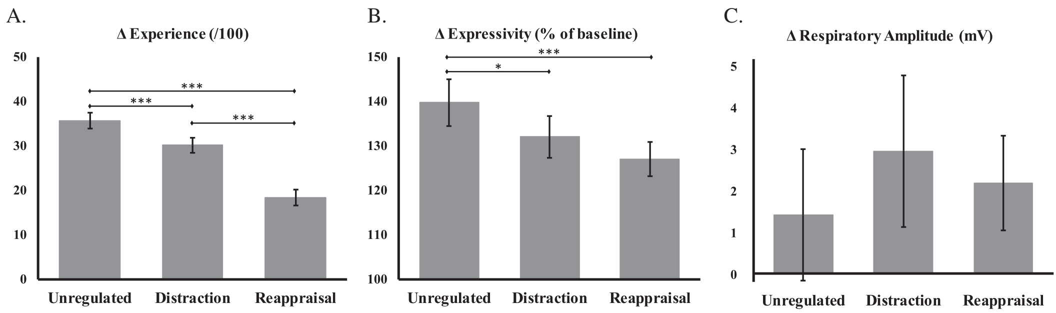

Figure 1. Changes in experience (A.), expressivity (B.), and respiratory amplitude (C.) following the presentation of negative pictures, in a condition of unregulated viewing and in two regulated conditions: one in which participants perform distraction and one in which participants performed reappraisal. Significant contrasts (determined by Tukey post-hoc tests) are indicated. *$p < .05$, ***$p < .001$.

Finally, for Respiratory Amplitude, we had $F_{(1,73)} = 0.11$, $p = .74$ for the main effect and $F_{(2,146)} = 0.49$, $p = .61$ for the interaction. To investigate to what extent regulation was efficient for these parameters, three one-way ANOVAs were conducted again, with a 3-level Regulation factor, which encompassed non-regulated, distraction, and reappraisal conditions.

ANOVA results show that experience was significantly impacted by Regulation, $F_{(2,\ 152)} = 79.2$, $p < .001$, $\eta^2 = .51$. Post-hoc Tukey's tests indicated that the experience felt during the unregulated condition was more intense (35.7) than the experience felt during both distraction (30.2, $p < .001$) and reappraisal (18.4, $p < .001$). This represents a reduction of 17.3 points of the experience felt during reappraisal (35.7–18.4), and of 5.5 points of the experience felt during distraction (35.7–30.2) as compared to the unregulated condition. The resulting experience felt during distraction (30.2) was moreover significantly more intense than the one felt during reappraisal (18.4, $p < .001$). These results are illustrated in Figure 1, panel A.

Regarding expressivity, Regulation was shown to impact corrugator's activity, as shown by an ANOVA significant main effect, $F_{(2,\ 152)} = 8.44$, $p < .001$, $\eta^2 = .10$. Tukey's post-hoc tests revealed that during the unregulated viewing, participants frowned significantly more (140% of baseline) than during both the distraction (132%, $p = .04$) and reappraisal (127%, $p < .001$) conditions. These two latter conditions were not statistically different ($p = .24$). This represents a decrease in expressivity of 10.5% if we contrast the unregulated to the average of the regulated conditions. These results are illustrated in Figure 1, panel B.

Finally, regarding respiratory amplitude, no effect of Regulation was shown $F_{(2,\ 152)} = 0.33$, $p = .72$. Changes in respiratory amplitude in each condition are depicted in Figure 1, panel C.

Physiological regulation efficiency when taking into account trait anxiety

Three ANOVAs were conducted with Regulation as factor and Trait Anxiety as continuous between-subject predictor, to examine the potential interaction between the two variables in the determination of heart rate, skin conductance level, and respiratory rate changes. Regarding heart rate changes, results showed a significant effect of Trait Anxiety, $F_{(1,75)} = 5.68$, $p = .02$, $\eta^2 = .07$, with no effect of Regulation, $F_{(2,150)} = 1.02$, $p = .36$, nor an effect of interaction, $F_{(2,150)} = 1.54$, $p = .21$. A regression analysis was then performed on the average heart rate changes in all conditions. Results are shown in Figure 2, panel A. A significant negative correlation between Trait Anxiety scores and heart rate changes additionally showed that the higher was the anxiety score, the larger was the drop in heart rate during picture viewing, $r_{(75)} = -.265$, $p = .02$.

