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Ph.D. THESIS

THE ROLE OF META-PROCESSES IN EMOTIONAL FUNCTIONING, EMOTIONAL DISORDERS, AND INSOMNIA: AN EMOTION REGULATION APPROACH

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*Notes.*_____

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Keywords: meta-processes; emotion regulation difficulties; emotional disorders; insomnia.

CHAPTER I. THEORETICAL BACKGROUND

Problematic emotions and psychopathology in the form of emotional disorders and insomnia are considered to be the results of maladaptive emotion regulation (ER) (Hofmann, Sawyer, Fang, & Asnaani, 2012). Recent theoretical conceptualizations defined maladaptive ER as an umbrella term which entails a series of components in which dysregulation/difficulties can emerge (Gratz & Roemer, 2004; Mennin & Fresco, 2010). In a recent model, Mennin and Fresco (2010), in an effort to determine the most relevant ER components, summarized three components that are considered central in psychopathology and problematic emotions, namely: (a) emotional awareness (entailing abilities to clarify, differentiate, and understand emotions), (b) negative reactivity towards emotions (entailing meta-cognitive and meta-emotional reactions), and (c) emotional control (entailing strategies that individuals use to regulate their emotions) (Mennin & Fresco, 2010). Increasing evidence supports the relevance of these secondary, strategic controlled ER processes (meta-processes) in relation to individuals' emotional functioning and psychopathology (Mennin, McLaughlin, & Flanagan, 2009). In the current thesis we focused mainly on these three ER components considered as being central in the empirical research.

However, despite the recent recognition of the importance of these three maladaptive ER processes (emotional awareness, negative reactivity towards emotions, emotional control), a number of limitations hamper the conclusions that can be drawn from the existing clinical and affective research regarding the contribution of these ER components to problematic emotions and psychopathology. First, building on the processes model of ER, much of the previous research was mainly focused on the emotional control component and on trait measures of ER, neglecting the components of negative reactivity towards emotions (NRTE) and emotional awareness, as well as the state measures of ER. Further, research has also neglected the interactions between these ER components in generating emotional problems. Finally, a number of methodological caveats limit the generalizability of the current findings on the construct of ER, such as the increased focus on using non-clinical samples and subjective measures of ER, as well as emotion induction procedures with low ecological validity.

In this context, the current project tries to take a closer look at the construct of ER bridging together both affective and clinical sciences in order to provide a more comprehensive and clinically relevant perspective on this construct by addressing these specific limitations. Starting from this integration, the current research is focused on the construct of ER examined in various forms (state vs. trait) and in relation to multiple clinical conditions (i.e., transdiagnostic). We also focused on its adaptive vs. maladaptive facets, as well as on its emotional consequences examined at various levels (subjective vs. physiological) in various contexts (more or less ecological). We therefore adopted a nuanced or granular perspective on the construct of ER in our endeavor, however we tried at the same time to maintain the clinical relevance of this investigation to the highest level possible. In the following section we describe in more detail the specific objectives formulated for this research thesis.

CHAPTER II. RESEARCH OBJECTIVES AND OVERALL METHODOLOGY

The current research aimed to address several objectives related to the construct of ER. First, given the theoretical and empirical considerations outlined in Chapter I, the general goal of this research was to approach ER from an integrative perspective, bridging together both clinical and affective sciences. Starting from this integration, we aimed to investigate the main processes underlying the construct of ER, especially the secondary, strategic controlled processes (meta-processes) as defined in Chapter I. To reach this goal, we focused on key secondary processes investigated in the empirical research of ER (Mennin & Fresco, 2010), such as (1) emotional awareness, (2) negative reactivity towards emotions, and (3) emotional control and we investigated their role in emotional functioning of individuals and psychopathology, specifically in relation to ED and insomnia.

The **first objective** of our research was to focus on the *negative reactivity towards emotions* component (entailing meta-cognitive and meta-emotional reactions) that was the most neglected ER component in the empirical research. Specifically, we aimed to investigate if this component is relevant in relation to ED and in relation to individuals' emotional functioning. An important aspect here is the extent to which this ER component is indeed a relevant *transdiagnostic factor associated with ED*, specifically with anxiety disorders and depression, as well as with a *poor emotional response* experienced by individuals in emotionally salient situations. Another important aspect to consider is the *distinction between dysfunctional NRTE* (e.g., irrational beliefs about emotions) vs. *functional NRTE* (e.g., rational beliefs about emotions, acceptance of emotions) which are considered to have different consequences on the course of emotional response of individuals. By contrasting the effects of these two different approaches towards one's own emotions on various outcomes (emotional and physiological), we can determine the adaptive or maladaptive nature of each approach and further inform intervention efforts to specifically target those that are considered maladaptive, while instructing individuals to adopt those considered adaptive. Finally, it is important to examine if individuals with ED report more dysfunctional meta-cognitive beliefs compared to healthy individuals, which are considered to report more functional meta-cognitive beliefs. This objective aimed at theoretical innovations and practical implications.

The **second objective** of our research was to investigate all three ER components in relation to individuals' emotional functioning and psychopathology (i.e., ED and insomnia) in several forms: (a) *cumulatively* (investigating all ER components cumulatively in relation to the outcome); (b) *comparatively* (investigating which ER component is the best predictor of the outcome); (c) *interactively* (investigating how each ER component interrelates with the other components).

We adopted this multiple perspective due to its potential to shed more light on the cumulative effect of various ER components on individuals' emotional functioning and psychopathology, but also to clarify which ER components may play a more central role, and which are less specific. Also, investigating the effect of a particular ER component on another ER component may shed more light on the complex interplay between various ER in contributing to a specific emotional outcome. Finally, such an approach could inform intervention efforts to target either overall ER difficulties, either specific ER deficits that might be more relevant in a given context or a specific ER deficit that contributes to another ER deficit which ultimately affects individuals' emotional functioning. This second objective aimed at theoretical innovations by elucidating the complex interrelations between various ER components, as well as at practical implications.

The **third objective** of our research was to study these ER difficulties in relation to individuals' emotional responses and psychopathology using a more *granular approach*, represented by: (a) the use of samples of individuals across the *normality-pathology continuum*, examining samples of *individuals that are healthy*, samples of individuals with symptoms of a specific pathology (e.g., insomnia symptoms) or *at-risk individuals*, and samples of *individuals with a clinical diagnosis*; (b) the use of *multiple levels of analysis* when assessing emotional responses, analyzing them both at a *subjective level* using self-report measures (psychometrically robust questionnaires), as well as at a *physiological level* using (neuro)physiological indexes (cardiovascular responses, skin conductance responses, EEG responses, brain reactivity responses); (c) the use of both *state and trait measures* of ER components, examining individuals' habitual, cross-situational use of ER abilities, as well as their context-dependent, momentary implementation in various ecological contexts; (d) the use of *emotion induction procedures* that fall on a continuum ranging from *low to high levels of ecological validity*.

This more nuanced approach towards the study of ER components is indeed relevant given that recent reviews and meta-analyses (Aldao, 2013; Aldao et al., 2010) highlighted the lack of research pertaining to the construct of ER across the normality-pathology continuum, especially on individuals diagnosed with clinical disorders (compared to healthy individuals), as well as the need to investigate the influence of these ER abilities on each domain of the emotional response (subjective, behavioral, physiological). Moreover, research has signaled that there is a need to continue to build on the empirical findings on ER components investigated at a trait level by examining these components also at a state level in more ecological situations (Aldao, 2013; Aldao et al., 2010). This third objective aimed at methodological developments in the study of ER components.

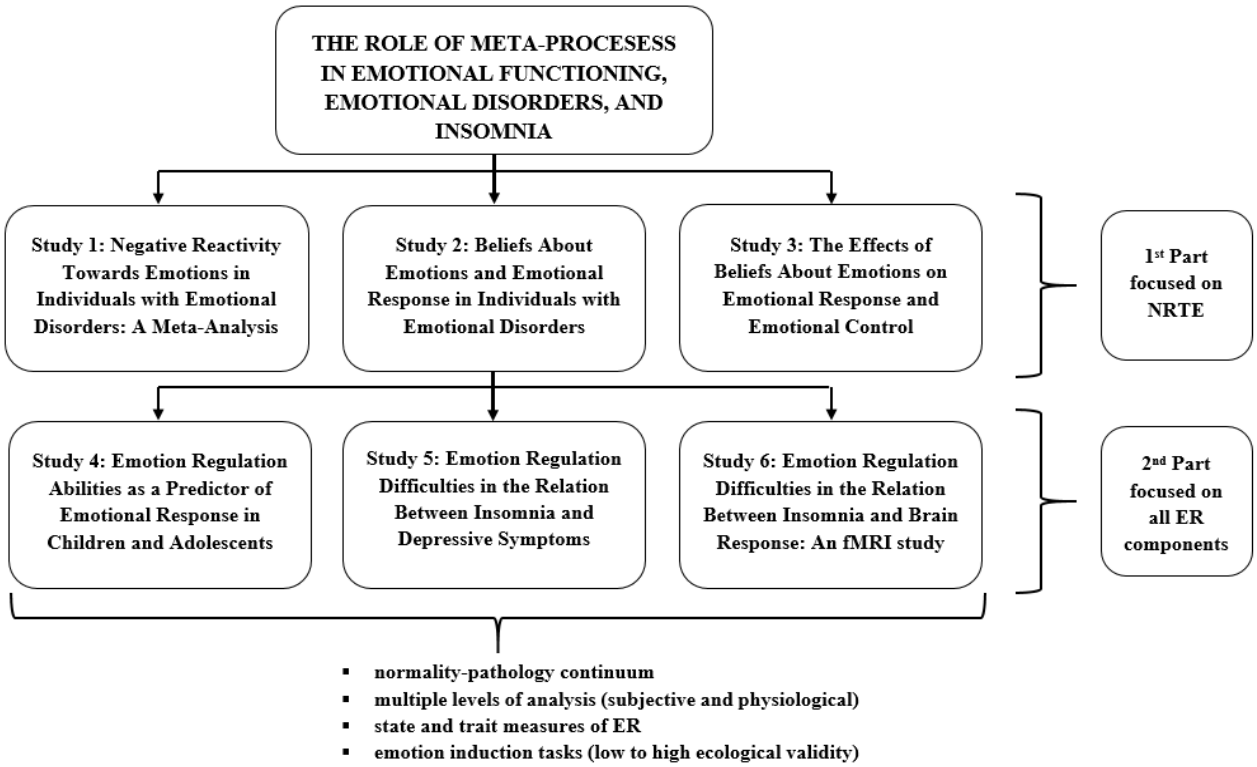

Figure 2. The structure of the current research thesis

CHAPTER III. ORIGINAL RESEARCH

3.1. Study 1. Negative Reactivity towards Emotions in Individuals with Emotional Disorders: A Meta-Analysis

Introduction

More and more researchers and theorists emphasize the importance of how individuals relate to their own emotional experiences (David & Szentagotai, 2006; Leahy, 2002). In this regard, research has suggested that a negative reactivity towards emotions (NRTE) is an important factor related to psychopathology, especially to emotional disorders (ED), such as anxiety and depression (Ford & Gross, 2018; Mennin & Fresco, 2010). Indeed, research has shown that individuals with ED usually experience an increased level of negative affect, and it is not uncommon for these individuals to negatively appraise/judge their negative emotions, as well as to react emotionally towards their own negative affect (i.e., develop negative meta-emotions/secondary emotions) (Low, Stanton, & Bower, 2008).

Furthermore, a considerable amount of literature has highlighted that this NRTE may also contribute to a poor control of emotions, specifically to the endorsement of maladaptive emotion regulation strategies (such as suppression) and/or to a less frequent use of strategies considered to be adaptive (such as reappraisal) (Ford & Gross, 2018). In this regard, preliminary data showed that individuals with ED judged their emotions as less acceptable in comparison to non-clinical individuals and further engaged in more suppression, which is considered a maladaptive emotion regulation strategy (Campbell-Sills et al., 2006).

Recently, NRTE has been broadly defined as the way individuals (1) cognitively appraise and (2) respond emotionally towards their own emotional experiences (Clen, 2013). According to this definition a NRTE includes beliefs about emotions, attitudes towards or evaluations about emotions, emotional reactions to one's affect, as well as the extent of willingness to experience one's emotions (Clen, 2013). To date, a number of psychological constructs derived from theoretical models and investigated in empirical research encompass this process of NRTE, such as such as anxiety sensitivity (Reiss, 1991), experiential avoidance (Hayes et al., 2006), emotional non-acceptance (Gratz & Roemer, 2004), distress intolerance (Simons & Gaher, 2005), fear of emotions (Williams, Chambless, & Ahrens, 1997), fear of fear (Chambless & Gracely, 1989), negative cognitive reactivity (Mennin et al., 2005), beliefs about emotions (Rimes & Chalder, 2010), emotional schemas (Leahy, 2002), meta-emotions/secondary emotions (Greenberg & Pascual-Leone, 2006), and meta-mood (Salovey, Mayer, Goldman, Turvey, & Palfai, 1995). Even though these constructs differ to some extent (e.g., the specific emotion towards which the negative reactivity is directed), all of them entail a *negative cognitive attitude* (e.g., "Emotions are bad and unbearable") and/or an *emotional reaction towards emotions* (e.g., "Feeling ashamed about feeling anxiety").

However, despite its theoretical and practical importance, NRTE has received surprisingly little attention as an overarching construct in the empirical literature. In this context, we investigated NRTE as an overarching transdiagnostic construct involved in ED. Although it is clear that prospective studies are needed in order to assess whether NRTE is an etiopathogenetic factor, the current meta-analysis provides a first step in testing the magnitude of difference between individuals with ED and non-clinical controls on NRTE. We also examined the magnitude of the association between NRTE and symptoms of ED in diagnosed/clinical samples. Such and endeavor is useful and timely because it will: (1) provide a more precise estimate of the difference between

individuals with ED and non-clinical controls on NRTE, as well on the relation between NRTE and symptoms of ED, (2) clarify the relative importance and the transdiagnostic nature of NRTE in relation to distinct types of disorders (e.g., PD, GAD, SAD, OCD, SP, MDD), as well as (3) the relative importance of distinct types of NRTE (e.g., anxiety sensitivity, experiential avoidance, meta-emotions, distress intolerance) in relation to ED.

Method

Literature search

Potential relevant studies for the current meta-analysis were identified by searching the following databases: PsychINFO, PubMed, Web of Science and Scopus. We included studies published by May 2017. The current searches were limited to studies that were (1) peer reviewed, (2) written in English, and were conducted on adult populations (aged 18 years or older). The following keywords (including truncated terms) related to NRTE ("emotion* *regulation", "emotion* *acceptance", "*acceptance of emotion*", "anxiety sensitivity", "fear of fear", "fear of emotion*", "belief* about emotion*", "emotion* schema*", "meta-emotion*", "metaemotion*", "distress *tolerance", "emotion* *tolerance", "experiential avoidance", "psychological *flexibility", "meta-mood") were crossed with terms related to ED ("MDD", "depress*", "dysthym*", "bipolar", "GAD", "anxiety", "anxious", "post-traumatic stress", "posttraumatic stress" , "PTSD" ,"*phobia", "SAD", "panic", "obsessive compulsive", "OCD", "mood disorder*", "emotion* disorder*").

Selection of studies

The systematic search generated a number of 16.472 potentially relevant studies. After duplicates removal, a total of 6466 articles were further examined in more detail based on their title and abstract. We looked both for comparison/categorical data (i.e., mean scores on NRTE by diagnostic group vs. control group) and correlational/continuous data (i.e., correlations between NRTE and relevant symptom measures in clinical samples). For comparison/categorical data we had the following inclusion criteria: (a) current ED (depressive or anxiety disorders) were diagnosed with clinical interview according to DSM-IV criteria (i.e., current disorder, formal diagnosis); (b) sample sizes, as well as means and standard deviations for the NRTE were reported both for the diagnostic group, as well as for the non-clinical/control sample; (c) if the study was part of an intervention/manipulation, the NRTE was measured at baseline, not after the manipulation. Also, studies were excluded if the diagnostic group consisted of individuals with multiple ED (i.e., mixed samples; e.g., some participants had depression as a principal diagnosis, others social anxiety in the same sample), as well as if the control group was an at-risk sample (e.g., panickers, even though non-clinical). However, comorbidities were allowed in the diagnostic groups.

Further, for correlational/continuous data we had the following inclusion criteria: (a) the clinical sample consisted of individuals with current ED (depressive or anxiety disorders) diagnosed with clinical interview according to DSM-IV criteria (i.e., current disorder, formal diagnosis); (b) reported sample size and relevant data (e.g., Pearson correlations) regarding the association between NRTE and self-report measures that assess the core symptom(s) of each ED (e.g., BDI-II for depression); (c) measures of NRTE and symptoms of ED were collected at the same time; (d) if the study was part of an intervention/manipulation, the NRTE and symptoms of ED were measured at baseline, not after the manipulation. As for the comparison data, studies were excluded if the clinical group was a mixed sample (comorbidities allowed).

Therefore, after considering the inclusion and exclusion criteria, we excluded 6046 studies. The full texts of the remaining 420 articles were examined in detail, and we found that another 297 studies did not meet the inclusion/exclusion criteria or did not provided sufficient data to calculate the effect sizes. Finally, a total number of 123 studies were included in the meta-analysis.

Coded variables

The following information was coded for each study included in the meta-analysis: identification data (names of the authors, year of publication), mean age of participants, number of participants included, percentage of female participants, type of ED (MDD, GAD, PTSD, PD, SAD, SP, OCD), type of NRTE (Anxiety Sensitivity, Experiential Avoidance, Distress Intolerance, Negative Meta-Emotions, Others), design (correlational, quasi-experimental), the general category of emotional disorder (anxiety, depression).

Meta-analytic procedure

Effect sizes (ESs) computation.