Similarly, regarding skin conductance level changes, results showed a significant effect of Trait Anxiety, $F_{(1,64)} = 6.69$, $p = .01$, $\eta^2 = .10$, with no effect of Regulation, $F_{(2,128)} = 0.30$, $p = .74$, nor effect

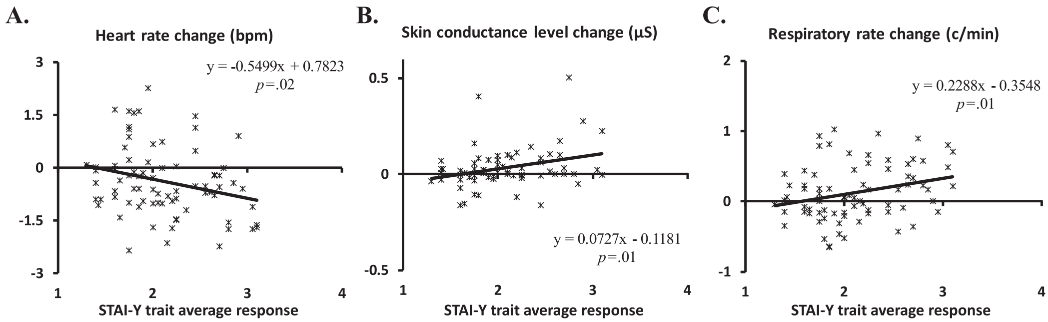

Figure 2. Changes in heart rate (A.), skin conductance level (B.) and respiratory rate (C.) following the presentation of negative pictures, as a function of STAI-Y trait average scores. Results are independent of regulatory processes. The regression equations, the corresponding *p*-values of the models, and the regression lines are displayed on the graphs.

of interaction, $F_{(2,128)} = 0.63$, $p = .53$. A regression analysis was then performed on the average skin conductance level changes in all conditions. Results are shown in Figure 2, panel B. A significant positive correlation between Trait Anxiety score and skin conductance changes additionally showed that the higher was the anxiety score, the larger was the skin conductance increase during picture viewing, $r_{(64)} = .308$, $p = .01$.

Finally, the same pattern of results was found for respiratory rate, with a significant effect of Trait Anxiety, $F_{(1,75)} = 6.22$, $p = .02$, $\eta^2 = .08$, with no effect of Regulation, $F_{(2,150)} = 0.37$, $p = .69$, nor effect of interaction between Trait Anxiety and Regulation, $F_{(2,128)} = 0.46$, $p = .64$. A regression analysis was then performed to explore Trait Anxiety effect. Results are shown in Figure 2, panel C. A significant positive correlation between Trait Anxiety score and respiratory rate changes additionally showed that the higher was the anxiety score, the larger was the increase in respiratory rate during picture viewing, $r_{(75)} = .277$, $p = .02$.

Discussion

Our first goal was to investigate negative emotional responses as a function of trait anxiety. Anxiety was supposed to be correlated with experience (Hyp.1a) and physiological arousal (Hyp.1b), but not with expressivity (Hyp.1c). The second goal was to contrast distraction and reappraisal efficiencies according to trait anxiety levels. We hypothesized that both regulation strategies could be efficient in regulating emotion (Hyp.2a), but that this efficiency may differ according to trait anxiety level, expecting lower efficiency for distraction (Hyp.2b) and reappraisal (Hyp.2c) when trait anxiety is high.

Our first set of hypotheses was only partially confirmed, anxiety being indeed correlated with physiological arousal (Hyp.1b) and not correlated with expressivity (Hyp.1c). However, we did not find a correlation between anxiety and emotional experience (Hyp.1a). Hypothesis 2a was confirmed for experience and expressivity, but not for physiological arousal. Neither Hypothesis 2b nor 2c was confirmed, since we did not find significant interactions between trait anxiety and efficiency of the emotion regulation strategies. We will first discuss the relationship between response changes and trait anxiety and then focus on the parameters for which regulation strategies were not efficient. Finally, we make some suggestions about why we could not show that emotion regulation efficiency depends on trait anxiety.

Relationship between emotion response changes and trait anxiety

Our findings suggest that, whether low or high on trait anxiety level, people share the same expressive and experiential reactivity. At the *expressive level*, our results corroborate those of other studies

(Smith, Bradley, & Lang, 2005; Weinberger et al., 1979). At the *experiential level*, our results are contrary to our hypothesis, which was based on the proneness for high trait anxiety individuals to experience negative affects. However, proneness may speak in favor of more frequent negative experiences, but does not necessarily imply more intense experience.

Relationships between emotional responses and trait anxiety are stronger when observing *physiological reactions*. Indeed, trait anxiety level was found to be negatively related to the heart rate changes, and positively related to respiratory rate and skin conductance level. Congruent with our hypothesis, these results show a stronger physiological arousal when trait anxiety increases.

A heart rate deceleration following a trigger shows an orienting response (Graham & Clifton, 1966; Lang et al., 1993) and is linked to action preparation, motivational system, and affective reactions (Bradley, 2009). Such reactions are frequently observed during the viewing of short-term emotional stimulations (Bradley & Lang, 2000; Dan-Glauser & Gross, 2011) and are proportional to their unpleasantness (Bradley & Lang, 2000; Bradley, Codispoti, Cuthbert, & Lang, 2001; Dan-Glauser & Gross, 2011). In the present study, heart rate deceleration is observed in each of our conditions (Table 1). As shown with our regression tests, this orienting response is stronger for participants that show high trait anxiety, which is congruent with their attentional bias toward negativity (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van Ijzendoorn, 2007; Yiend & Mathews, 2001).

Skin conductance level was positively associated with trait anxiety, as also shown in previous studies (Nagai, Critchley, Featherstone, Trimble, & Dolan, 2004; Nielsen & Petersen, 1976). Increased skin conductance indicates energy mobilization (Dawson, Schell, & Filion, 1990), task engagement (see e.g., Munro, Dawson, Schell, & Sakai, 1987), and reduced coping potential (Pecchinenda, 1996). This last point is particularly interesting since anxious individuals were also shown to underestimate their coping ability (Burton & Naylor, 1997; Carver & Scheier, 1988; Lazarus & Smith, 1988; Smith & Lazarus, 1993). In our study, it is possible that anxious participants underestimated their coping potential while being asked to regulate, which increased their skin conductance level.

We show a positive correlation between respiratory rate and trait anxiety scores. This result is remarkably in line with previous literature showing a positive correlation between trait anxiety and respiratory rate in anticipation or during negative situations (Homma & Masaoka, 2008; Masaoka & Homma, 1997, 2001). This could be explained by the prevalence of fear when anxiety is high, an emotion state that triggers an increase in respiratory rate (Ax, 1953).

We can conclude from these reactivity results that physiological responses are the emotional parameters that are the most sensitive to trait anxiety, which is congruent with the dominant symptoms reported by patients with a clinical diagnosis of anxiety disorders (Simon, Pollack, Tuby, & Stern, 1998; Yardley, Masson, Verschuur, Haacke, & Luxon, 1992).

Regulation efficiency independently of trait anxiety

One of our aim was to evaluate distraction and reappraisal efficiency in decreasing experiential, expressive and physiological responses during negative image viewing.

Negative emotional experience was significantly reduced by both reappraisal and distraction, regardless of the individual differences. However, our study also shows that using reappraisal is largely more efficient than using distraction, reducing experience by 17.3 points, against 5.5 points for distraction. Reappraisal superiority over distraction regarding experience has already been shown (McRae et al., 2010; Schönfelder et al., 2014), but our results suggest that this effect is independent from trait anxiety.

Our results show that the tested strategies impact expressivity, reducing it by 11%, with no noticeable difference between distraction and reappraisal. This is congruent with the previous results on distraction that were mentioned in the introduction section. Two mechanisms could explain such effect: a direct one, where the emotion regulation simply reduces the expressive manifestation, or an indirect one, in which keeping the individual's attention focused on the tasks prevents expressive stances. Of note, none of the considered regulation strategies impacts physiological arousal. This is congruent with many past results (see the introduction section) but has received no satisfactory explanation so far.

The tested strategies had an immediate effect on experience and expressivity, but not on physiological arousal. We mentioned in the introduction that some studies had found an impact of these strategies over physiological arousal (Pavlov et al., 2014; Sammy et al., 2017; Sheppes et al., 2009), while others had not (Gross, 1998a, 2002; Urry, 2009). Authors have argued that the type of regulation (for example downregulation or upregulation), the task objectives, or the time at which regulation is implemented could explain these discrepancies. Further studies are needed to clarify this point.