In the current meta-analysis, we computed two major sets of ESs: (1) Hedge's g coefficients (*g*) for comparison/categorical data (studies comparing clinical samples with a control group on NRTE), as well as (2) Pearson product-moment correlations (*r*) for correlational/continuous data (studies examining associations between NRTE and relevant symptom measures in clinical samples). We extracted means and standard deviations to compute ESs for comparison data, as well as Pearson's *r* correlations for correlational data (where provided). A number of 71 studies did not provide sufficient data to compute ESs in the original articles, thus the authors were further contacted via email. After request, data was provided for a number of 14 studies. Important to note, Hedge's g coefficients were interpreted as small (a value between 0.2 and 0.5), moderate (a value between 0.5 and 0.8), and large (a value of 0.8 or higher). Also, according to common conventions Pearson's *r* correlations were interpreted as small (a value between 0.1 and 0.3), moderate (a value between 0.3 and 0.5), and large (a value of 0.5 or higher).

Overall, the study sample was used as the unit of analysis. However, for certain subgroup analysis that included studies reporting comparisons between multiple clinical groups (MDD, SAD, PD) and a control group, or studies reporting comparison between a clinical group and a control group on multiple relevant outcomes (anxiety sensitivity, experiential avoidance), we assumed the independence of that specific comparison or outcome. The same principle was applied for the correlational/continuous data that included studies reporting associations between NRTE and relevant symptom measures in multiple clinical samples, or studies reporting associations between multiple measures of NRTE and symptom measures.

Further, we calculated the overall effect sizes for the comparison/categorical data, as well as for the correlational/continuous data using a random effects model due to high expected heterogeneity among studies. Also, heterogeneity was tested using two indexes, the *Q* statistic and I^2 index (Borenstein, Hedges, Higgins, & Rothstein, 2009). *Q* statistic (Cochran's *Q*) is calculated by summing the squared deviations of each study's estimate from the overall meta-analytic estimate, while I^2 represents the percentage of variation across studies that is due to true heterogeneity rather than chance (Higgins, Thompson, Deeks, & Altman, 2003). I^2 ranges between 0% and 100%. A value of 0% represent no observed heterogeneity, while larger values depicts increasing heterogeneity (i.e., 25% - low, 50% - moderate, and 75% - high heterogeneity).

Two methods were used in in the current meta-analysis to assess the potential publication bias. First, we used the fail safe N procedure (Rosenthal, 1991) to estimate the number of missing studies that would be required to nullify the effect. Second, we used the Trim and Fill method (Duval & Tweedie, 2000) which estimates the unbiased effect size, specifically the likely number of missing studies on the basis of asymmetry in the funnel plot, yielding at the same time corrected ESs and confidence intervals adjusted to account for these missing studies (Cooper, Hedges, & Valentine, 2009; Duval & Tweedie, 2000).

Moderator analyses.

Age and percentage of females were examined as continuous moderators using the unrestricted maximum likelihood meta-regression analysis. In this case, a significant *Z* value indicates a significant association between the continuous variables and the ESs. All analyses were run using the Comprehensive MetaAnalysis version 2.0 software (Biostat, Englewood, NJ, USA).

Results

Overall, 204 effect sizes were included in the current meta-analysis from 123 studies, more specifically 147 for the comparison between clinical samples and a control group on NRTE (*N*=21105) and 57 for the association between NRTE and relevant symptom measures in clinical samples (*N*=4504). Two studies provided data both for the comparison, as well as for the correlational data, thus we assumed their independence. As a consequence, in the current meta-analysis we included 123 studies (82 for the categorical data and 41 for the correlational data) as part of 121 original articles. Studies included in the meta-analysis were published between 1993 and 2017.

Overall effect sizes

The overall effect size of the comparison between individuals with ED (when collapsing anxiety disorders and depression together) and a control group on NRTE was high (k = 82), g = 1.47 (95% *CI* = [1.344; 1.599]). In this case, heterogeneity was also high and significant, Q (81) = 565.55, $p < .001$, $I^2 = 85.67$. Further, with respect to the association between NRTE and symptoms of ED (when collapsing symptoms of anxiety disorders and depression together) the overall effect size was moderate (k = 41), r = 0.406 (95% CI = [0.367; 0.444]). Heterogeneity was also moderate and significant, Q (40) = 81.799, $p < 0.001$, $I^2 = 51.100$.

Comparison between individuals with anxiety disorders and controls on NRTE. For the comparison between individuals with anxiety disorders (collapsing all anxiety disorders together and assuming independence for some comparisons) and controls on NRTE the effect size was high (k = 114), g = 1.40 (95% *CI* = [1.282; 1.518]), with high heterogeneity, Q (113) = 1081.36, $p < .001$, $I^2 = 89.55$. At a specific level (for each anxiety disorder separately), the effect size was high for PD (k = 39), g = 1.76 (95% *CI* = [1.605; 1.926]), followed by GAD (k = 24), g = 1.43 (95% *CI* = [1.204; 1.674]), SAD (k = 20), g = 1.24 (95% *CI* = [0.959; 1.528]), PTSD (k = 12), g = 1.19 (95% *CI* = [0.786; 1.595]), and OCD (k = 9), g = 1.17 (95% *CI* = [1.008; 1.335]). The only moderate effect size was for SP (k = 10), g = 0.67 (95% *CI* = [0.488; 0.864]). Heterogeneity was significant and high for each comparison (ps<.05; $I^2 > 75$), with the exception of OCD and SP for which heterogeneity was moderate (ps<.05; $I^2 > 50$).

Comparison between individuals with depression and controls on NRTE. For the comparison between individuals with depression and controls on NRTE the effect size was high (k = 14), g =

1.38 (95% *CI* = [1.155; 1.605]), with significant and high heterogeneity, Q (13) = 63.66, $p < .001$, $I^2 = 79.58$.

Association between symptoms of anxiety disorders and NRTE. For the association between NRTE and symptoms of anxiety disorders (collapsing all anxiety disorders together and assuming independence for some associations) the effect size was moderate (k = 38), $r = 0.403$ (95% *CI* = [0.362; 0.442]). At a specific level (considering symptoms of anxiety separately for each disorder), the effect size was moderate for symptoms of SAD (k = 5), $r = 0.447$ (95% *CI* = [0.368; 0.520]), followed by a moderate effect size for symptoms of PD (k = 16), $r = 0.434$ (95% *CI* = [0.374; 0.489]), PTSD (k = 8), $r = 0.391$ (95% *CI* = [0.280; 0.413]), GAD (k = 2), $r = 0.363$ (95% *CI* = [0.192; 0.512]), and OCD (k = 7), $r = 0.311$ (95% *CI* = [0.216; 0.400]). Heterogeneity was significant and moderate for PD and PTSD (*p*s<.05), and non-significant for OCD, SAD and GAD (*p*s>.05).

Association between symptoms of depression and NRTE. For the association between NRTE and symptoms of depression the overall effect size was moderate (k = 7), $r = 0.393$ (95% *CI* = [0.291; 0.486]). Heterogeneity was significant and moderate, Q (6) = 12.937, $p < 0.001$, $I^2 = 53.622$.

Subgroup analysis

Type of NRTE

We also conducted subgroup analyses to investigate the effect sizes for different types of NRTE. We coded 4 types of NRTE: (1) general anxiety sensitivity (ASI, ACQ, BSQ), (2) experiential avoidance (AAQ-II), (3) Distress Intolerance (DT), (4) Negative Meta-Emotions (DERS-N, ACS, EAQ – FNE), and Others (LESS, ERSQ, KIMS, DPSS-R-Ds, ICARUS).

Comparison/Categorical data.

For the comparison between individuals with ED and controls on different types of NRTE, the effect size was high for general anxiety sensitivity (k = 55), $g = 1.51$ (95% *CI* = [1.340; 1.683]), followed by experiential avoidance (k = 8), $g = 1.50$ (95% *CI* = [1.168; 1.840]), distress intolerance (k = 2), $g = 1.37$ (95% *CI* = [0.818; 1.939]), others (k = 4), $g = 1.32$ (95% *CI* = [0.759; 1.899]), and negative meta-emotions (k = 19), $g = 1.30$ (95% *CI* = [1.083; 1.536]). Heterogeneity was significant and high for each comparison (*p*s<.05; $I^2 > 75$), with the exception of distress intolerance for which the heterogeneity was non-significant (*p*>.05).

Correlational/continuous data.

For the association between symptoms of ED and different types of NRTE, the effect size was moderate for others (k = 3), $r = 0.488$ (95% *CI* = [0.425; 0.554]), followed by distress intolerance (k = 3), $r = 0.486$ (95% *CI* = [0.301; 0.634]), general anxiety sensitivity (k = 28), $r = 0.404$ (95% *CI* = [0.362; 0.443]), and experiential avoidance (k = 7), $r = 0.383$ (95% *CI* = [0.250; 0.502]). Also, the effect size was small for negative meta-emotions (k = 3), $r = 0.259$ (95% *CI* = [0.128; 0.382]). Further, heterogeneity was significant and moderate for anxiety sensitivity and experiential avoidance (*p*s<.05; $I^2 > 50$), as well as non-significant for distress intolerance, negative meta-emotions and others (*p*s>.05).

Continuous Moderator Analyses

Age positively predicted the effect sizes for the comparison between individuals with ED and a control group on NRTE ($B = 0.031$, $z = 14.523$, $p < 0.001$). Also, age positively predicted

the effect sizes of the associations between NRTE and symptoms of ED (B = 0.018, z = 5.681, p < 0.001). Further, the percentage of female was a significant predictor of the effect sizes for the comparison between individuals with ED and a control group on NRTE (B = -0.012, z = -11.881, p < 0.001). However, the percentage of female was a non-significant predictor for the associations between NRTE and symptoms of ED (p>.05).

Publication bias

For the comparison/categorical data we obtained a Fail-safe N of 4586. This indicates that a number of 4586 missing studies are required to nullify the effect (i.e., 55.92 missing studies for each observed comparison). In addition, the value of Fail-safe N is much greater than the critical value of Fail-safe N for the comparison/categorical data (5*82+ 10 = 420). Further, the Trim and Fill method identified 13 studies to the left of the mean that would reduce the effect size of the comparison between individuals with ED and controls on NRTE to g = 1.30 (95% CI = [1.178; 1.439]).

For the correlational/continuous data we obtained a Fail-safe N of 3756. This means that a number of 3756 missing studies are required to nullify the effect (i.e., 65.89 missing studies for each observed association). Also, for the correlational/continuous data the value of Fail-safe N is much greater than the critical value of Fail-safe N (5*57 + 10 = 295). Trim and Fill method identified no study to the left of the mean that would reduce the effect size of the association between symptoms of ED and NRTE. Thus, Trim and Fill point estimate and 95 % confidence interval are similar to those already reported (r = .406; 95% CI = [0.367; 0.444]).

Discussion

The current meta-analysis revealed that there is a significant difference between individuals with ED (when collapsing anxiety disorders and depression together) and non-clinical controls on NRTE, with a high effect size. At a more specific level, both individuals with anxiety disorders, as well as those with depression significantly differed from non-clinical controls on NRTE, with a high effect size. Also, when considering each anxiety disorder separately, current results showed a significant difference between individuals with PD, GAD, SAD, PTSD, OCD and non-clinical controls on NRTE, with a high effect size. Individuals with SP also differed significantly, however the effect size was only moderate.

Further, we looked at the association between NRTE and symptoms of ED in individuals diagnosed with ED. Overall, we found a significant and moderate association between NRTE and symptoms of ED (when collapsing symptoms of anxiety disorders and depression together). At a more specific level, we found significant and moderate associations between NRTE and both symptoms of anxiety disorders, as well as symptoms of depression. Also, when considering each category of anxiety symptoms separately, current results showed a significant and moderate association between NRTE and symptoms of SAD, PD, OCD, PTSD, and GAD. However, there were not enough studies to examine the association between NRTE and SP.

With respect to different types of NRTE, current results revealed significant differences with high effect sizes between individuals with ED and non-clinical controls on all types of NRTE, with the greatest effect size for anxiety sensitivity, followed by negative meta-emotions, experiential avoidance, distress intolerance, and other types of NRTE category (i.e., which included negative beliefs about emotions, non-acceptance of emotions, and a negative reactivity towards disgust). Also, current results revealed significant associations with moderate effect sizes

between symptoms of ED and all types of NRTE, with the exception of negative meta-emotions for which the effect size was small. The greatest moderate effect size was for the other types of NRTE category (i.e., which included general intolerance of emotions and non-acceptance of emotions), followed by anxiety sensitivity, distress intolerance, and experiential avoidance.

Finally, we examined age and percentage of females as continuous moderators. Age positively predicted the effect sizes of the differences between individuals with ED and a non-clinical controls on NRTE. In other words, larger differences were observed between individuals with ED and controls on NRTE as the age of participants increased. Similarly, age positively predicted the effect sizes of the associations between NRTE and symptoms of ED, which means that the magnitude of the associations increased as the age increased. The percentage of females negatively predicted the effect sizes of the differences between individuals with ED and a non-clinical controls on NRTE. Thus, a decrease in the number of women was associated with larger differences in NRTE between individuals with ED and non-clinical controls. However, the percentage of females was not a significant moderator for the associations between symptoms of ED and NRTE.

In sum, the current meta-analysis indicates that individuals with ED are characterized by an increased level of NRTE compared to non-clinical controls, and that endorsing a NRTE by individuals with ED is associated with greater severity of their symptoms. In addition, current results point out that the differences between ED individuals and non-clinical controls on all types of NRTE are similar, as well as the associations between symptoms of ED and all types of NRTE, with the exception of negative meta-emotions for which the effect was small. A possible explanation is that all these psychological constructs underlie the same general construct and might be best investigated as a general NRTE. In this regard, future research should examine the latent structure of this construct using a factor analysis approach. Finally, current results suggest that older participants, as well as male participants might be more prone to be affected by this NRTE.

Therefore, current findings support previous research showing that individuals with ED are characterized by a negative cognitive attitude towards emotions and/or by a negative emotional reaction towards emotions compared to non-clinical individuals (Campbell-Sills et al., 2006). In addition, current results support recent research highlighting the important role of NRTE in relation to various symptoms of anxiety disorders, as well as depression (Naragon-Gainey, 2010). To our knowledge, this is the first meta-analysis demonstrating more firmly the transdiagnostic nature of this construct.

3.2. Study 2. Beliefs about Emotions, Negative Meta-Emotions, and Perceived Emotional Control During an Emotionally Salient Situation in Individuals with Emotional Disorders[1]

Introduction

Emotional disorders (ED), such as depression and anxiety disorders are highly prevalent mental health conditions with a recurrent and chronic trajectory, imposing a considerable personal and societal burden (Kessler et al., 2012). Previous research highlighted that these conditions are frequently comorbid, suggesting that common mechanisms may be at play in their development and maintenance (Kroenke et al., 2007).

In the last decade, emotion dysregulation has been consistently proposed as a transdiagnostic factor underling ED (Werner & Gross, 2010). Research to date has highlighted that individuals with ED are characterized by a number of ER difficulties compared to healthy individuals, which are considered to further expose affected individuals to negative consequences in overall emotional experience, social functioning, and wellbeing (Gross & John, 2003).

Recent theoretical models and conceptualizations defined emotion dysregulation as an umbrella term entailing a series of components in which dysregulation can emerge (Gratz & Roemer, 2004; Mennin & Fresco, 2010). For example, a well-established conceptual framework developed by Mennin and Fresco (2010) summarized three ER components that are considered central in ED. More specifically, the authors argue that individuals with ED show significant difficulties in three main ER components, namely: (a) emotional awareness, (b) negative reactivity towards emotions (entailing meta-cognitive and meta-emotional reactions), and (c) emotional control (entailing strategies that individuals use to regulate their emotions) (Mennin & Fresco, 2010).

However, despite the widespread recognition of the importance of these three maladaptive ER processes (emotional awareness, negative reactivity towards emotions, emotional control) in individuals with ED, a major limitation in literature is that much of the previous research was mainly focused on the emotional control and emotional awareness components, neglecting the component of negative reactivity towards emotions (entailing beliefs about emotions, negative meta-emotions). Research on this particular ER process is growing as more researchers highlight the importance of examining individuals' fundamental beliefs about emotions and how these beliefs further influence the experience of meta-emotional reactions (David et al., 2019), as well as how individuals control emotions (Ford & Gross, 2018).

Given this background, the current study investigated specific ER difficulties in individuals with ED that emerged in a momentary fashion in a more ecological emotional situation. We specifically focused on maladaptive ER processes that were understudied in ER research, such as

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negative beliefs about emotions and negative meta-emotions. In addition, we sought to clarify the specific role of irrational beliefs about emotions as an underlying process (mediator) related to the experience of negative meta-emotions and to low perceived control of emotions.

To test this, we asked individuals with ED and a group of non-clinical controls to complete an emotion-provoking autobiographical recall task. First, we compared their subjective (negative emotions) and cardiac activity (heart rate, heart rate variability) experienced in response to this emotion-provoking task. We do not expect significant differences between groups to exist, as previous laboratory studies showed that individuals with ED do not necessarily differ significantly in their primary emotional reactions experienced during an emotional situation, but more on how they react towards and handle these negative emotions that arise in these situations (Campbell-Sills et al., 2006). Therefore, our general hypothesis is that individuals with ED will show more ER difficulties (related to beliefs about emotions, negative meta-emotions, and perceived emotional control) compared to individuals without these disorders. In this regard, we specifically expected that individuals with ED will show (1) more irrational beliefs about emotions and (2) more negative meta-emotions, as well as (3) poorer perceived emotional control in response to this emotion-provoking task. Conversely, we predicted that non-clinical controls will show (4) more rational beliefs about emotions. Also, consistent with previous suggestions, we predicted that participants with ED will endorse (5) more irrational beliefs about emotions than the control group, which in turn will predict an increased level of negative meta-emotions (mediation model 1) and a decreased perceived control of emotions (mediation model 2). Finally, we investigated the association between cardiovascular reactivity elicited by the emotional induction and the ER mechanisms employed by individuals with and without ED.

Method

Participants

The final sample consisted of 36 individuals who met criteria for an ED and 50 non-clinical controls (NC). Most participants were female (87.2%) and the mean age was 20.60 (SD = 2.11, range = 18 to 29). All participants were undergraduate students and unanimously White Caucasians. Participants were invited to participate via different communication channels (announcements via Facebook groups dedicated to University's students for academic matters and via email). Clinical participants were diagnosed with the Structured Clinical Interview for DSM-IV (SCID). In the current study, we examined the following ED: major depressive disorder (MDD), social anxiety disorder (SAD), generalized anxiety disorder (GAD), post-traumatic stress disorder (PTSD), obsessive-compulsive disorder (OCD), specific phobia (SP), bipolar disorder, and dysthymia. Individuals were excluded from the clinical group if they were psychotic, suicidal, substance-abusing, currently undergoing psychiatric and/or psychological treatment, as well as if they had a severe cognitive impairment and/or medical condition.