Regulation efficiency when taking into account trait anxiety

Unexpectedly, interactions between anxiety and regulation were not found. Regarding experience and expressivity, this may be due to the absence of an initial impact of anxiety on these responses. Future studies addressing regulation efficiency will need to use an induction procedure that first triggers anxiety-linked difference of experience and expressivity, which could consequently permit the detection of differential strategy impacts.

We had hoped that our study could highlight a strategy that would be particularly efficient in a high anxiety population. Investigating physiological arousal according to strategies and level of anxiety was very promising as many physiological parameters are impacted by trait anxiety. However, our results do not show interactions between trait anxiety and strategy efficiency regarding physiological arousal. This is unfortunate since the physiological domain is exactly the emotional response that is characteristic for this group (Bell-Dolan, Last, & Strauss, 1990; Jones, Hanton, & Swain, 1994; Vaccarino, Evans, Sills, & Kalali, 2008). We conclude that, for sub-clinical high trait anxiety individuals, distraction and reappraisal might not be the most adequate strategies to target the physiologically related symptoms, and that other strategies may better reach this goal. *Situation selection* could be one of those, as it was shown to successfully reduce physiological arousal (Thuillard & Dan-Glauser, 2017). We could also think of strategies specifically designed to target responses rather than the antecedent of the emotional reaction (Sheppes & Meiran, 2007). This is the case of acceptance, which additionally successfully impacts anxiety (Hofmann, Sawyer, Witt, & Oh, 2010). We could also turn to regulation practices involving direct modulation of physiological reactions. For example, a recent study showed that years of yoga practice significantly modifies respiratory patterns (Mocanu, Mohr, Pouyan, Thuillard, & Dan-Glauser, 2018), which could be a way to target anxiety-related increase in respiratory rate.

Limitations and future directions

Several limitations could be discussed. First, we focused on female student participants and generalization of the results are hence limited. In their review, McLean and Anderson (2009) showed that even though there were almost no gender differences concerning physiological measures, women scored higher on the Anxiety scale. This might indicate that women express anxiety more cognitively than affectively, which might interact with some emotion regulation strategies and not with others. Second, it appears that distraction could involve several different processes. We chose an arithmetic task, a form of distraction already investigated in the past (Sheppes & Meiran, 2008; Zhang et al., 2013). Testing alternative distracting procedures (see e.g., Sheppes, Brady, & Samson, 2014) could reveal more efficient kinds of distraction, particularly on physiological responses. Third, we of course cannot guarantee that only reappraisal and distraction were performed during our experiment. We are confident in the strategy implementation, since we replicate previous results and the gradation between strategies, particularly regarding experience. Informal discussions with participants comforted us in the idea that they performed the desired emotion regulation strategies. However, it is possible that other explicit or even implicit emotion regulation strategies may have been simultaneously implemented, leaving results reflecting the efficiency of a blend of strategies, instead of the pure effect of distraction or reappraisal. Fourth, while the absence of regulation effects on physiological arousal is congruent with previous findings, we could argue that analyzing other physiological parameters may reveal an impact of regulation. Future studies could include additional physiological measures, along the idea that a broader set of physiological extraction is preferable to adequately portray emotion (Collet, Vernet-Maury, Delhomme, & Dittmar, 1997). Finally, the extension of reaction and regulation efficiency assessments over longer periods of time could bring more information on the persistence of the regulation effect.

Concluding comments

We tested the impact of individual differences such as trait anxiety on the reactivity and regulation efficiency of distraction and reappraisal at the experiential, expressive, and physiological level. We found that the physiological responses are the ones that vary the most with trait anxiety. Conversely, none of the tested regulation strategies shows efficiency on these physiological responses. Thus, we show a lack of overlap between the specific responses targeted by these strategies (experience and expressivity) and the responses impacted by trait anxiety (physiological channels). This triggers two major inferences. First, the selection of strategies to be used must take into account the emotional responses that one wishes to regulate. Second, for particularly disruptive symptoms of anxiety, such as extreme cardiac reactivity or sweating, other strategies than reappraisal and distraction might be preferred. These observations may have implications to define the best-tailored strategies to use in specific populations in order to target selected physiological parameters. Clearly, to reduce experience or expressivity, one of the two considered strategies could be used. For regulating physiological arousal, however, one may need to turn to another kind of strategies. This complex interplay between individual characteristics, strategy use and physiological parameters is a crucial indication that, if one wants an emotion regulation implementation that successfully alleviates anxiety symptoms, it should specifically target which symptoms are to be reduced.

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