Individuals from the control group were eligible if they reported no current diagnosis on the overview and screening modules from the SCID. Where it was not clear from the screening interview, specific SCID modules were conducted to clarify the non-clinical status of participants. The ED and NC samples did not differ with respect to gender, $\chi 2$ (1, N = 86) = 0.06, p = .79, or age, t (84) = -0.2, p = .79. However, significant differences emerged with respect to depression, t (84) = -11.41, p < .001, and anxiety severity, t (84) = -8.68, p < .001, with greater severity for individuals with ED. Participation to current study was voluntary and participants were given a personalized report with regard to their diagnostic status, as well as credit course. Written consent

was obtained from all participants and data protection was ensured. The study was approved by the Institutional Review Board.

Procedure

Eligible participants were invited into the laboratory where they sat at a desk in front of a computer and devices to measure cardiac activity were attached. Physiological measures were collected continuously during the experimental procedure. First, in order to induce a comparable neutral mood across groups at the beginning of the task, participants watched a 4-min emotionally neutral video depicting 3D motion graphics followed by a baseline assessment of their subjective negative emotions. They next had to complete an autobiographical recall task while in the background a low-mood inducing music was played (extract from Adagio for Strings by Samuel Barber) (for more details see *Supplementary Material 2*). Immediately after the task, they were asked to complete measures of their negative emotions, beliefs about emotions, negative meta-emotions and perceived emotional control experienced during the recall task. After completing these measures, participants were asked to watch again the 4-min emotionally neutral video as a recovery period and after that to rate again their level of negative emotions, as well as to complete a series of manipulation check questions. The experiment lasted approximately 60 minutes.

Measures

The Positive and Negative Affect Schedule (PANAS) (Watson, Clark, & Tellegen, 1988) is a 20-item self-report scale that assesses negative and positive affect. In the current study we used the negative affect subscale (PANAS-N) to measure state negative emotions experienced by participants in three moments: baseline, recall task, and recovery.

The State Difficulties in Emotion Regulation Scale (S-DERS) (Lavender, Tull, DiLillo, Messman-Moore, & Gratz, 2017) is a 21-item self-report scale that assesses state emotion dysregulation represented by: (1) a non-acceptance stance towards current emotions represented by a tendency to experience negative meta-emotions (Negative Meta-Emotions) *("I feel guilty for feeling this way"*), (2) perceived difficulties in modulating emotional and behavioral responses in the present moment (Perceived Emotional Control) *("My emotions feel out of control"*), (3) a limited awareness *("I am acknowledging my emotions"*), and (4) clarity about current emotions (*"I am confused about how I feel").* The scale has a total emotion dysregulation score as well as partial scores on the four subscales. In the current study, two subscales were used, (1) the Negative Meta-Emotions subscale to measure negative meta-emotions, and (2) the Perceived Emotional Control subscale to measure perceived emotional control.

The Rational and Irrational Beliefs about Emotions Scales (RI-BAES) are two self-report scales developed for the current study to measure irrational (4 items) and rational (4 items) beliefs about negative emotions.

Manipulation checks questions

We also developed 7 items for the current study to measure (a) participants' ability to recollect the distressing event (4 items), (b) the extent to which they have managed to follow the experimental instructions (1 item), (c) how difficult it was (1 item), and (d) how successful they believe they were (1 item). Participants were asked to rate on a 7-point Likert scale (1=not at all, 7=to a great extent) the extent to which each item applied to them.

Physiological Measures

Cardiac data was acquired using the ECG100C Electrocardiogram Amplifier (MP150: Biopac Systems Inc., USA), at a sampling rate of 1000 Hz using Ag/AgCl electrodes placed on the chest according to a modified II Lead configuration. Raw ECG signals were analyzed using standard preprocessing using the software Kubios, v2.0 (Tarvainen, Niskanen, Lipponen, Ranta-aho, & Karjalainen, 2014).

Data analysis

First, to analyze changes in negative emotions (PANAS-N) and cardiac activity (HR, HRV) through the experiment, three separate analysis of variance tests (ANOVAs) were conducted, with time (baseline, recall, and recovery) as a within-subjects factor, and group (ED and HC) as a between-subjects factor. Second, to investigate group differences in ER difficulties experienced during the recall task, a multivariate analysis of variance (MANOVA) was conducted with all ER variables examined concurrently as dependent variables (negative meta-emotions, perceived emotional control, negative beliefs about emotions). Given the expected correlations between these variables (see *Supplementary Material 2*), the use of MANOVA is a common approach in order to reduce type 1 error rate (Field 2013). Next, to examine the mediator role of irrational beliefs about emotions in the relation between group and negative meta-emotions, as well as perceived emotional control, we conducted two mediation analyses. We used a bootstrapping procedure (bias-corrected, with 5000 iterations) assessing indirect effects. In this case, mediation occurs if the 95% bootstrapping confidence interval (CI) does not contain zero. Overall negative emotions were entered as a covariate in the mediation models. Finally, to test the relationships between negative meta-emotions and cardiovascular reactivity, we performed a series of Person's r correlations for each group separately. Statistical analyses were performed using IBM SPSS Statistics, version 20 (IBM Corp., Armonk, NY, USA).

Results

Manipulation check

With respect to changes in PANAS-N, HR, and HF-HRV, ANOVAs with the Huynd-Feldt correction to correct for violations of the assumption of sphericity showed a significant effect of time for PANAS-N, F (1.74, 146.31) = 218.37, $p < .001$, partial $\eta 2 = .722$, as well as for HR, F (2, 168) = 85.65, $p < .001$, partial $\eta 2 = .505$, but not for HF-HRV, $p = .438$. Also, the main effect of group was significant for PANAS-N, F (1, 84) = 27.17, $p < .001$, partial $\eta 2 = .244$, but non-significant for HR and HF-HRV (ps > .05). Finally, no interaction effects between time and group were found for PANAS-N, HR, and HF-HRV (ps>.05).

Post hoc tests (Sidak corrected) revealed that overall, the ED group showed significantly higher levels of PANAS-N than the NC group (*mean difference* = 5.00, *SE* = .96, $p < .05$). Further, post hoc tests (Sidak corrected) evidenced a significant increase in PANAS-N from baseline to recall task (*mean difference* = 15.26, *SE* = .87, $p < .05$) and a significant decrease from task to recovery (*mean difference* = 11.46, *SE* = .79, $p < .05$). For HR, post hoc tests (Sidak corrected) evidenced a significant increase from baseline to task (*mean difference* = 6.67, *SE* = .83, $p < .05$) and a significant decrease from task to recovery (*mean difference* = 9.90, *SE* = .77, $p < .05$). Thus, the recall task achieved the desired effect of increasing negative emotion and HR in the short term, however the repeated measure and group interaction was not significant, suggesting that the task

impacted the ED and NC participants similarly, even though ED participants reported higher overall levels of negative emotion on the PANAS-N.

Also, a series of manipulation checks questions were developed for the current study to ensure that participants understood and followed the instructions. The results showed that there were no differences between ED and NC participants with respect to their ability to recollect the distressing event [t (84) = -.32, p > .05], follow the experimental instructions [t (84) = .54, p > .05], how difficult they perceived the task [t (84) = -.53, p > .05], and how successful they believe they were in applying the instructions [t (84) = .28, p > .05]. Moreover, there were no significant differences between ED (M = 88.61; SD = 12.07; *range* = 50-100) and NC participants (M = 85.06; SD = 10.82; *range* = 50-100) with respect to the most distressing event selected for the recall task [t (84) = -1.42, p > .05].

Group differences in specific ER difficulties experienced during the recall task

Our first hypothesis was that ED group would endorse greater ER difficulties (beliefs about emotions, negative meta-emotions, perceived emotional control) during the emotion induction task. To investigate this hypothesis a MANOVA was conducted to examine the differences in these reported ER difficulties between the ED sample and the NC sample. We found a significant difference between the two groups (Wilks' Lambda = 0.02), F (4, 81) = 8,74, p < 0.001. Individuals with ED reported more difficulties in perceived emotional control [F (1, 84) = 16.10, p < .001, partial $\eta 2$ = .161], more negative meta-emotions [F (1, 84) = 22.62, p < .001, partial $\eta 2$ = .212], as well as more irrational beliefs about emotions [F (1, 84) = 27.75, p < .001, partial $\eta 2$ = .248] during the recall task. Also, individuals in the NC group reported significantly more rational beliefs about emotions [F (1, 84) = 10.71, p < .05, partial $\eta 2$ = .113].

Irrational beliefs about emotions as a specific pathway to negative meta-emotions and low perceived emotional control

We next examined whether irrational beliefs represent a specific pathway to higher levels of negative meta-emotions, as well as to lower perceived emotional control. To investigate this, irrational beliefs about emotions were investigated as a mediator in the relation between group (ED vs. NC) and the experience of negative meta-emotions (Model 1), as well as between group and low perceived emotional control (Model 2). Overall negative emotions were entered as a covariate. As it can be seen in *Figure 1*, irrational beliefs about emotions were a significant mediator between group and negative meta-emotions (B = 3.09, CI .1.316, 5.356), as well as between group and low perceived emotional control (B = 2.83, CI .1.256, 4.786), after accounting for overall negative emotions. In addition, the direct effect of group on negative meta-emotions (B = 1.81, p > .05) and low perceived emotional control (B = 2.24, p > .05) was no longer significant when controlling for irrational beliefs about emotions, suggesting that irrational beliefs about emotions are a full mediator in these relations. In other words, having a ED was related to endorsing more irrational beliefs about emotions, which in turn was related to higher levels of negative meta-emotions, as well as to lower perceived emotional control experienced during the recall task.

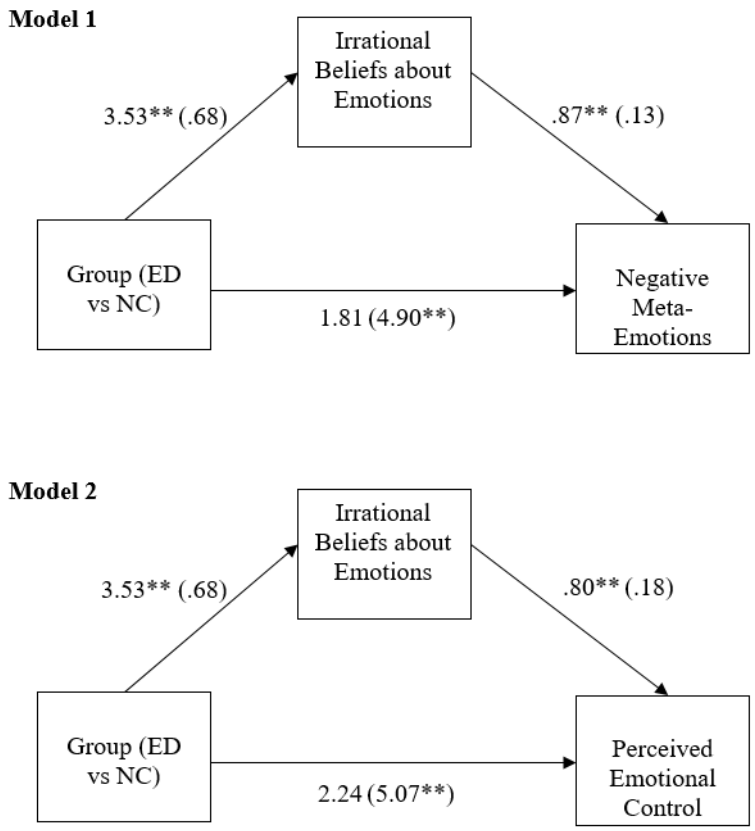

Figure 1. Irrational beliefs about emotions as a mediator between group (ED vs NC) and negative meta-emotions (Model 1), as well as between group (ED vs NC) and perceived emotional control (Model 2). Pathways represent unstandardized regression coefficients. *$p < .05$; **$p < .001$.

Negative meta-emotions and physiological indexes

Finally, a series of Person's r correlations were conducted for each group to explore the relationship between negative meta-emotions and cardiovascular reactivity. For the NC group, results showed a significant positive correlation between the level of negative meta-emotions and HR reactivity ($r = 0.28$, $p < .05$), but not a significant relation with HF-HRV ($p > .05$). Conversely, for the ED group, results showed a significant positive correlation between the level of negative meta-emotions and HF-HRV ($r = 0.33$, $p < .05$), but not a significant relation with HR ($p > .05$).

Discussion

As predicted, when exposed to the same emotionally provoking task, individuals with ED showed significantly more irrational beliefs about their own emotions and more negative meta-emotions, as well as lower perceived emotional control compared to NC individuals. Conversely, NC individuals showed significantly more rational beliefs about emotions. No significant differences between groups were observed with respect to the emotional and cardiovascular response during this emotionally salient situation. In other words, current results showed that compared to NC sample, individuals with ED do not necessarily differ significantly in how they respond emotionally and physiologically, but more on how they react towards and handle these

negative emotional states that arise in this emotional recall task, both meta-cognitively, through irrational beliefs, as well as meta-emotionally, through negative meta-emotions. In addition, current results showed that ED individuals are characterized by lower perceived emotional control, not knowing how to effectively manage these negative emotions when they arise.

Further, as we expected irrational beliefs about emotions were a significant mediator in the relation between group (ED vs. NC) and negative meta-emotions, as well as between group and low perceived emotional control. In other words, having an ED (vs. NC) was related to endorsing more irrational beliefs about emotions, which in turn predicted higher levels of negative meta-emotions and lower perceived emotional control. Thus, it may be the case that individuals with ED have specific difficulties in how they appraise their emotions when they experience such negative states, which further expose them to more negative meta-emotions and to lower perceived emotional control. Finally, our results revealed that an increased level of negative meta-emotions in the clinical group was related to an increased level of HF-HRV reactivity, reflecting greater vagal control of heart rate. Conversely, an increased level of negative meta-emotions in the NC group was related to an increased level of HR but not of HF-HRV, indexing a larger sympathetic activation.

Therefore, at a more general level our results suggest that individuals with ED are characterized by a number of ER difficulties in the face of an emotional autobiographical recall task. At a more specific level, our results showed that individuals with ED endorse more irrational beliefs about emotions, which in turn is related to more negative meta-emotions and to lower perceived emotional control. At a more practical level, current findings also suggest that clinical interventions may benefit from assessing and targeting "in-the-moment" beliefs about emotions. Specifically, instructing individuals to shift from a dysfunctional/irrational approach towards their emotions to a rational/functional approach (by helping them to identify and test the accuracy of their beliefs about emotions) or shift to an accepting approach (by helping them to observe, accept non-judgmentally and remain in contact with their emotions) might further improve emotional functioning and regulation for individuals with ED.

3.3. Study 3. The Effects of Irrational, Rational, and Acceptance Beliefs about Emotions on The Emotional Response and Perceived Control of Emotions[2]

Introduction

It is very common for individuals to experience negative emotions in stressful situations, but it is also clear that these individuals differ on how they evaluate their emotional responses that arise in these contexts (Ford & Gross, 2018). Recently, an increased interest has been observed in investigating individuals' evaluations of emotions or beliefs about emotions (BAEs).

Consistent with these data, classic cognitive behavioral therapies, and in particular, rational-emotive behavior therapy (REBT) (David & Cristea, 2018; Ellis, 1991) suggests that endorsing irrational BAEs might be detrimental for individuals' emotional functioning. Similarly, more recent "third wave" approaches, such as Acceptance and Commitment Therapy (ACT) suggest that the persistence of negative emotions results mainly from evaluative judgments that some emotions are unacceptable (*"Feeling negative emotions is unacceptable")* (Hayes et al., 1999). To sum up, both REBT and ACT point towards the detrimental effects of endorsing irrational BAEs for emotional functioning and regulation. However, despite this similarity, they differ in their conceptualization of how is best to approach emotions when they arise in distressing situations. On the one hand, ACT argues that a non-evaluative, accepting stance is the most adaptive reaction towards emotions with beneficial effects on the emotional response, especially for an efficient recovery from distressing situations (Campbell-Sills et al., 2006). On the other hand, REBT suggests that endorsing rational BAEs, in terms of (1) flexibly preferring not to feel negative emotions (*"I prefer not to feel negative emotions, but I accept it if this does happen"*), (2) considering them unpleasant but not awful/terrible and (3) tolerating negative emotions (*"It's unpleasant but not awful to feel negative emotions and I can stand it"*), as well as (4) unconditionally accepting one's self for having negative states (*"I'm valuable even if I experience negative emotions"*) might also be beneficial for emotional functioning (Ellis, 1991). Thus, the REBT framework (unlike ACT) considers that approaching emotions with negative evaluations/judgements (*"It's bad to feel negative emotions"*) is adaptive, as long as these evaluations are formulated rationally (*"This is bad but not terrible and I can stand it"*). Also, in this conceptualization individuals are encouraged to effectively control their emotions. Hence, from a general perspective, the main theoretical differences between these two approaches are related to two main components: (1) the approach towards emotions (evaluative in REBT vs. non-evaluative in ACT), and (2) the effect of each approach with respect to emotional control (active control in REBT vs. no control in ACT).

However, despite the recognized importance of various BAEs, few studies investigated their impact on (1) the emotional response, as well as on (2) the emotional control. In this context,

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[2] This study has been published.

Predatu, R., David, D. O., & Maffei, A. (2020). The effects of irrational, rational, and acceptance beliefs about emotions on the emotional response and perceived control of emotions. *Personality and Individual Differences*, 155, 109712.

The authors contributed to the article as follows: Predatu, R: study conception and design, data acquisition and analysis, interpretation of data and manuscript writing; David, D.O: study conception and design, data acquisition and analysis, interpretation of data and manuscript writing. Maffei, A: data acquisition and analysis, interpretation of data and manuscript writing.

the goal of the current study was to investigate the effects of endorsing different BAEs (irrational, rational, acceptance) on the emotional response and perceived emotional control in individuals exposed to a negative film clip. Based on REBT we expected that (1) endorsing rational BAEs would decrease negative emotions during the emotion induction relative to a control group, as this approach was conceptualized as an adaptive approach. With respect to individuals endorsing irrational BAEs we predicted that (2) they will experience significantly more negative meta-emotions and poorer perceived emotional control during the emotion induction relative to the other groups (as both ACT and REBT suggest). However, (3) in terms of decreases in negative emotions our investigation was exploratory, as REBT does not clearly specify the effects of this irrational approach during an emotional situation (would rather point towards increases in negative emotions), while ACT suggests that (4) this approach is associated with reductions in negative emotions. Further, we expected that after a recovery period, (5) only individuals endorsing rational and acceptance BAEs to show significant decreases in negative emotions in comparison with the control group. We did not expect (6) significant differences to emerge between the rational and acceptance-based approaches, as both are conceptualized as adaptive, however (7) we expected acceptance to be particularly important in the recovery period. Finally, after the recovery we expected that (8) individuals endorsing irrational BAEs to show significant increases in negative emotions (as REBT and ACT suggested) in comparison with the other groups. Although we were primarily interested in the subjective emotional response, we also conducted exploratory analyses to investigate the effects of BAEs at the psychophysiological level, and to provide a multidimensional evaluation of the individual emotional reactivity.

Methods

Participants

Two hundred and fourteen undergraduate students (186 females, 28 males) participated in this study. The mean age was 19.9 years (range=18–25; *SD*=1.42). All participants were Romanian, White Caucasians. Participants were recruited through online postings on University's groups and rewarded with credit course. Written consent was obtained and data protection was ensured. The study was approved by the Institutional Review Board.

Procedure

The experimental procedure took approximately 1 h. First, participants were asked to give their consent and to complete two self-report measures to assess their depressive symptoms and their habitual tendency to avoid internal experiences. Further, participants in the experimental groups (irrational/rational/acceptance) took part in a 15-min training to familiarize with the BAEs they had to endorse in the experimental session (as assigned to their group). After this training, participants had a ten-minutes break, followed by the experimental session. The control group did not receive any training, they started directly with the experiment. In the experimental session, participants were invited to sit in front of a computer where devices to measure physiological activity were attached. The experiment began with a 3-min baseline in which participants sat quietly, followed by an assessment of their negative emotions. After the baseline period, participants were asked to watch a 171-sec film clip depicting a boy grieving his father's death (extracted from the movie "The Champ"). Participants were instructed to adopt specific BAEs while watching the film. In the Irrational BAEs group, participants were asked to endorse BAEs represented by (1) rigidly demanding not to feel negative emotions, (2) catastrophizing and (3) evaluating them as unbearable, as well as (4) globally evaluating one's self for having negative states. In the Rational BAEs group, participants were asked to endorse BAEs represented by (1)

flexibly preferring not to feel negative emotions, (2) considering them unpleasant but not awful, and (3) tolerating negative emotions, as well as (4) unconditionally accepting one's self for having negative states. The instructions for irrational and rational BAEs were developed according to a REBT guide (DiGiuseppe et al., 1988) *(Supplementary Material 1)*. In the Acceptance-focused BAEs group, participants were asked to endorse BAEs represented by a non-evaluative and accepting stance towards emotions in the present moment. Acceptance instructions were developed according to protocols described by Hayes et al. (1999) *(Supplementary Material 1).* Participants in the control group were instructed to watch the film carefully with no further instructions. Immediately after the film, participants were asked to complete measures of negative emotions, negative meta-emotions and perceived emotional control experienced during the emotional task. Finally, participants were asked to rest for 3-min as a recovery period, and at the end to rate their negative emotions, as well as to complete a series of manipulation check questions.

Measures

The Beck Depression Inventory (BDI-II) (Beck, Steer, Ball, & Ranieri, 1996) is a 21-item self-report scale that measures depressive symptoms.

The Acceptance and Action Questionnaire - II (AAQ-II) (Bond et al., 2011) is a 7-item self-report scale that measures the tendency to avoid unwanted internal experiences.

The Positive and Negative Affect Schedule (PANAS) (Watson et al., 1988) is a 20-item self-report scale that measures negative and positive emotions. For this study, we used the negative affect subscale to assess negative emotions (10 items).

The State Difficulties in Emotion Regulation Scale (S-DERS) (Lavender et al., 2017) is a 21-item self-report scale that measures emotion dysregulation as a state. For this study, two subscales were used, (1) the Non-Acceptance subscale to measure negative meta-emotions ("I am embarrassed for feeling negative emotions"), and (2) the Modulation subscale to measure perceived emotional control ("My emotions feel out of control").

Manipulation checks questions

To check if participants followed the instructions, we developed a 10-item measure assessing the extent to which participants (a) irrationally evaluated emotions (2 items), (b) rationally evaluated emotions (2 items), and (c) accepted emotions (2 items). Also, we examined the participants' ability to (d) watch the film carefully (3 items) and (e) follow the experimental instructions (1 item) *(Supplementary Material 2)*. Participants were asked to rate on a 7-point Likert scale (1=*to a small extent*, 7=*to a great extent*) the extent to which each item applied to them.

Psychological measures

Psychophysiological signals were collected using a BIOPAC amplifier (MP150:Biopac Systems Inc., USA, sampling rate=1000 Hz) using disposable electrodes placed on the chest (ECG) and second and middle finger of non-dominant hand (SCL), and using a resistive belt placed on participants' chest (RSP). Raw ECG signals were analyzed using standard preprocessing with the software Kubios, v2.0 (Tarvainen et al., 2014). Raw skin conductance and respiration signals were analyzed using custom MATLAB (v. 2015b) scripts. Raw respiration signals were downsampled to 100 Hz and filtered with a 4th order zero-phase band-pass Butterworth filter with cut frequencies of 0.05 and 1 Hz. After visual inspection in order to identify and discard rare artifacts, peaks corresponding to breathing were identified and the respiratory rate (RSP) was

computed (in breath per minute, bpm) for each time interval considered (Baseline, Film, Recovery).

Data analysis

Changes in negative emotions (PANAS-N) and physiological indexes (SCL, RSP, HR) through the experiment, were analyzed with a series of repeated measures analysis of variance (rmANOVA), including Time (Baseline, Film, Recovery) as a within-subjects factor, and Group (Irrational, Rational, Acceptance, Control) as a between-subjects factor. Second, to investigate group differences in negative meta-emotions and perceived emotional control experienced during the film, a series of ANOVAs were conducted with these variables examined as dependent variables.

Results

Preliminary analysis

No significant differences between-groups were found for age [$F(3,210)=1.722$, $p=.16$], depressive symptoms [$F(3,210)=.303$, $p=.82$], and experiential avoidance [$F(3,210)=.162$, $p=.92$], but significant differences emerged with respect to gender [$\chi 2$ (3, $N=214)=11.864$, $p=.008$]. Thus, gender was used as a covariate in all statistical analyses.

Manipulation check questions

The manipulation checks revealed a significant effect of Group on the extent to which participants irrationally evaluated their emotions [$F(3, 206) = 159.13$, $p<.001$, $\eta 2p = .69$], rationally evaluated their emotions [$F(3, 206) = 14.52$, $p<.001$, $\eta 2p = .17$], and accepted their emotions [$F(3, 206) = 36.81$, $p<.001$, $\eta 2p = .34$]. Post-hoc test confirmed the efficacy of the manipulation showing that the Irrational BAEs group engaged more in an irrational evaluation, the Rational BAEs group more in a rational evaluation, and the Acceptance-focused BAEs group more in acceptance compared to other groups ($ps<.05$). Finally, no between-groups differences were found with respect to participants' ability to watch the film carefully or to follow the experimental instructions ($ps>.05$).

The effects of BAEs on negative emotions and physiological indexes

For PANAS-N, results (Greenhouse-Geisser corrected) showed a significant effect of Time [$F(1.815, 379.276) = 7.34$, $p<.001$, $\eta 2p = .03$], Group [$F(3, 209) = 4.05$, $p<.05$, $\eta 2p=.05$], and Time by Group interaction [$F(5.444, 379.276) = 2.78$, $p<.05$, $\eta 2p = .03$].

For SCL (Huynh-Feldt corrected), we found a significant Time effect [$F(1.428, 279.876) = 9.69$, $p<.001$, $\eta 2p = .04$], but a non-significant Group and Time by Group interaction effect ($ps>.05$). Similarly, a significant Time effect was found for RSP (Greenhouse-Geisser corrected) [$F(1.827, 372.609) = 6.40$, $p<.05$, $\eta 2p = .03$], but a non-significant Group and Time by Group interaction effect ($ps>.05$). For HR, no significant effects were found ($ps>.05$).

Pairwise comparisons on negative emotions

Pairwise comparisons (Sidak corrected) performed on the main effect of Time revealed a significant increase in negative emotions from baseline to film (*mean difference* = -3.45, $SE = .40$, $p<.001$, 95%CI = [-4.43; -2.48]), and a significant decrease from film to recovery (*mean difference* = .30, $SE = .32$, $p<.001$, 95%CI = [3.51; 5.09]) when collapsing across conditions (thus, our emotional manipulation proved to be effective). Also, pairwise comparisons (Sidak corrected) performed on the main effect of Group revealed that the Rational BAEs group reported less

negative emotions than the Control group (*mean difference* = -2.68, *SE* = .81, *p*<.05, 95%*CI* = [-4.84; -0.52]). No other Group differences were found.

Time by Group pairwise comparisons (Sidak corrected) revealed that after the film, the Rational BAEs group (*mean difference* = -4.04, *SE* = 1.06, *p*<.001, 95%*CI* = [-6.85; -1.22]) and the Irrational BAEs group (*mean difference* = -2.84, *SE* = 1.03, *p*<.05, 95%*CI* = [-5.59; -0.10]) reported significantly less negative emotions compared to the Control group. However, after the recovery, only the Rational BAEs group (*mean difference* = -3.07, *SE* = .91, *p*<.05, 95%*CI* = [-5.49; -0.66]) and the Acceptance-focused BAEs group (*mean difference* = -2.36, *SE* = .89, *p*<.05, 95%*CI* = [-4.73; -0.01]) reported significantly less negative emotions compared to the Control group (*Figure 1*). Moreover, after the recovery, the Rational BAEs group reported significantly less negative emotions compared to the Irrational BAEs group (*mean difference* = -2.56, *SE* = .91, *p*<.05, 95%*CI* = [-4.97; -0.14]). No other significant differences were found.

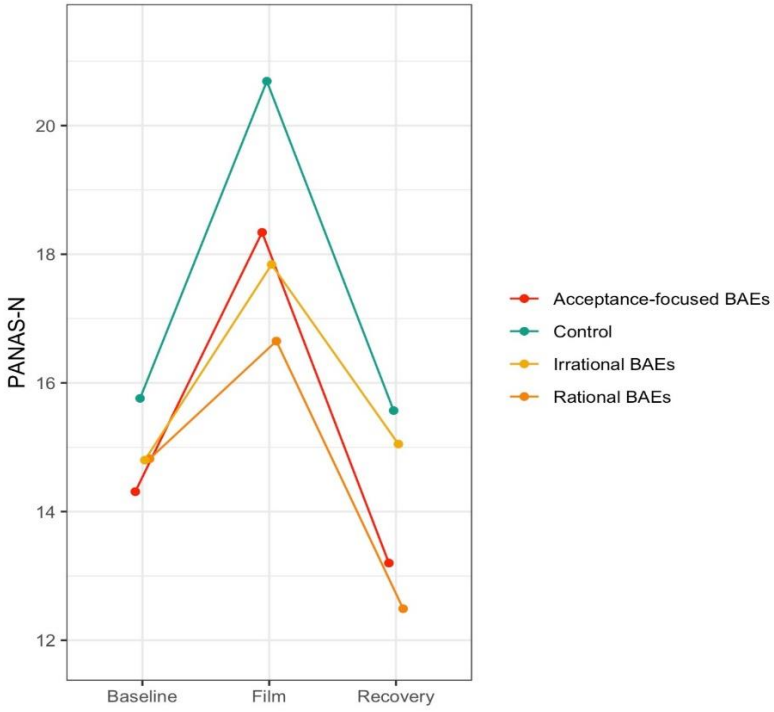

Figure 1. The effects of BAEs on negative emotions

Pairwise comparisons on physiological indexes

Pairwise comparison (Sidak corrected) revealed a significant increase in SCL from baseline to film (*mean difference* = -.85, *SE* = .07, *p*< .001, 95%*CI* = [-1.04; -0.67]), but a non-significant decrease from film to recovery when collapsing across conditions (*p*s>.05). For RSP, pairwise comparison (Sidak corrected) revealed an overall significant increase from baseline to film (*mean difference* = -.98, *SE* = .24, *p*< .001, 95%*CI* = [-1.56; -0.40]), and a significant decrease from film to recovery (*mean difference* = 1.20, *SE* = .22, *p*<.001, 95%*CI* = [0.65; 1.75]).

The effects of BAEs on negative meta-emotions and perceived emotional control

ANOVAs confirmed the effect of BAEs on negative meta-emotions [*F (*3, 209) = 19,27, *p*<.001, η2p=.21] and on perceived emotional control [*F (*3, 209) = 4,41, *p*<.05, η2p=.06].

Pairwise comparisons on negative meta-emotions and perceived emotional control

Pairwise comparisons (Sidak corrected) revealed that the Irrational BAEs group reported significantly more negative meta-emotions compared to the Rational BAEs group (*mean difference* = 4.41, *SE* = .73, *p*<.001, 95%*CI* = [2.46; 6.35]), Acceptance-focused BAEs group (*mean difference* = 5.02, *SE* = .72, *p*<.001, 95%*CI* = [3.11; 6.94]), and Control group (*mean difference* = 3.38, *SE* = .71, *p*<.001, 95%*CI* = [1.49; 5.28]). Further, with respect to perceived emotional control, pairwise comparisons (Sidak corrected) revealed that the Rational BAEs group reported significantly less problems in perceived emotional control than the Irrational BAEs group (*mean difference* = -3.14, *SE* = .92, *p*< .05, 95%*CI* = [-5.60; -0.69]), but no other significant differences were found.

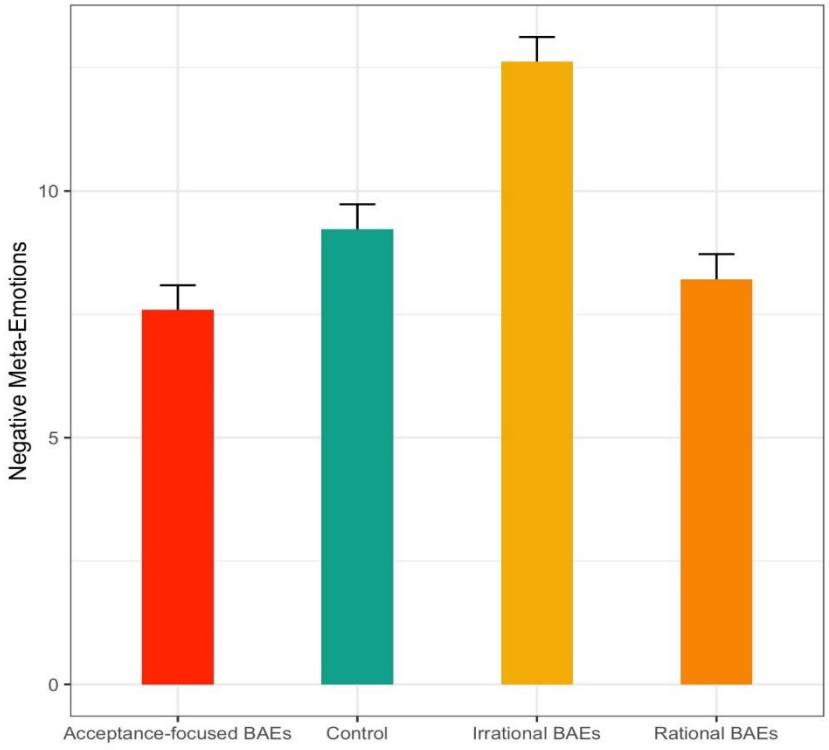

Figure 2. The effects of BAEs on negative meta-emotions

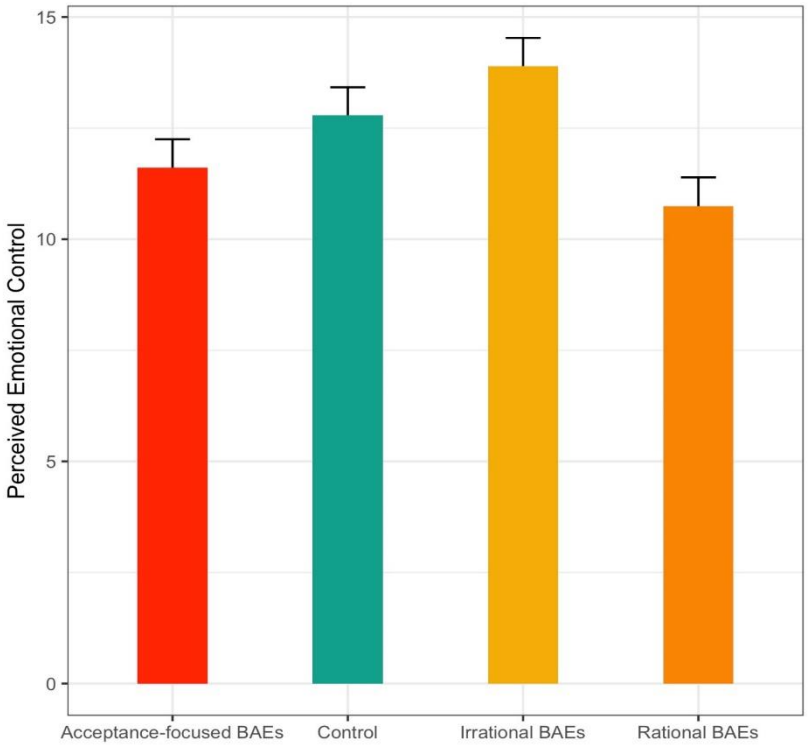

Figure 3. The effects of BAEs on perceived emotional control

Discussion

Current results revealed that individuals endorsing irrational BAEs during an emotional film, as well as those endorsing rational BAEs showed significant decreases in negative emotions compared to the control group. However, the former reported significantly more negative meta-emotions compared to the other groups and poorer perceived emotional control compared to those endorsing rational BAEs. Thus, even though both approaches were effective in decreasing negative emotions, endorsing irrational BAEs comes with a meta-emotional cost and with a poorer perceived emotional control. Further, after a recovery period it seems that only individuals endorsing rational BAEs and those endorsing an acceptance-based approach showed significant decreases in negative emotions. Importantly, endorsing an acceptance-based approach during the film was beneficial only in the recovery period, while endorsing rational BAEs were effective in reducing negative emotions both during and after the film. Indeed, this result is in line with recent suggestions that acceptance might be especially important in recovering from distressing situations (Troy et al., 2018). Finally, no significant differences emerged between groups on the physiological indexes.

However, current findings take an important step in establishing the effects of various BAEs underlying different therapeutic conceptualizations on the emotional response and perceived emotional control experienced by individuals in an emotional situation. Specifically, results point towards the detrimental effects of irrational BAEs by contributing to more negative meta-emotions and to poorer perceived emotional control during an emotional film. Also, this study highlights the adaptive role of endorsing rational BAEs in decreasing negative emotions, as well as of an acceptance-based approach, especially in the recovery period. Thus, at a general level, these findings support recent empirical research suggesting that endorsing BAEs entails important consequences influencing the perceived emotional control, as well as the subjective emotional response (Ford & Gross, 2018). Altogether, these findings suggest that assessing the content of BAEs in individuals and helping them develop more rational BAEs might improve their emotional functioning when facing emotional situations.

3.4. Study 4. Emotion Regulation Abilities as a Predictor of Emotional Response Experienced by Children and Adolescents in the Face of Stress

Introduction

The period of adolescence, as well as the transition from childhood to adolescence are often demanding, characterized by numerous external and internal challenges that have to be faced (Kushner, 2015). In this context, the abilities needed to cope with stressful situations, as well as with negative emotions are indispensable and can distinguish from optimal adaptation in the face of stress or risk for further maladjustment and psychopathology (Shapero, Abramson, & Alloy, 2016). Research has emphasized that children's and adolescents' abilities in emotion regulation (ER) are associated with numerous favorable outcomes (general emotional well-being), and are considered a protective factor when encountering stressful situations (Sprung, Münch, Harris, Ebesutani, & Hofmann, 2015). Conversely, difficulties in ER abilities are related to detrimental outcomes (such as the development of affective disorders), and are considered a risk factor for more intense and labile emotions in challenging situations (McLaughlin, Hatzenbuehler, Mennin, & Nolen-Hoeksema, 2011).

Across these multiple conceptualizations, ER is considered a multidimensional construct with many different abilities that can be included under the umbrella of this construct (Thompson, 1994). For example, a well-known conceptual model developed by Mennin and Fresco (2010) identified three ER abilities/components that are considered essential and in which difficulties might emerge, namely: (a) emotional awareness, (b) negative reactivity towards emotions (entailing meta-cognitive reactions/beliefs about emotions and meta-emotional reactions/secondary emotions), and (c) emotional control.

Research suggests that difficulties in emotional awareness, negative reactivity towards emotions, and emotional control predict dysfunctional emotional consequences (the level of negative emotions) among children and adolescents facing stressful situations and can constitute risk factors for maladjustment and psychopathology. However, despite these suggestions, few studies have yet investigated the association between these ER abilities and emotional response in laboratory-based contexts, using various emotion-induction paradigms/tasks, such as an impromptu speech task, a social interaction task, an autobiographical recall task, and other tasks used to induce emotions in a laboratory setting (Tan et al., 2012). Moreover, most of the studies were conducted on adult samples, and were limited to the implementation of specific ER strategies, such as reappraisal, suppression, rumination (Troy, Wilhelm, Shallcross, & Mauss, 2010). Another important limitation in ER research is the assessment of emotional response only at the subjective level, with self-reports (Webb et al., 2012). In order to advance the field, researchers have suggested that employing multiple measures to assess emotions it's most informative and reliable.

The current study aimed to address these gaps in the literature by examining the associations between ER abilities (emotional awareness, anxiety sensitivity, emotional control) and the subjective and physiological emotional response experienced by children and adolescents during a stressful situation (impromptu speech task). Our general hypothesis is that poor ER abilities in each of these areas would be related to higher levels of state anxiety and lower levels of positive emotions experienced during this stressful task, as well as with a more intense and dysregulated biological response, represented by a higher HR and right frontal asymmetry. In addition, for exploratory purposes we examined which ER ability has the best predictive value of

the emotional response. Considering the scarce literature, no explicit hypotheses were formulated regarding this analysis.

Methods

Participants

Participants included 134 children and adolescents (56 males and 78 females), enrolled in two public schools located in a small urban community. The age of participants ranged from 10 to 16 years (M = 12.94, SD = 2.05). All participants were White Caucasians. Children and their parents gave their informed consent prior to being enrolled in the study. No compensation was offered. Ethical approval for the study was obtained from the Ethical Review Board of the institution to which the authors belong.

Procedure

Children and adolescents were asked to deliver an impromptu speech task while their subjective and physiological emotional responses were collected. First, participants were accustomed to the apparatus and to the experimental environment for 10 minutes while the calibration of the physiological measures was also conducted. Immediately after, they completed a baseline measure of trait ER abilities, state anxiety and state positive emotions, followed by a 3-min baseline recording of HR and frontal brain electrical activity (EEG; baseline phase). After that, they were informed that in the next 3 min they have to deliver a speech in front of a video camera on a given topic. Next, they were asked to rate their anticipatory anxiety and positive emotions, followed by a 3 min recording of HR and regional EEG anticipating the speech (anticipatory phase). Further, children and adolescents delivered the actual speech, while HR and regional EEG were collected continuously (speech phase). After the speech, they rated their state anxiety and positive emotions experienced during speech. Finally, after a recovery period of 3 min in which HR and regional EEG were collected, they rated again their state anxiety and positive emotions (post-recovery phase). Children and adolescents were seated during the entire experimental procedure. At the end of the experiment, children and adolescents were debriefed and thanked for their participation. A similar procedure was also used in other studies (Koval et al., 2015).

Measures

Profile of Affective Distress (PED) (Opris & Macavei, 2007) is a 26-item self-report scale that measures negative emotions related to dimensions of concern/anxiety and sadness/ depression. In the current study we used the concern/anxiety subscale to measure state anxiety experienced by children and adolescents in response to a stressful task.

Functional and Dysfunctional Child Mood Scales (FD-CMS; Authors, under review) is a 9-item self-report scale that measures negative and positive emotions in children and adolescents. In the current study 3 items from the positive emotions subscale were used to assess state positive emotions (happiness, trust, and calmness).

The Emotion-Regulation Index for Children and Adolescents (ERICA) (MacDermott, Gullone, Allen, King, & Tonge, 2010) is a 17-item self-report scale designed to measure ER in children and adolescents. In the current study, we used two subscales of the ERICA questionnaire: (1) emotional control that measures dysregulated negative affect or inappropriate emotional displays; (2) emotional self-awareness that assess emotional awareness and recognition, as well as modulation. *The Childhood Anxiety Sensitivity Index* (CASI) (Adornetto et al., 2008; Silverman, Goedhart,

Barrett, & Turner, 2003) is a 13-item self-report scale that measures negative interpretations and fear of anxiety-related symptoms in children and adolescents.

HR measurement

Participants' HR was monitored using a Polar H7 HR sensor (Polar Electro Oy, Finland). Children and adolescents wore a belt around their chest that transmitted data via Bluetooth directly to an Apple iPad Air 2 with Polar Beat App. Data was continuously collected during the entire experimental session. Polar Beat App was manually set to calculate and save the average heart beat for every phase of the impromptu speech task (baseline, anticipation, speech, and post-recovery) and was later collected by the experimenter. Previous studies have successfully utilized portable HR monitors in experimental studies (Rimmele et al., 2009).

AA measurement

Data collection

Regional EEG data was recorded continuously during the experiment using an EMOTIV EPOC+ 14 Channel Mobile EEG (Emotive Systems, Inc., San Francisco, CA). The active electrodes included AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, and AF4, referenced to the common mode sense (CMS-left mastoid)/driven right leg (DRL-right mastoid) ground. The acquired data were digitized and sent to the computer through wireless technology. During the experiment, the quality of sensor contact was visually monitored by experimenter to ensure quality and the markers were manually set in conformity with each phase of the experiment.

Pre-processing steps and analysis

Raw data pre-processing and analysis was conducted in EEGLab and Brainstorm.

Statistical analysis

To assess whether the impromptu speech task was distressing for children and adolescents, a series of repeated measures ANOVAs were used to analyze the changes in state anxiety, positive emotions, HR, and AA through the emotion induction procedure. Pearson r correlations were conducted to investigate the associations of ER abilities with subjective and biological indexes of emotional response. Finally, a series of hierarchical multiple regression analyses were conducted to determine whether ER abilities significantly predicted the emotional response experienced by children and adolescents during the speech task, after accounting for age and gender.

Results

Manipulation check

A series of repeated measures ANOVAs were conducted to examine if the impromptu speech task was a relevant stressful task for children and adolescents. Results showed a significant effect of time on state anxiety (Huynh-Feldt corrected F [2.36, 310.21] = 5.80, $p < .05$, η_p^2=.04), positive emotions (F [1, 120] = 11.72, $p < .001$, η_p^2=.09), HR (Greenhouse-Geisser corrected F [1.48, 194.18] = 6.24, $p < .05$, η_p^2=.05), and AA (Greenhouse-Geisser corrected F [2.20, 134.17] = 5.95, $p < .05$, η_p^2=.08), after controlling for age and gender.

Pairwise comparisons with Sidak correction revealed that state anxiety significantly increased from baseline to anticipation (*mean difference* = -6.25, *SE* = .59, p<.001, *95%CI* = [-7.83; -4.67]), and from anticipation to speech (*mean difference* = -8.29, *SE* = .70, p<.001, *95%CI* = [-10.17; -6.41]), as well as decreased from speech to post-recovery period (*mean difference* =

13.81, *SE* = .85, *p*<.001, *95%CI* = [11.54; 16.08]). Further, for HR pairwise comparisons (Sidak corrected) revealed that HR significantly increased from baseline to anticipation (*mean difference* = -5.35, *SE* = .48, *p*<.001, *95%CI* = [-6.63; -4.06]), and from anticipation to speech (*mean difference* = -10.97, *SE* = 1.17, *p*<.001, *95%CI* = [-14.11; -7.82]), as well as decreased from speech to post-recovery period (*mean difference* = 17.82, *SE* = 1.10, *p*<.001, *95%CI* = [14.85; 20.78]). For AA, pairwise comparisons (Sidak corrected) revealed that the scores have significantly decreased from baseline to anticipation (*mean difference* = 0.62, *SE* = .20, *p*<.05, *95%CI* = [0.09; 0.11]), but there were no other significant decreases ($p > .05$). Finally, results showed that positive emotions significantly decreased from baseline to speech (*mean difference* = 8.83, *SE* = .73, *p*<.001, *95%CI* = [7.39; 10.28]). Thus, current results indicate that the emotion induction procedure was successful in modulating the subjective and physiological responses, irrespective of age and gender.

Relations between ER abilities and levels of emotional response experienced during speech

As expected, a higher state anxiety experienced during speech was related to poor emotional awareness and poor emotional control, as well to higher levels of anxiety sensitivity. Also, the experience of lower levels of positive emotions during speech was related to lower levels of emotional awareness and emotional control, and to higher levels of anxiety sensitivity. Thus, all three ER abilities were significantly associated with state anxiety and positive emotions (see *Table 1*). Interestingly, no associations were found between biological indexes (HR and AA) and ER abilities, with the exception of anxiety sensitivity that was positively associated with speech HR. It is important to note, however, that speech AA was negatively related to state anxiety, and positively related to positive emotions experienced during speech, indicating that AA represents an index of individual affective state (see *Table 1*). Thus, due to the lack of association of AA with ER abilities, this index was excluded from further regression analyses.

Hierarchical multiple regression analyses for ER abilities in predicting levels of emotional response during speech

In the next step, we used a series of hierarchical regression analyses to examine the contribution of ER abilities (emotional awareness, anxiety sensitivity, and emotional control) in predicting the emotional response (the level of state anxiety, positive emotions, and HR) experienced by children and adolescents during the stressful task. Three separate regression analysis were conducted for each outcome variable. To control for possible confounding effects, we entered age and gender in the first step of each analysis.

In the first regression, ER abilities were entered as predictors of state anxiety in step 2, after entering age and gender in step 1. The model was significant, *F* (5, 126) = 4.81, *p*<.001, and explained 16 % of the variance in state anxiety experienced by children and adolescents during the speech task. However, as can be seen from *Table 2*, only emotional control was a significant predictor in the model (β = -.21, *p*<.05). In the second regression, ER abilities were entered as predictors of positive emotions in step 2, after entering age and gender in step 1. This model was also significant, *F* (5, 122) = 2.76, *p*<.05, and accounted for 10% of the variance in positive emotions experienced by children and adolescents during the speech task. Of the three ER abilities, emotional awareness was the only significant predictor in the model (β = .20, *p*<.05). Finally, in the third regression, ER abilities were entered as predictors of HR in step 2, after entering age and gender in step 1. The results showed that the model was significant, *F* (5, 131) = 6.81, *p*<.001, and accounted for 21 % of the variance in HR level experienced by children and adolescents during

the speech task. Interestingly, only gender (β = .33, p<.001) and age (β = .23, p<.05) were significant predictors in the model. Anxiety sensitivity was only marginally significant when age and gender were included in the model (β = .17, p =.057).

Table 2. Hierarchical multiple regression analyses for ER abilities in predicting state anxiety, positive emotions, and HR during speech

Variable	*B*	SE *B*	β	R^2
State Anxiety				
Step 1				.01
Age	.27	.52	.04	
Gender	-1.81	2.15	-.07	
Step 2				
Age	-.01	.50	-.01	.16*
Gender	-2.09	2.06	-.08	
Emotional Awareness	-.70	.37	-.17	
Anxiety Sensitivity	.35	.25	.12	
Emotional Control	-.56	.24	-.21*	
Positive Emotions				
Step 1				.01
Age	-.02	.38	-.01	
Gender	-.15	1.54	-.01	
Step 2				.10*
Age	.11	.37	.02	
Gender	-.26	1.53	-.01	
Emotional Awareness	.56	.27	.20*	
Anxiety Sensitivity	-.10	.18	-.05	
Emotional Control	.29	.18	.15	
Heart rate				
Step 1				.18*
Age	1.51	.63	.19*	
Gender	12.28	2.61	.37**	
Step 2				.21*
Age	1.84	.64	.23*	
Gender	10.81	2.67	.33**	
Emotional Awareness	.12	.48	.02	
Anxiety Sensitivity	.64	.33	.17	
Emotional Control	.50	.31	.14	

Note: *p < .05; **p < .001.

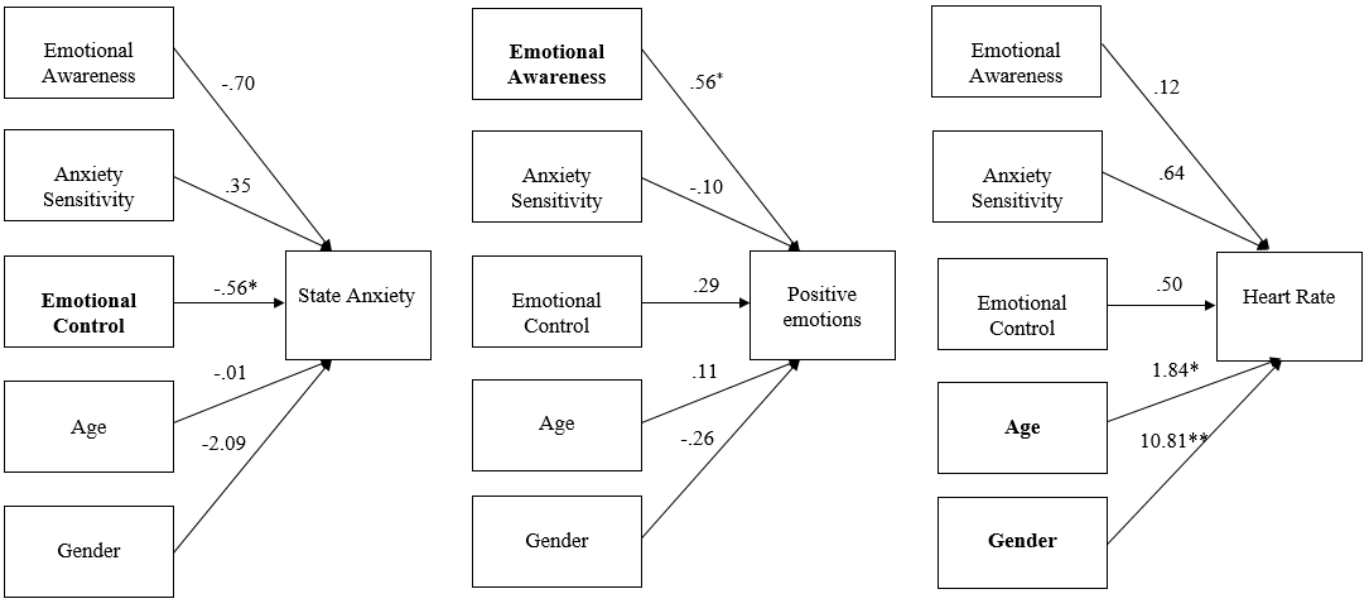

Figure 1. ER abilities as predictors of emotional response at step 2. Pathways represent unstandardized regression coefficients.

*$p < .05$; **$p < .001$.

Discussion

As expected, current results showed that all three investigated ER abilities were significantly associated with state anxiety and positive emotions in the proposed direction. Specifically, poor emotional awareness and poor emotional control, as well as high anxiety sensitivity were associated with greater state anxiety and lower levels of positive emotions experienced during speech.

In addition, poor ER abilities significantly predicted higher levels of state anxiety and lower levels of positive emotions experienced by children and adolescents in this performance situation. Regression models were significant and indicated that poor ER abilities accounted for 16 % of the variance in state anxiety, and 10 % of the variance in positive emotions, respectively. However, beyond ER abilities in general, regression analysis pointed out that particular ER abilities were significant predictors of specific facets of the emotional response. First, our results showed that out of the three ER abilities included in the model, only poor emotional control was a significant predictor of an increased level of state anxiety experienced during the speech task. These results suggest that children and adolescents' inability to access effective ER strategies and implement them appropriately contribute to more intense state anxiety experienced in a stressful situation. Second, with respect to lower levels of positive emotions experienced during speech, only poor emotional awareness was a significant predictor in the model. This suggests that poor abilities in attending to emotions, clarifying, and differentiating between various emotional states make children and adolescents prone to experience low levels of positive emotions. However, it should be noted that, because of the psychometric weaknesses of the emotional awareness subscale in our sample, these results should be treated with caution. In brief, even though all three ER abilities were significantly associated with state anxiety and positive emotions, it seems that only particular ER abilities contributed significantly in predicting the levels of emotional response experienced by children and adolescents.

Despite providing evidence for the relationship between ER abilities and subjective emotional response, current results provided only partial support for the association between ER abilities and biological indexes. Correlation analysis indicated that greater anxiety sensitivity was

associated with higher HR experienced during speech. However, when included in the regression model controlling for age and gender, anxiety sensitivity was only marginally significant in predicting speech HR. Interestingly, age and gender were the only significant variables predicting HR during speech, specifically higher HR was predicted by being a girl and of greater age.No other associations were found between ER abilities and biological indexes.

Thus, current findings take an important step in establishing which deficits may be at play in contributing to elevated levels of anxiety and lower levels of positive emotions experienced in stressful situations. More specifically, current findings suggest that, when facing real-life situations, such as performance and social situations (at school), having difficulties in ER abilities (emotional awareness and control of emotions) might expose children and adolescents to poor emotional functioning (an exaggerated negative emotional response), poor performance (problems in goal-directed behaviors when distressed), and other maladjustments in that specific moment.

At a practical level, current results have important implications for the prevention and intervention efforts. For example, clinicians and teachers might focus on instructing children and adolescents to attend to their emotions, clarify, and differentiate between various emotional states, as well as the interoceptive signs of emotions by improving their emotional vocabulary and by helping them to better understand the causes and consequences of emotions. At the same time, clinicians and teachers might focus on teaching children and adolescents to flexibly select and implement various ER strategies to regulate their emotions in order to attain their goals, especially those strategies considered to be adaptive (such as reappraisal, acceptance, problem-solving). Thus, current findings further support the potential benefit of integrating modules for the training of specific ER abilities (such as emotional awareness and emotional control) into existing treatment packages in order to improve the efficacy of psychological interventions for children and adolescents.

3.5. Study 5. The Role of Emotion Regulation Difficulties in the Relation Between Insomnia and Depressive Symptoms[3]

Introduction

Symptoms of insomnia affect an estimated 30% of adults in industrialized countries, whereas about 6-18% of this population suffers from insomnia as a disorder, reporting both nighttime disturbances and daytime impairments (Ohayon, 2002). One of the most investigated lines of research with respect to emotional disturbances in individuals with insomnia concerns the link with depression. Depression is the most common comorbid psychiatric condition in individuals with insomnia symptoms and is closely connected to it (Ohayon, 2002). The reversed relationship also exists, with depression being a predictor of insomnia symptoms (Fang et al., 2019). While research supports a robust bi-directional relation between insomnia and depression, it is clear now that insomnia also precedes depression (Fang et al., 2019).

Given this background, it is important to explore the potential underlying mechanisms that might explain the insomnia-depression relationship (Baglioni et al., 2010). Therefore, one of the psychological mechanisms that could explain the relationship between insomnia and depression is the experience of emotion regulation (ER) difficulties (Baglioni et al., 2010). The construct of ER difficulties has been broadly conceptualized as multifaceted, involving: (1) a lack of awareness and clarity of emotions, (2) non-acceptance of emotions, (3) an inability to control impulsive behaviors and to behave in accordance with one's goals when distressed, and (4) an inability to access effective strategies to regulate negative affect (Gratz & Roemer, 2004). Individuals with insomnia symptoms report a range of ER difficulties compared to good sleepers, such as a poor emotional processing, as well as a limited access to effective ER strategies and a more use of maladaptive ER strategies (worry, rumination) (Șandru & Voinescu, 2014). It has been suggested that these difficulties in ER contribute to the development of depressive symptoms in individuals with insomnia (Baglioni et al., 2010).

In sum, ER difficulties may be more severe in individuals with sleep difficulties (such as insomnia), which in turn may explain the experience of depressive symptoms in these individuals. However, to our knowledge, to date no study directly tested this hypothesis. In this context, we aimed to address these gaps in the literature by examining the indirect association between possible insomnia disorder and depressive symptoms through ER difficulties. We hypothesized that participants with possible insomnia disorder would experience greater severity of depressive symptoms and ER difficulties compared to individuals without possible insomnia disorder (controls). Then, we predicted that having possible insomnia disorder (vs. not having possible insomnia disorder) would be associated with an increased level of ER difficulties, which in turn

[3] This study has been accepted for publication.
Predatu, R., Voinescu, B. I., & David, D. O. (accepted). The role of emotion regulation difficulties in the relation between insomnia and depressive symptoms. *International Journal of Behavioral Medicine*.

The authors contributed to the article as follows: Predatu, R: study conception and design, data acquisition and analysis, interpretation of data and manuscript writing; Voinescu, B. I: study conception and design, data acquisition and analysis, interpretation of data and manuscript writing; David, D.O: study conception and design, data acquisition and analysis, interpretation of data and manuscript writing.

would be associated with more severe depressive symptoms (model of indirect association). Additional exploratory analyses were conducted to examine whether specific difficulties in ER would explain the relation between possible insomnia disorder and depressive symptoms. Considering the few existing studies on this issue, no explicit hypotheses were formulated.

Methods

Participants

The sample consisted of 107 individuals (81 females, 26 males) with possible insomnia disorder and 268 individuals (182 females, 86 males) controls, who participated in two online studies about sleep difficulties (Voinescu, 2018; Voinescu & Szentagotai-Tatar, 2015). Participants were included in the group with possible insomnia disorder symptoms if they had a score of 16 or higher on the Sleep Condition Indicator (SCI), which is considered a cut-off point for possible insomnia disorder (Espie et al., 2014). Those with lower scores than 16 on SCI were included in the control group. All participants were of Romanian nationality and White Caucasians. Their ages ranged between 18 and 64 years (M= 28.23, SD=9.96).

Procedures

The study was approved by the University's Institutional Review Board and was based on two larger surveys conducted online between July 2014-November 2014 and April 2016-January 2017, respectively. However, data presented here is a novel and unique contribution, as well as an extension of past published work. Both surveys were created using the software SurveyGizmo Survey (SurveyGizmo, Boulder, Colorado, USA) and were published on a website aimed to increase the awareness regarding sleep difficulties. The participants were invited via different communication channels (press communications, announcements on websites and Facebook, and by flyers in several medical centers in two cities in Romania). All participants gave their informed consent before completing the survey. Participation was unpaid and all the respondents received a brief interpretation of their scores on the completion of the questionnaires.

Measures

The Sleep Condition Indicator (SCI) (Espie et al., 2014) is an 8-item self-report scale designed to assess the severity of insomnia symptoms in the previous month. SCI was used as a screening measure to obtain a sample with possible insomnia disorder and the control group.

Patient Health Questionnaire (PHQ-9) (Spitzer et al., 1999) is a 9-item self-report scale that measures depressive symptoms according to DSM-IV criteria for depression. PHQ item-3 which evaluates sleep problems ("Trouble falling or staying asleep, or sleeping too much.") was excluded from the total score of PHQ-9 in order to prevent overlapping with the insomnia scale.

The Difficulties in Emotion Regulation Scale (DERS) (Gratz & Roemer, 2004) is a 36-item self-report scale that assesses emotion regulation difficulties represented by: (1) a non-acceptance approach towards emotions ("When I'm upset, I become embarrassed for feeling that way"), (2) difficulties engaging in goal-directed behaviors ("When I'm upset, I have difficulty getting work done") and (3) controlling impulsive behaviors when distressed ("When I'm upset, I have difficulty controlling my behaviors"), (4) limited access to effective ER strategies ("When I'm upset, I believe there is nothing I can do to make myself feel better"), (5) lack of emotional awareness ("When I'm upset, I acknowledge my emotions"; reversed score), and (6) lack of emotional clarity ("I have difficulty making sense out of my feelings").

Statistical Analysis

Means, standard deviations and associations of variables were calculated using descriptive statistics. Chi-square test and student's t-test were selected to compare demographic characteristics between individuals with possible insomnia and controls. The group differences in depressive symptoms and ER difficulties were explored with MANOVA test using total PHQ-9, total DERS, and each DERS subscales scores as dependent variables. The indirect association between insomnia status (0 = with possible insomnia disorder, 1 = controls) and depressive symptoms through ER difficulties was examined using a bootstrapping procedure (bias-corrected, with 5000 iterations) that examined the indirect effects (Preacher & Hayes, 2008). The indirect association occurs if the 95% bootstrapping confidence interval (CI) does not include zero. Statistical analyses were performed using IBM SPSS Statistics, version 20 (IBM Corp., Armonk, NY, USA). The indirect association analysis was specifically conducted using the SPSS PROCESS macro function (Hayes, 2017).

Results

Demographics

No significant differences were observed on any demographic variable between individuals with possible insomnia disorder and controls ($p > .05$).

Group differences in depressive symptoms and ER difficulties

Means and standard deviations for all study variables are presented in *Table 2*.

Table 2. Descriptive Statistics for Insomnia Severity, Depressive Symptoms, and Emotion Regulation Difficulties

Measure	Individuals with possible insomnia disorder (n = 107) *M (SD)*	Controls (n = 268) *M (SD)*	Statistical significance (F)	partial $\eta 2$
Insomnia Severity	20.11 (3.38)	7.91 (4.39)	F (1, 373) = 665.761; p < .001	.641
Depressive Symptoms*	9.71 (4.67)	4.89 (3.60)	F (1, 373) = 114.473; p < .001	.235
ER Difficulties				
Total DERS	88.69 (22.23)	72.47 (17.84)	F (1, 373) = 54.608; p < .001	.128
Clarity	11.36 (4.02)	9.33 (3.29)	F (1, 373) = 25.456; p < .001	.064
Strategies	20.14 (7.72)	15.06 (5.79)	F (1, 373) = 48.178; p < .001	.114
Non-acceptance	14.03 (6.25)	11.02 (4.61)	F (1, 373) = 26.236; p < .001	.066
Goals	14.81 (4.33)	12.11 (4.14)	F (1, 373) = 31.523; p < .001	.078
Impulse	14.17 (5.09)	11.17 (4.29)	F (1, 373) = 33.568; p < .001	.083

Note. *(no sleep item); Total DERS = Total score on the Difficulties in Emotion Regulation Scale; Clarity = difficulties in emotional clarity; Strategies = difficulties in emotional control; Non-acceptance = tendency to experience meta-emotions; Goals = difficulties in goal-directed behaviors when distressed; Impulse = difficulties in controlling impulsive behaviors when distressed; M = Mean; SD = Standard Deviation.

Our first hypothesis was that individuals with possible insomnia disorder would show greater severity of depressive symptoms, as well as greater ER difficulties compared to controls. A MANOVA was conducted to examine these group differences in depressive symptoms and ER difficulties. A significant difference was found between the two groups (Wilks' Lambda = 0.75), F (7, 367) = 16.926, $p < .001$. As seen in *Table 2*, individuals with possible insomnia disorder reported significantly more depressive symptoms and more overall difficulties in ER. With respect to specific difficulties in ER, individuals with possible insomnia disorder reported significantly more difficulties in goal-directed behaviors when distressed (Goals), in controlling impulsive behaviors when distressed (Impulse), in emotional clarity (Clarity), in accessing effective ER strategies (Strategies), and in experiencing negative meta-emotions (Non-acceptance).

The indirect association between insomnia status and depressive symptoms through ER difficulties

Next, we tested the indirect association between insomnia status (0 = with possible insomnia disorder, 1 = controls) and depressive symptoms through overall ER difficulties (*Figure 1*). To explore which specific difficulties in ER explained this association, we conducted an additional analysis that examined the indirect association between insomnia status and depressive symptoms through specific ER difficulties (all DERS subscales were entered concurrently in the same model) (*Figure 2*). Coefficients of the indirect effects and bootstrapping confidence intervals (95% *CI*) are presented in *Table 3*.

The indirect association between insomnia status and depressive symptoms through overall ER was significant. The direct association between insomnia status and depressive symptoms was also significant. The reversed model, specifically the indirect association between depressive symptoms and insomnia status through ER difficulties, was not significant; however, the direct association between depressive symptoms and insomnia status reached the significance level. The additional exploratory analysis showed that the indirect associations between insomnia status and depressive symptoms through difficulties in goal-directed behaviors when distressed, in emotional clarity, and in accessing effective ER strategies were significant. No other ER difficulties were significant variables in this association.

Table 3. The indirect association between insomnia status (0 = with possible insomnia disorder, 1 = controls) and depressive symptoms through specific ER difficulties

Outcome	Mediator	*B*	*SE (B)*	95% *CI*
Depressive symptoms	Total	1.77	.30	[1.196, 2.384]
	Non-acceptance	.26	.14	[-.007, .577]
	Goals	.40	.18	[.074, .807]
	Impulse	-.30	.24	[-.811, .159]
	Strategies	1.14	.31	[.562, 1.812]
	Clarity	.37	.13	[.155, .663]

Note. Clarity = difficulties in emotional clarity; Strategies = difficulties in emotional control; Non-acceptance = tendency to experience meta-emotions; Goals = difficulties in goal-directed behaviors when distressed; Impulse = difficulties in controlling impulsive behaviors when distressed; *B*= unstandardized regression coefficient; *SE*= standard deviation; 95% *CI*= 95% bootstrapping confidence interval.

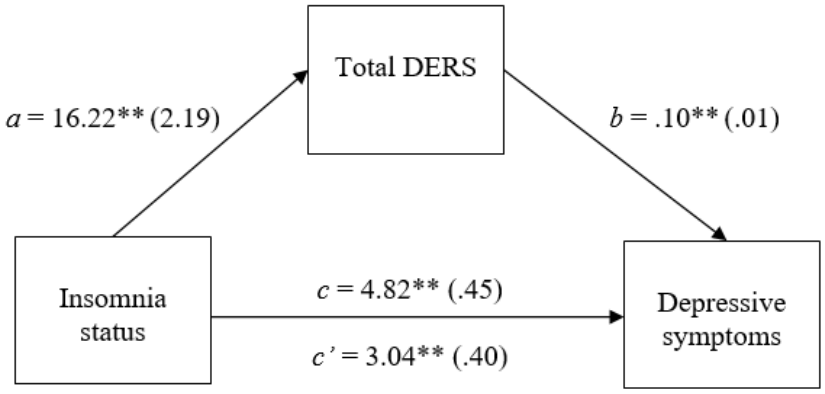

Figure 1. The indirect association between insomnia status (0 = with possible insomnia disorder, 1 = controls) and depressive symptoms through overall ER difficulties. Total DERS represents the total score on the Difficulties in Emotion Regulation Scale. Pathways represent unstandardized regression coefficients. Standard errors are presented in brackets. Path *a* represents the association between insomnia status and total ER difficulties. Path *b* represents the association between total ER difficulties and depressive symptoms. *c* = *c* path of total association; *c'* = *c'* path of direct association; **p*< .05; ***p*< .001.

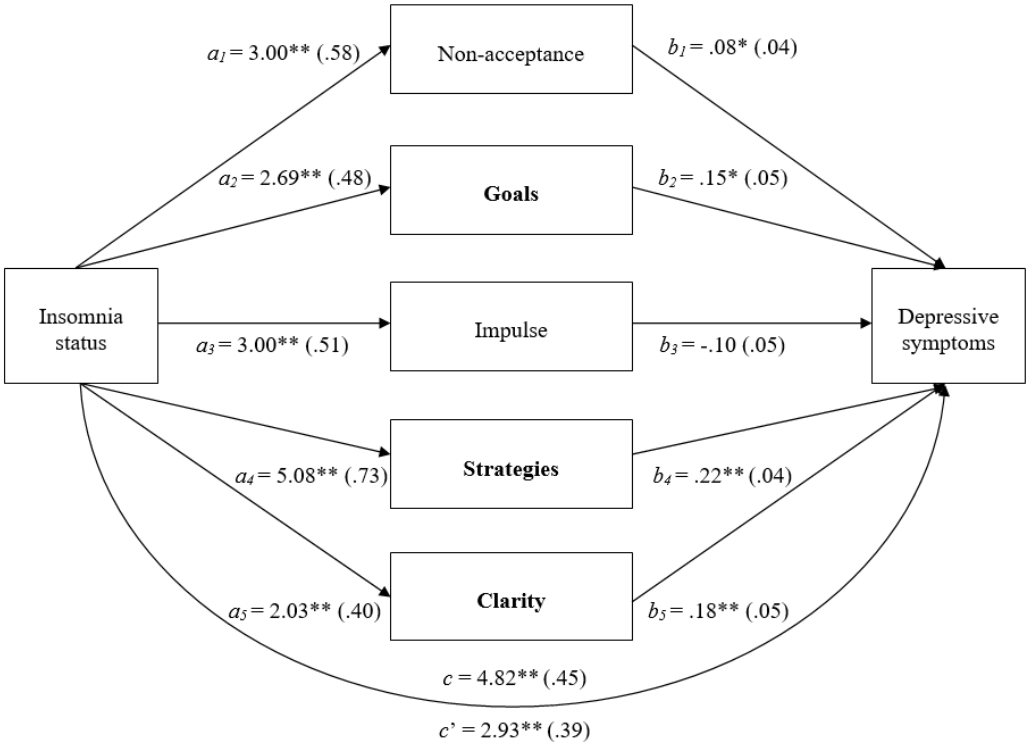

Figure 2. The indirect association between insomnia status (0 = with possible insomnia disorder, 1 = controls) and depressive symptoms through specific ER difficulties. Significant ER difficulties are presented in bold. Pathways represent unstandardized regression coefficients. Standard errors are presented in brackets. Paths a_1, a_2, … a_5 represent the associations between insomnia status and specific ER difficulties. Paths b_1, b_2, … b_5 represent the associations between specific ER difficulties and depressive symptoms. *c* = *c* path of total association; *c'* = *c'* path of direct association; **p*< .05; ***p*< .001.

Discussion

In this study, individuals with possible insomnia disorder showed more depressive symptoms and ER difficulties compared to controls, which is in line with previous research (Palagini et al., 2018). Specifically, these individuals reported more difficulties in goal-directed behaviors and in controlling impulsive behaviors when distressed, in emotional clarity and in accessing effective ER strategies, as well as an increased tendency to experience negative meta-emotions. These results further support previous studies showing that individuals with insomnia symptoms report various ER difficulties when confronted with sleep difficulties (Palagini et al., 2018).

With respect to the examination of the indirect associations, our results showed that having possible insomnia disorder was related to endorsing more severe ER difficulties, in particular a lack of emotional clarity, a limited access to effective ER strategies, and problems in goal-directed behaviors when distressed, which in turn was associated with the experience of more depressive symptoms. Further, insomnia status showed a direct association with depressive symptoms, while the reversed association was also significant. Thus, our findings support a bidirectional association between insomnia and depression. Having possible insomnia disorder was directly related to depressive symptoms (Fang et al., 2019). The reversed model was also significant suggesting that these conditions are not just arbitrarily linked. Our study showed a significant indirect association between insomnia status and depressive symptoms through ER difficulties. Consistent with previous assumptions, our results showed that ER difficulties were more severe in individuals with possible insomnia disorder, which in turn were related to the experience of depressive symptoms (Baglioni et al., 2010). Our results add to the current literature showing that experiencing poor sleep was associated with specific difficulties in individuals' abilities to understand and clarify their emotions, use effective ER strategies, and concentrate and get things done when distressed, which were further associated with the experience of depressive symptoms.

In sum, we propose that some ER difficulties may be more informative than others with regard to elevated levels of depressive symptoms in the face of poor sleep. However, given the fact that these ER difficulties were not specified a priori, current results should be regarded as preliminary. Future research is needed to provide convergent evidence of such specificity, but our findings identified which difficulties could play a more central role, and which are less specific. Such an approach could inform intervention efforts to target specific ER difficulties in individuals with possible insomnia disorder and further reduce depressive symptoms in this at-risk category. For example, interventions that focus on guiding individuals to develop their ER abilities, such as Emotion Regulation Therapy (ERT), Dialectical Behavior Therapy (DBT), Mindfulness-Based Cognitive Therapy (MBCT) should be considered as an adjunct to Cognitive Behavioral Therapy for Insomnia (CBT-I) for individuals affected by insomnia symptoms and associated depressive symptoms.

3.6. Study 6. Emotion Regulation Difficulties in the Relation Between Stress-Related Insomnia and Brain Response to Emotional Faces: An fMRI Study

Introduction

Insomnia is the most prevalent sleep disorder that negatively affects numerous individuals worldwide on a daily basis (e.g., around 30 % of adults affected by insomnia symptoms and 6-18% by insomnia as a disorder) (Ohayon, 2002). Numerous studies have reported that having a poor sleep is associated with an altered emotional reactivity to and processing of emotional information (Baglioni et al., 2010). Laboratory-based studies using sleep deprivation paradigms demonstrated that sleep deprived individuals show an increase in their negative affect, less positive emotions, and greater emotional reactivity when processing emotional information (Baglioni et al., 2010). Preliminary studies also showed that individuals affected by chronic sleep deprivation in the form of insomnia symptoms report more negative affect and less positive emotions as a daytime consequence, more ER difficulties, as well as poor emotional processing in comparison to individuals without insomnia symptoms (Șandru & Voinescu, 2014). In sum, research to date point towards the negative impact of inadequate sleep, either in an acute or chronic form, on emotional reactivity. However, despite the demonstrated relationship between poor sleep and emotional reactivity, brain mechanisms underlying these associations are still poorly understood.

Most of the studies to date focused on the association between brain responses and poor sleep in an acute form (using sleep deprivation paradigms) or in a chronic form (investigating patients with insomnia symptoms) (Baglioni et al., 2010). However, to our knowledge, no study to date focused on insomnia due to stress (situational insomnia) in relation to brain responses. In addition, we are not aware of imaging studies investigating whether emotion regulation (ER) difficulties are a relevant factor involved in the relation between the experience of insomnia symptoms and emotional reactivity. Recent observational studies suggest that individuals with insomnia symptoms show various ER difficulties, such as a poor emotional awareness, impairments in the effective implementation of ER strategies (e.g., impairments in using reappraisal as an ER strategy) and the use of other ER strategies considered to be maladaptive (e.g., rumination, worry), which in turn might be associated with poor emotional functioning at a subjective level (increased negative affect, emotional reactivity, mood instability) (Baglioni et al., 2010). However, to our knowledge no study to date investigated if ER difficulties play a substantial role in the interplay between insomnia symptoms and emotional reactivity investigated at a neural level.

In this context, the aim of the current study was to investigate if the severity of insomnia and insomnia due to stress are associated with an increased brain response to the presentation of emotional faces. Given that insomnia was previously conceptualized as a hyperarousal disorder, we expected that having insomnia symptoms or insomnia due to stress will modulate the BOLD response in brain areas related to arousal and salience. In addition, given the emergent evidence for the importance of ER difficulties in the relation between sleep difficulties and emotional reactivity (Baglioni et al., 2010), we also examined if the effect of these sleep difficulties on emotional reactivity at brain level is dependent on the experience of ER difficulties.

Methods

Participants

The current sample consisted of 37 participants (20 females, 17 males) selected from a larger group of 120 respondents that completed a survey about sleep problems, recruited through online and local advertisements. Their ages ranged between 19 and 57 years (*M*=33.57, *SD*=11.01). In the current study, all participants were White Caucasians. Also, all of them were right-handed and free of any psychoactive medication. Individuals were excluded from the current study if they were fMRI-incompatible (claustrophobic participants, participants with MRI-incompatible implants, pregnant participants, and participants with brain lesions), currently under psychiatric medication, or they had a severe cognitive impairment or medical condition. The current study was approved by the Institutional Review Board of the Babes-Bolyai University and conducted in accordance with the Declaration of Helsinki.

fMRI Experiment and Data Acquisition

All participants gave their informed written consent prior to inclusion in the study. Eligible participants were invited to attend the MRI acquisition session for which a 3T Siemens Magnetom Skyra (Siemens, Erlangen, Germany) with a 20-channel coil was used. The acquisition protocol included a high-resolution 3D anatomical T1 MPRAGE sequence, two runs of stress BOLD sequences, one run of a resting-state BOLD sequence and the default protocol for basic diagnosis (such as T2 axial turbo spin-echo, T1 coronal, T2 axial dark fluid, T1 the acquisition and DWI data). The BOLD fMRI images were acquired using data matrix 64 x 64, voxel size 2.5x2.5x2.5 mm, TE 30 ms TR 3 s and echo spacing 0.65 ms. The anatomical MPRAGE images were collected using data matrix 256 x 256, voxel size 1x1x1 mm, TE 30 ms and TR 1.65s.

In the fMRI experiment, participants underwent the fMRI assessment while completing an emotional face-processing task (Lundqvist, Flykt, & Öhman, 1998). Participants were exposed to a series of emotional faces of four actors (two females and two males) displaying each of six emotional expressions (i.e. neutral, happy, sadness, fearful, disgusted, angry) interspersed with fixation crosses (+) and different arrows (→ and ←). A total of 45 conditions were presented to each participant. Each condition started with a fixation cross (5.5 seconds), followed by an emotional face (1 second) and ended with the same fixation cross (2 seconds) when participants had to press a specific keypress (see *Figure 1* for more details). All 36 emotional faces (6 faces for each emotional expression) and 9 arrows were randomly presented. The arrows were intercalated during the face presentation to ensure that participants were paying attention to the task (control stimuli). The fixation cross was presented in order to facilitate that participants maintain their gaze at the center of the screen. Furthermore, to ensure that participants were paying attention to the task without disclosing that our goal was on the expressed emotions of the emotional faces, they were asked to decide for each emotional face, whether it was the same as the previous one, by pressing a button (right button to confirm the same face, left button to confirm the opposite). All emotional stimuli were presented using PsychoPy software (Peirce, 2007). The duration of one functional run was 6 min and 39 seconds and all participants underwent the same procedure twice. Thus, the fMRI assessment with the emotional faces lasted 13 min and 18 seconds.

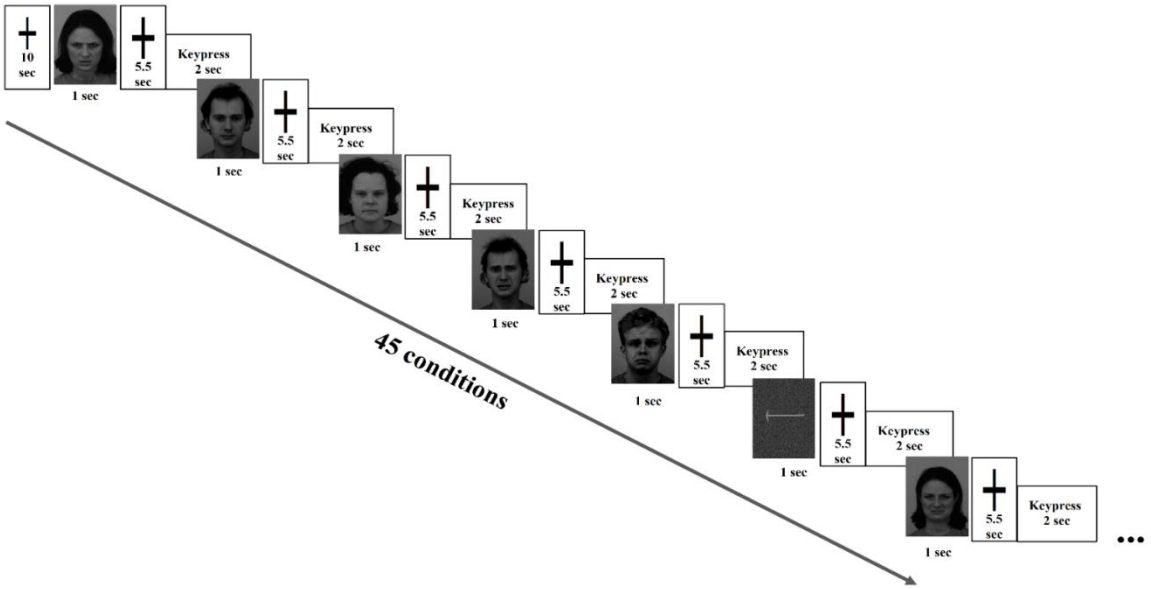

Figure 1. The flow of the experimental task, which consists of 10 seconds fixation cross and 45 conditions, each condition starting with a fixation cross (5.5 seconds), followed by a face depicting one of the six emotional expressions or an arrow (1 second), and a final fixation cross (2 seconds) where participants had to confirm the similarity (or dissimilarity) of the current emotional face with the previous one (i.e., keypress in the figure).

Measures

Four questions regarding insomnia disorder from the Basic Nordic Sleep Questionnaire (BNSQ) (items 1, 3, 5, and 6), as well as other three added from the Sleep Condition Indicator (SCI) (items 5, 6, 7) were used to calculate an insomnia severity index for the current sample (score range 7–31, Cronbach's alpha = 0.85).

The Basic Nordic Sleep Questionnaire (BNSQ) (Partinen & Gislason, 1995) was used to identify symptoms of insomnia in the past 3 months. For the current study purposes, items 3, 5, and 6 from BNSQ were used to determine the severity of insomnia in this sample (along with some items from SCI).

The Sleep Condition Indicator (SCI) (Espie et al., 2014) is an 8-item self-report scale used to assess the severity of insomnia in the last month. For the current study purposes, items 5–7 from SCI were used to determine the severity of insomnia in this sample (along with some items from BNSQ).

Ford Insomnia Response to Stress Test (FIRST) (Drake et al., 2004) is an 9-item self-repot scale used to assess sleep problems in response to various common stressful situations.

Epworth Sleepiness Scale (ESS) (Johns, 1991) is an 8-item scale used to assess daytime sleepiness in individuals.

Dysfunctional Beliefs and Attitudes about Sleep Scale, 10-item version (DBAS-10) (Espie, Inglis, Harvey, & Tessier, 2000) is a 10-item self-report scale used to assess various sleep/insomnia-related beliefs.

Patient Health Questionnaire (PHQ-9) (Spitzer et al., 1999) is a 9-item self-report scale used to quantify depressive symptoms in individuals, according to DSM-IV criteria for major depression.

Generalized Anxiety Disorder Scale (GAD-7) (Spitzer et al., 2006) is a 7-item self-report scale used to assess the severity of generalized anxiety in individuals.

The Difficulties in Emotion Regulation Scale (DERS) (Gratz & Roemer, 2004) is a 36-item self-report scale used to assess various ER difficulties in individuals represented by: (1) a non-acceptance approach towards one's own emotions, (2) difficulties engaging in goal-directed behaviors and (3) controlling impulsive behaviors when distressed, (4) lack of effective ER strategies, (5) lack of emotional awareness, and (6) lack of emotional clarity.

Data Analysis

Means and standard deviations were calculated for each study variable. Pearson r correlations were conducted to investigate the associations between sleep difficulties (insomnia severity, FIRST, ESS, DBAS), mood symptoms (PHQ-9, GAD-7), and ER (DERS) variables. Statistical analyses were performed using IBM SPSS Statistics, version 20 (IBM Corp., Armonk, NY, USA).

fMRI data processing and analysis

FMRI data processing has been run using a combination of ANTs (http://stnava.github.io/ANTs), FSL (https://fsl.fmrib.ox.ac.uk/fsl/fslwiki) and AFNI (afni.nimh.nih.gov). Data preprocessing included the following steps: structural brain extraction (using ANTsBrainExtraction.sh), rigid body motion correction of functional images by aligning each volume to the mean across volumes (using AFNI's 3dvolreg), functional brain extraction (FSL's BET) (Smith, 2002), affine registration of mean functional volumes to anatomical (antsRegistrations), nonlinear registration of anatomical to the MNI template (antsRegistrationSyN.sh). The transformations obtained for the coregistration and anatomical to standard space registration steps have been concatenated and applied to the motion corrected images in a single interpolation step using antsApplyTransforms and LanczosWindowedSinc interpolation. In the same step, functional images were resampled to 3x3x3 mm resolution. The subject level GLM (run using AFNI's 3dDeconvolve) modeled contrasts of each emotionally valenced stimulus type minus neutral faces, as well as control minus emotional faces, with 6 motion parameters included as nuisance regressors (rotations and translation around X, Y and Z axes). T statistical maps obtained from each contrast in the subject level GLM have been iteratively smoothed using AFNI's 3dblur2FWHM and submitted to the higher level analysis. Group level analysis has been run using nonparametric permutation test as implemented with FSL's randomise. Smoothed T statistical maps have been submitted to a one sample t test with 5000 permutations and FIRST scores of each participant modeled as a covariate of interest for each contrast. P values for each contrast have been corrected for the family wise error using Threshold-Free Cluster Enhancement (TFCE) (Smith & Nichols, 2009). All the analyses were run at the level of the whole brain.

Results

Preliminary Analyses

Correlations between all study variables are presented in *Table 2*.

Variable	1	2	3	4	5	6	7
1. Insomnia Severity	-	.78**	.34**	.68**	.72**	.70**	.51**
2. FIRST		-	.38**	.74**	.69**	.73**	.45**
3. ESS			-	.37**	.37**	.36**	.27
4. DBAS				-	.70**	.78**	.54**
5. PHQ-9					-	.88**	.60**
6. GAD-7						-	.62**
7. DERS Total							-

Note: FIRST = Ford Insomnia Response to Stress Test; ESS = Epworth Sleepiness Scale; DBAS = Dysfunctional Beliefs and Attitudes about Sleep Scale; PHQ-9 = Patient Health Questionnaire; GAD-7 = Generalized Anxiety Disorder Scale; DERS = Difficulties in Emotion Regulation Scale; $^{**}p < .001$.

fMRI data

No significant effect of insomnia severity has been observed. FIRST showed significant effects across all the contrasts that included emotional faces with the exception of fear (summarized in Table 3), but not for faces > control stimuli. Emotional faces had a significant effect in the right insula and in areas of the parietal cortex (including superior parietal lobule and precuneus). Some motor areas, including supplementary motor area and precentral gyrus had an effect in the negative > neutral and disgust > neutral. Most of the observed effects were strongly lateralized with more prominent activation in the right hemisphere. When controlling for DERST, two clusters in the angry > neutral contrast remained significant, one in the posterior part of the insula (99 voxels, max t = 0.9; MNI coordinates in mm: x=35, y=13.2, z=0.5) and another one in the anterior insula (66 voxels, max t = 0.97; MNI coordinates in mm: x=37.5, y=-9.25, z=3).

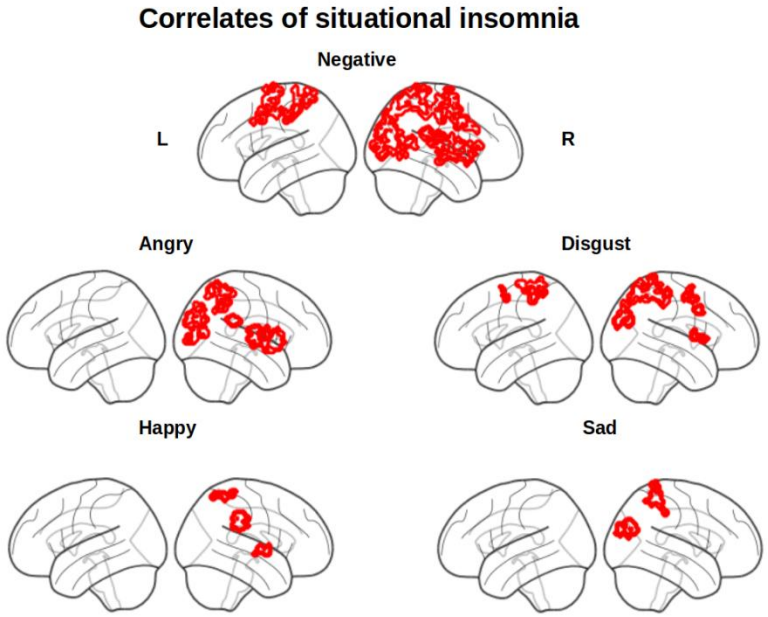

Figure 2. Neural activations for different emotional faces that covariate with FIRST. L- Left, R- Right. The statistical maps were thresholded at $p<0.05$, family wise error corrected.

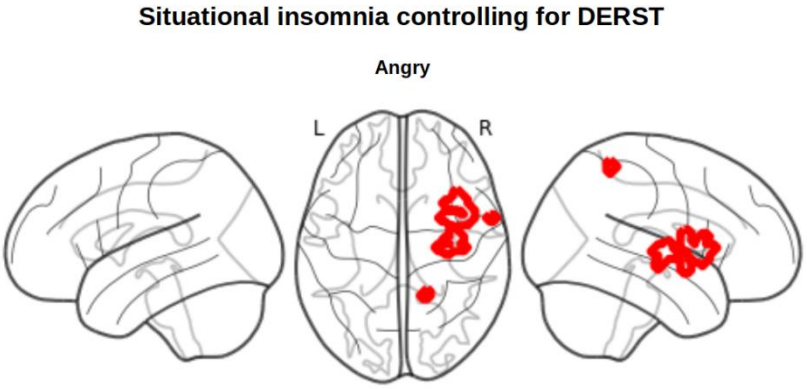

Figure 3. The effect in insula remains significant only for the angry minus neutral contrast, although the effect in parietal lobe is lower. L- Left, R- Right. The statistical maps were thresholded at $p<0.05$, family wise error corrected.

Discussion

In this study, we examined the associations between insomnia symptoms and insomnia due to stress with the brain response of individuals when exposed to the presentation of emotional faces. Our results indicate that the tendency to experience situational insomnia due to stress but not insomnia symptoms per-se modulates brain activity during emotionally valanced faces in areas of the *parietal cortex*, *insula* and *surrounding opercular voxels*. Important to note, these effects tend to appear across categories of emotionally valenced faces, rather than being specific for a given emotion. In addition, the observed effects seem to be specific for emotionally valenced faces, as no significant effect has been observed for faces vs. control stimuli. Furthermore, difficulties in ER might play an important role, as the effect of situational insomnia on most of these brain regions

disappears when controlling for difficulties in ER. However, the tendency to experience situational insomnia maintained an effect in insula during the presentation of angry faces, suggesting that such tendency may increase brain's response to anger in insula relatively independent from difficulties in ER.

At a more general level, the strong activation found in the insular cortex, especially in the right hemisphere, supports the hypothesized relationship between insomnia due to stress and disturbances in emotional processing and reactivity. Insular cortex is an important region known to be recruited by emotional processing and to be involved in the central mapping of the autonomic state of the organism (Craig, 2011). Indeed, emotional stress experienced in the context of insomnia can have a profound impact on the state of the autonomic nervous system and might lead to autonomic *hyperarousal*, especially for what concerns the state of the cardiovascular system (Cacioppo, 1994). In turn, this autonomic hyperarousal increases the occurrences and the severity of the sleep disturbances (de Zambotti et al., 2014). Thus, the current findings might suggest that individuals affected by stress-related insomnia are characterized by a stronger bodily recruitment when presented with emotional information, especially negative and aversive (but not limited to them), which is reflected by a larger response in the insula.

For what concerns the strong effect also found in the parietal cortex, especially in the superior parietal lobule and the precuneus, the results suggest a strong involvement of the so-called default mode network (DMN). The DMN is one of the most important brain network, which is usually found activated when the brain is in a resting mode, an activity which is thought to reflect a state of inward attention (Raichle, 2015). Nonetheless, a growing amount of research is showing that DMN is active not only at rest, but also in passive viewing conditions, and its activity is modulated by the presentation of emotional information (Nummenmaa et al., 2012), as well as stimuli, like faces, with an inherent socio-emotional content (Gentili et al., 2009). Indeed, the postero-medial portions of the parietal cortex represent a central DMN hub, and the present results might reflect that stress-related insomnia determines a state of heightened inward attention, which is an increased tendency to orient the attention to the inner state of the organism compatible with the profile of an autonomic hyperarousal. It is important to note that the current activations are highly specific for emotional vs. neutral faces, but no effects have been observed for the face vs. control stimuli, suggesting that these results could not be simply ruled-out as a general effect of viewing a face.

In conclusion, it seems that as the severity of situational insomnia increases, individuals show an enhanced brain response when presented with emotional stimuli (either positive or negative), which might represent a possible ER deficit in these individuals, as well as a precipitant of the hyperarousal state. Thus, interventions that focus on targeting individuals' ER difficulties might be effective in reducing the hyperarousal state in these individuals (even at the brain level) and in improving their emotional functioning.

CHAPTER IV. GENERAL CONCLUSIONS AND IMPLICATIONS

The current research thesis aimed to examine the construct of ER from an integrative perspective bridging together both clinical and affective sciences. Specifically, we focused on the secondary, strategic controlled processes (meta-processes), such as (1) emotional awareness, (2) NRTE, and (3) emotional control and investigated their role in individuals' emotional functioning and psychopathology, especially in relation to ED and insomnia.

4.1. Theoretical, Conceptual and Clinical Implications

The **first objective** of our research was to focus on the NRTE component (entailing meta-cognitive and meta-emotional reactions) that was the most neglected ER component in the empirical research. On the theoretical level, we thought that a necessary initial step is to establish the *transdiagnostic* status of this component. Consequently, in the first study we aimed to provide the first meta-analytic examination of the associations between NRTE and various ED (i.e., depression, PTSD, OCD, GAD, PD, SAD, SP) (Study 1). Our results showed that individuals with a diagnosed ED report an increased level on NRTE in comparison with non-clinical controls. Moreover, our results revealed that as the severity of NRTE increases, the severity of ED symptoms also increases. To our knowledge, this is the first study which confirmed that NRTE is a relevant construct involved in multiple ED (i.e., transdiagnostic) and that the more severe is this NRTE in individuals diagnosed with an ED, the more severe are their symptoms.

Building on the results of the meta-analysis, in the next study we focused on a specific type of NRTE, namely irrational/dysfunctional beliefs about emotions, which originated from the classic cognitive-behavioral therapies, in particular from Rational-Emotive Behavior Therapy (REBT). In this second study, we investigated if individuals diagnosed with an ED (compared to healthy individuals) report more irrational/dysfunctional beliefs about emotions as they emerge in an emotionally salient situation (autobiographical recall task) (Study 2). Moreover, we examined if these irrational beliefs about emotions further relate to the experience of negative meta-emotions and to lower perceived emotional control in these individuals. As expected, having an ED was related to endorsing more irrational beliefs about emotions, which in turn predicted higher levels of negative meta-emotions and lower perceived emotional control. To our knowledge, this is the first study which highlighted that individuals with ED have specific difficulties in how they appraise their negative emotions (i.e., irrational beliefs about emotions), which further expose them to maladjustment. On the conceptual level, our study demonstrates the maladaptive nature of endorsing this specific type of NRTE, namely irrational beliefs about emotions on the emotional response experienced by individuals in an emotional situation.

Further, in the third study, we compared the differential effects of two general types of NRTE, a dysfunctional type represented by irrational beliefs about emotions and a functional type represented by rational beliefs about emotions and acceptance-focused beliefs about emotions. These two general types are considered to have different consequences on the course of emotional response of individuals. In Study 3, we found that endorsing irrational beliefs about emotions has a detrimental effect on the emotional response by contributing to the experience of more negative meta-emotions and to lower perceived emotional control during an emotional film. Our study also demonstrated the adaptive role of endorsing rational beliefs about emotions and acceptance-focused beliefs about emotions in decreasing negative emotions, especially after a recovery period for the acceptance-focused approach. Taken together, this study highlights that how individuals evaluate their emotions has consequences for emotional functioning and the nature of these

consequences (helpful or harmful) depend of the nature of the evaluations/beliefs about emotions endorsed (functional vs. dysfunctional). On the conceptual level, as far as we know, this is the first study that experimentally demonstrated the differential effects of these two different types of NRTE (functional vs. dysfunctional) on various outcomes.

Finally, on a more practical note, all these three studies suggest that clinical interventions may benefit from assessing and targeting these beliefs about emotions. Specifically, instructing individuals to shift from a dysfunctional/irrational approach towards their emotions to a rational/functional approach (by helping them to identify and test the accuracy of their beliefs about emotions) or shift to an accepting approach (by helping them to observe, accept nonjudgmentally and remain in contact with their emotions) might further improve emotional functioning and regulation in individuals with ED, as well as in healthy individuals.

The **second objective** of our research was to investigate all three ER components in relation to individuals' emotional functioning and psychopathology (ED and insomnia) in several forms: cumulatively, comparatively, and interactively. With respect to the cumulative examination, our studies showed the important role of all three ER abilities in predicting the emotional outcome in individuals. In study 4, we showed that deficits in all three ER abilities concurrently predicted the emotional responses of children and adolescents facing a stressful task, specifically an increased level of state anxiety and a decreased level of positive emotions. In Study 5, all ER deficits examined concurrently explained the increased level of depressive symptoms experienced by individuals with probable insomnia disorder. Finally, in Study 6, our results highlighted the important role of all ER difficulties showing that the effect of insomnia due to stress on brain reactivity (when processing emotional information) disappears when controlling for overall ER difficulties. In other words, overall ER difficulties may explain the increased emotional response showed by individuals (even at brain level) when confronted with sleep difficulties due to stress. Therefore, all these findings point towards the cumulative effect of ER abilities in predicting individuals' emotional functioning and suggest that interventions should consider to target all these three ER abilities in order to improve individuals' emotional functioning. However, there are some instances when particular ER abilities may play a more central role than others in relation to the emotional outcomes.

Consequently, we next focused our research on clarifying which ER components are more informative, and which are less informative (i.e., comparative approach). In Study 4, our results showed that out of all ER abilities investigated, only poor emotional control was a significant predictor of an increased level of state anxiety in children and adolescent facing a stressful task. In addition, with respect to lower levels of positive emotions experienced during the stressful task only poor emotional awareness was a significant predictor. In other words, it seems that particular ER abilities might predict specific facets of the emotional response. Further, in Study 5, our results revealed that out of all ER abilities investigated, only difficulties in emotional clarity, in emotional control, and in goal-directed behaviors when distressed were further associated with the experience of depressive symptoms in individuals with probable insomnia disorder. Therefore, current results suggest that particular ER abilities are more informative than others with respect to individuals' emotional functioning and psychopathology. When such specificity exists, intervention efforts should consider targeting these particular ER abilities that are impaired and further improve overall emotional functioning. In brief, current research adds to the existing research by highlighting the important role of poor emotional control in relation to the experience of more negative emotions, and poor emotional awareness in relation to less positive emotions. However, current results

should be regarded as preliminary and future research is needed to provide convergent evidence of such specificity of ER difficulties.

Finally, with respect to the interactive examination of ER abilities, our studies focused on two ER components, namely NRTE and emotional control. The examination of the complex interactions among various ER components has been scarce, and little is known about the processes by which individuals with psychopathology or healthy individuals develop rigid patterns of dysregulation. Therefore, in Study 2 we showed that endorsing a specific type of NRTE (i.e., irrational beliefs about emotions) was associated with the experience of a poor emotional control for individuals with ED. To our knowledge, this is the first study to show that individuals with ED report more difficulties on how they appraise their emotions which further relates to a poor emotional control. Also, in Study 3, we experimentally demonstrated that endorsing irrational beliefs about emotions (vs. endorsing rational beliefs about emotions) leads to a poor emotional control in healthy individuals. To our knowledge this is also the first study to experimentally show that endorsing a dysfunctional type of NRTE contributes to problems in the emotional control component.

Taken together, at a conceptual level, these results provide a preliminary insight on how ER abilities contribute to the clinical outcome, either cumulatively, comparatively, or interactively. In this regard, out study showed mainly that: (a) the cumulative effect of ER components is relevant for individuals' emotional responses (either positive or negative), (b) that out of all ER components investigated, emotional control seems to be the most predictive component of individuals' emotional functioning and psychopathology, and (c) an increased NRTE is significantly related to a poor emotional control, which eventually could contribute to the clinical outcome. At a practical level, these results could inform intervention efforts to target either overall ER difficulties, either specific ER deficits that might be more relevant in a given context or a specific ER deficit that contributes to another ER deficit which ultimately affects individuals' emotional functioning. This second objective aimed at theoretical innovations by elucidating the complex interrelations between various ER components, as well as at practical implications.

4.2. Methodological Innovations

The **third objective** of our research was to study these ER components in relation to individuals' emotional responses and psychopathology using a more *granular approach*, represented by the use of samples of individuals across the *normality-pathology continuum*, the use of *multiple levels of analysis* when assessing emotional responses, the use of both *state and trait measures* of ER components, and the use of emotion induction procedures that fall on a continuum ranging from *low to high levels of ecological validity*.

4.3. General Conclusions

Several important conclusions can be drawn from our endeavor to approach the construct of ER, more specifically the secondary, strategic controlled processes (meta-processes) in relation to individuals' problematic emotions and psychopathology. These conclusions are:

1. NRTE represents a *transdiagnostic factor* that is significantly associated with multiple ED and with a poor emotional response experienced by individuals in emotionally salient situations.
2. Individuals with an ED report more irrational beliefs about emotions (i.e., a *dysfunctional type of NRTE*) in comparison with healthy individuals, which are further associated with

the experience of a poor emotional response (i.e., more negative meta-emotions) and poor emotional control in an emotional situation. Also, healthy individuals report more rational beliefs about emotions (i.e., a *functional type of NRTE*) in comparison with individuals diagnosed with an ED. Thus, it seems that individuals with ED (vs. healthy individuals) have specific difficulties in how they appraise their negative emotions, which further expose them to maladjustment.

3. Endorsing irrational beliefs about emotions in an emotional situation leads to a poor emotional response (i.e., more negative meta-emotions) and poor emotional control in healthy individuals. In comparison, endorsing rational beliefs about emotions leads to a more effective emotional response (i.e., less negative emotions) and more effective emotional control. Approaching emotions with acceptance-focused beliefs leads also to a more effective emotional response after a recovery period. Thus, the nature of the NRTE endorsed (*functional vs. dysfunctional*) has different consequences on the course of emotional responses and regulation of emotions of individuals.
4. All three ER components (emotional awareness, NRTE represented by anxiety sensitivity, emotional control) are significantly associated with the subjective emotional response (i.e., state anxiety and positive emotions) experienced by children and adolescents during a stressful situation (i.e., impromptu speech task). Emotional awareness and emotional control are also significant predictors of greater state anxiety and lower positive emotions occurred in this situation. Thus, it seems that difficulties in emotional awareness and emotional control predict the subjective emotional response experienced by youths during a stressful situation.
5. Difficulties in ER components are more severe in individuals with probable insomnia disorder (vs. good sleepers), which further explain the experiences of depressive symptoms in these individuals. Thus, it seems that ER difficulties represent a specific risk factor for further emotional maladjustment in the face of poor sleep.
6. Difficulties in ER components explain the increased brain reactivity endorsed by individuals with sleep difficulties due to stress when exposed to an emotional processing task (i.e., presentation of emotional faces). It seems that ER difficulties represent a specific risk factor for increased emotional reactivity (even at brain level) for individuals affected by sleep difficulties due to stress.

Overall, all these conclusions suggest the importance of difficulties in these secondary, strategic controlled processes in contributing to problematic emotions and psychopathology in individuals.

4.4. Limitations and Future Directions

Despite the important theoretical and clinical contributions of the current research thesis, there are several limitations that need to be considered in interpreting the results. In the following, we address some general limitations inherent to most of our studies. In addition, we further suggest some important future directions.

One of the most important general limitation of the current thesis is related to the sample representativeness. In our studies, the samples used consisted of individuals of limited age range, mostly undergraduate students, overwhelmingly females and entirely Caucasian. Thus, the generalizability of our findings are limited. We highlight that future studies should replicate current findings in more heterogeneous samples of individuals.

Another general limitation is represented by the cross-sectional nature of most of our studies which prevented us to draw any conclusions about causality. Moreover, the cross-sectional nature of the studies also prevented us to clearly specify the directionality and temporality of the associations between investigated variables. To address this limitation, future studies should experimentally manipulate individual's ER abilities and further investigate their effects on individual's emotional functioning and psychopathology. Also, longitudinal designs should be used to prospectively predict how changes in individual's ER abilities relate to changes in individuals' emotional functioning and psychopathology.

Finally, there are some notable methodological limitations to our studies that are worth mentioning. First, even though in our studies we investigated the interaction between ER components in relation to emotional outcomes we used only basic data analysis procedures (i.e., regression analysis). Thus, to elucidate the interactions between various ER components in relation to various outcomes, more advanced data analysis procedures, such as structural equation modeling (SEM) (i.e., path analysis) are needed. Second, whilst we assessed ER components as a state in the context of a well-controlled laboratory environment, more advanced methods of momentary assessments in real-life are needed to better tap ER as state. A specific method that could be used is the ecological momentary assessment (EMA) method (Shiffman, Stone, & Hufford, 2008), which involves the repeated sampling of individuals' current experiences (e.g., emotional, cognitive) in real time, in individuals' natural environments.

Despite these limitations, the findings of this research thesis provide novel information about maladaptive ER processes – examined in various forms – as a specific pathway to the experience of problematic emotions and psychopathology in various samples of individuals navigating diverse contexts. In conclusion, our thesis suggests that difficulties in the secondary, strategic controlled ER processes, namely emotional awareness, NRTE, and emotional control represent important factors related to individuals' emotional functioning and psychopathology and clinical interventions that focus on guiding clients/patients to develop these ER abilities may be effective in improving overall emotional functioning and emotional well-being. Thus, interventions such as Emotion Regulation Therapy [ERT], Dialectical Behavior Therapy [DBT], Mindfulness-Based Cognitive Therapy [MBCT]) and other similar interventions could be considered as an effective adjunct to CBT in the treatment of ED, insomnia and the associated emotional difficulties, as well as in improving individuals' emotional functioning.

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